Gaming for Graduates: Exploring the use of video games to develop graduate attributes

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Abstract

This work examines the effects of playing commercial video games on the development of the student abilities referred to as 'graduate attributes'. Graduate attributes are those generic skills such as critical thinking, communication, resourcefulness or adaptability which are considered desirable in graduates, particularly where employability is concerned. However, most Higher Education courses have not hitherto been explicitly designed to teach or develop these attributes. Many commercial video games, on the other hand, require players to exercise a range of such skills and competences in order to progress; for example, communicating with fellow players in order to succeed in a team-based multiplayer title. Despite suggestions from scholars including James Paul Gee, Kurt Squire, and John Seely Brown that games may be of educational and developmental benefit to players, there exists little empirical evidence for the efficacy of using commercial video games to develop these skills. The work described here addresses this lack of evidence and proposes a positive correlation between the development of specific skills and the playing of video games in a university environment.

Three distinct studies are described: a small pilot study, the main experimental study, and a large cross-sectional survey. The pilot study indicated that of the attributes identified by the host institution, effective communication, adaptability, and resourcefulness were the most promising candidates for further study. The pilot was also used to identify instruments suitable for the measurement of these attributes.

For the main experimental study, undergraduate students in the first and second of four years in the College of Arts were randomly assigned to either an intervention ($N = 16$) or a control group ($N = 20$). Previously validated survey-based instruments designed to measure adaptability, resourcefulness, and communication skill were administered to both groups at the beginning and at the end of the eight-week study, over the course of which the intervention group played specified video games under controlled conditions. A large effect size was observed, with mean score change 1.1, 1.15, and 0.9 standard deviations more positive in the intervention group than the control on communication, adaptability, and resourcefulness scales respectively ($p = 0.004$, $p = 0.002$, and $p = 0.013$ for differences in groups by unpaired t-test). A second communication measure revealed generally positive score changes for the intervention group, but the difference between control and intervention was not statistically significant.

The large effect size and statistical significance of these results supported the hypothesis that playing video games can improve self-reported graduate skills. Qualitative analysis of post-

intervention interviews with study participants further supported the hypothesis, and offers insight into how students perceive the potential benefits of playing video games in a university context. Interview data revealed that, in particular, students see value in exercising the communication, collaboration, and problem solving skills that are required to succeed in a commercial video game. It was also found that participants valued the opportunity to relieve stress afforded by playing video games on campus, and that playing games also allowed for players to consider wider ethical, social, and cultural issues.

A large (N = 2145) survey of students' existing game play habits and attribute attainment was also conducted in order to gain insight into how the results of the laboratory-based study compared to the student population in general. The survey revealed that the effects on graduate attribute attainment observed in the experimental study were not observable in relation to existing game play habits. Indeed, non-players were often found to score best on self-report measures of graduate skills. While no causal relationship can be inferred from these survey data, it appears likely that the most effective means by which games can be used to develop such skills at university level is to deploy them in a formal learning environment, such as that described here. Furthermore, the survey revealed that the skills gained by undergraduates over their four-year degree were relatively slight, compared to the gains measured over the course of the eight-week game-based intervention.

This study suggests that a game-based intervention of the type described here can be effective in developing certain graduate attributes, and indicates that such attributes may be developed in a relatively short space of time, contrary to the tacit assumption that they can only be acquired slowly over an entire degree programme.

Dedication

For Eva & Suzanne.

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Terminology

The term '**video game**', has been used throughout this work. This was chosen over 'computer games', or some of the more prosaic terminology for this particular form of digital entertainment, for much the same reason outlined by Tristan Donovan in his book, *Replay: The History of Video Games* (2010). As Donovan points out, the earliest such games, including *Pong*, did not make use of a computer: no microchips were used in their construction. Also, I favour the inclusiveness of the term 'video game', as 'computer games' can often be associated more closely with gaming on a PC, to the exclusion of console-based gaming.

Abbreviations

CAS	Communicative Adaptability Scale
Civ	*Civilization*
COTS	Commercial Off-the-Shelf
DRM	Digital Rights Management
FPS	First Person Shooter
GBL	Game-Based Learning
HE	Higher Education
I-ADAPT-M	Measure of adaptability based on the I-ADAPT construct
LAN	Local area network
MOBA	Multiplayer Online Battle Arena
Mod	User-modified version of a game or level
MUD	Multi-User Dungeon
MMORPG	Massively Multiplayer Online Role-playing Game
NPC	Non-player Character
PBL	Problem-based Learning
PC	Personal Computer *or* Player Character
PS3	PlayStation 3
PSN	PlayStation Network
RPG	Role-playing Game
RTS	Real-time Strategy
SJT	Situational Judgement Test
SPCCS/SCCS	Self-Perceived Communication Competence Scale
UKIE	Association of UK Interactive Entertainment
WoW	*World of Warcraft*

1. Introduction

1.1 Background

Over the last three decades, video gaming has evolved from a niche pursuit enjoyed by a small minority of (largely male) young enthusiasts, into a pervasive and culturally significant aspect of everyday life. According to the Interactive Software Federation of Europe (IFSE), 32% of all adults in the UK describe themselves as 'gamers' (34% of men, 31% of women), while one child in two plays games every day (ISFE, 2010). As an industry, games generate as much revenue as – or more than – the film or music business, with blockbuster releases such as 2011's Call of Duty: Modern Warfare 3 out-grossing the last four Harry Potter films combined (GFK Chart-Track, 2011). The average age of a gamer is estimated to be somewhere in the mid-thirties, with the US-based Entertainment Software Association (ESA) placing the current figure as high as 37 (ESA, 2011) – a figure which must surely rise with an ever-aging population. In the UK, The Telegraph reported in July 2013 that "the typical video game player is 35, has one child and earns more than £23,000 a year", based on a survey of 2000 self-identified video game players carried out on behalf of the video games social network Pixwoo.com (Goldhill, 2013).

Every article or thesis on video games and learning seems to open with a paragraph of facts and figures that are intended to underline the significance of video games, regardless of whether the medium's ubiquity is related to the thesis of the work. This *de facto* requirement may be rooted in a general lack of confidence that research involving video games will be taken seriously. However, given games' ubiquity, and the existence of a generation of gamers now in their thirties and forties, for whom video games have long represented a significant pastime, ethical and social questions naturally arise about the effects of gaming on the population. Furthermore, for the purposes of this work, it is important to establish that the commercial games used in the study are already played by a large proportion of the population, which could have implications for any findings.

The alleged ill-effects of video games – with particular reference to children and violence – are well publicised (e.g. Gentile *et al*., 2004), and have been the subject of much consideration[1] but there exists a body of literature that suggests video games can be a force for good in peoples' lives. Authors such as McGonigal (2011) and Johnson (2005a), argue vociferously for

[1] Including the UK government-commissioned Byron Review, whose 'Safer Children in a Digital World' report (2008) looked at the potentially harmful effects on children of exposure to unsuitable material on the internet and in video games.

the beneficial effects of gaming, claiming that good video games provide clues for how to improve our 'real' lives. Aside from the obvious pleasure afforded by gaming, games have been used in a variety of other contexts, for example, to aid rehabilitation of stroke victims (Merians *et al*., 2011), to increase quality of life in the elderly (Basak *et al*., 2008) and to help young people cope with their cancer treatment (Lee, 2006). Granic, Lobel, & Engels (2014) offer an overview of the cognitive, social, and emotional benefits that games have been shown to produce, and suggest that games offer untapped potential for mental health care. Many of these titles might be described as 'serious games', a term often used to describe games developed for non-entertainment purposes (the phrase was most likely coined by Clark C. Abt in his 1970 book of the same name, albeit in relation to traditional board games). The learning potential of games has already received considerable academic attention, as has the design and development of bespoke educational titles, which also fall under the purview of 'serious games'. Researchers including Squire (2003), Jenkins (2006), and Gee (2008b) have been particularly influential in establishing the pedagogical value of video games, and it is on their work that those who follow must build.

However, with some notable exceptions, such as the work of Kurt Squire with the *Civilization* games (2004) and that of Egenfeldt-Nielsen (2005), the potential to learn from commercially released games – those designed to entertain, rather than educate – has not been explored to its full potential. In addition, much of the existing research has pertained to school-age children using video games in, or alongside, their regular classes. While this is valuable, this work will focus on the current generation of Higher Education students – young adults for whom video games are an accepted part of everyday life, even if not everyone chooses to play them. The extent to which these games have educated or otherwise influenced adult players without their explicit knowledge is an area that remains largely unexplored. While it would be of great interest to chart the development of players' skills and attitudes over decades of game play, it is clearly beyond the scope of this work. Furthermore, the alternative approach – to query current students' past gaming habits and attempt to find some correlation between their contemporary skills or attitudes and the games they once played – would result in retrospective, anecdotal data of dubious veracity. Thus, the approach taken to this work will be largely experimental in nature, examining the effects of commercial video games on university students over a shorter period.

While learning might take the form of knowledge acquisition, of greater interest here is the claim that video games have helped develop certain skills and generic attributes in those who play them. The work is situated within the broad context of game-based learning, and thus requires an understanding of the existing research on this topic, including the use of educational games and the application of commercially available titles in educational settings. It also requires an appreciation of the existing pedagogical theory that will underpin learning from video games – even if such learning is incidental.

1.2 Research Questions

This work initially sought to address a number of questions broadly associated with the idea of incidental learning from video games. Ultimately, the research focused on the potential for games to help develop desirable skills and competencies at university level.

As the work was refined, and the concept of graduate attributes (see 2.1.1 below) was identified as encapsulating the skills relevant to Higher Education students, the primary research question could be more precisely stated as follows:

- Is playing selected commercial video games associated with measurable gains in the desirable skills known as graduate attributes?

Secondary research questions may be expressed as follows:

- Are players aware of, and do they reflect on or value, the skills developed through video game play?
- Might commercial games be used more extensively in Higher Education to develop graduate attributes?

2. The Current State of Play: A Review of the Literature

The learning potential of computer and video games has been much discussed in the literature, as has the design and development of bespoke educational titles, which typically fall within the purview of 'serious games'. Researchers including Gee (2003/2007) and Jenkins (2009) have been particularly vocal in arguing for the pedagogical value of video games. However, with some notable exceptions, such as the work of Kurt Squire with the *Civilization* games (2004), Derek Robertson (Robertson & Miller, 2009) and Simon Egenfeldt-Nielsen (2005), the potential to learn from commercially released games — those designed to entertain, rather than educate — has not been fully explored. In addition, much of the existing research has pertained to school-age children using video games in, or alongside, their regular classes. Perhaps this is to be expected: it is widely accepted that humans and other animals learn through play, and structured play forms an important part of primary-level education (Bruce, 1987; Moyles, 1989). If video games, which many incorrectly assume are played for the most part by children, are simply toys with educational potential then it follows that much of the initial work in this area has concerned minors.

In *Video Games and Learning* (2011, p. 5), Squire suggests that we can learn 'academic' content through games, including the in-game terminology, a range of strategies, and "the emergent properties of the game as a system". That video games can help develop systemic understanding – analysing the game world, as opposed to simply learning facts – is an idea echoed by James Paul Gee (2005b, p. 82), who states that what gamers learn is "empathy for a complex system" (discussed in more detail below). Both Squire and Gee note that the best-designed games typically comprise a series of coinciding or intersecting goals, with short-, medium- and long-term conclusions. They suggest that this arrangement of goals, which permits the student to progress on a number of fronts simultaneously — even when one goal is seemingly out of reach — has significant advantages for student engagement because those struggling with one task can choose to make headway on another, rather than disengaging altogether. Such overlapping goals are familiar to anyone who has played Bioware's *Star Wars: Knights of the Old Republic*, Blizzard's *World of Warcraft*, or the later *Grand Theft Auto* games from Rockstar. However, they are perhaps more difficult to implement in a structured, often didactic, educational environment such as a school or university, where curricula may not offer the flexibility to allow different students to be working on many different problems at the same time. At most stages in our education we do take a mixture of subjects, but there is little latitude for individual students within a class to simultaneously study completely unrelated topics.

This chapter aims to provide an overview of current research in the field of video games and learning, drawing on established key texts and more recent papers. It will begin with an overview of some of the most relevant educational and learning theory. Moving on to games, the chapter will look at games developed specifically for educational purposes, then go on to examine some of the characteristics of games that make them suitable for education, and discuss the learning potential in commercial video games.

2.1 Taxonomies of learning

An area of learning theory that might be considered to sit apart from much of the larger body is that concerned with how learning is measured or quantified and, ultimately, assessed. Course learning objectives (or aims) and intended learning outcomes are terms familiar to most 21st century educators and are most often closely coupled to the material being taught. More generally applicable taxonomies of learning may be used to describe pedagogical attainment in a wide variety of educational settings. Bloom's Taxonomy (Bloom *et al.*, 1956) – perhaps the most widely cited such classification – comprises three domains: cognitive (related to knowledge), affective (attitudes and values) and psychomotor (skills), originally conceived as a means of making assessment more systematic (Draper, 2005). The first of these domains – cognitive – is by far the most widely cited in the educational literature, although Bloom never actually completed the psychomotor domain. Bloom's affective domain model (Bloom *et al.*, 1956), while less frequently cited and perhaps less readily understood, is also relevant to learning from video games, and is discussed briefly below.

While Bloom's model of the cognitive domain is concerned primarily with knowledge, the ability to recall or recite knowledge is merely the first level in the hierarchy. From this starting point, the learner may move on to comprehend (make inferences from, or reconstruct) acquired knowledge and ultimately be able to apply it in scenarios other than those in which the material was originally presented. Beyond this point, they begin to analyse and organise information, synthesise and reorganise it and, ultimately, evaluate and critique what they know.

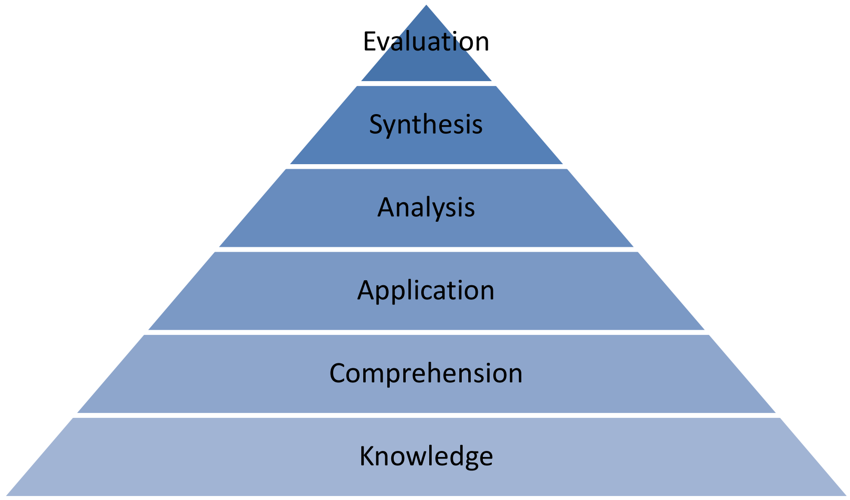

Figure 1: Bloom's Taxonomy – Cognitive Domain (adapted from Bloom *et al.*, 1956)

Bloom's mapping of the affective domain (Bloom *et al*., 1956) deals with what the authors refer to as "values", or emotional responses and attitudes. It starts at the lowest level, 'Receiving', wherein the learner is no more than aware of the issues being put forward or the phenomena experienced. As the learner moves up the hierarchy through 'Responding' and 'Valuing', they become better able to place a value on the issues at hand and begin to categorise and group these values into a system. In gaming terms, the affective model seems to correspond best with social aspects of multiplayer games, wherein players become more adept at playing in teams and prioritising interactions with other players as they ascend the hierarchy. Aside from their engagement with other players, the affective domain might also be used to describe how players deal with the issues presented by more complex games' content.

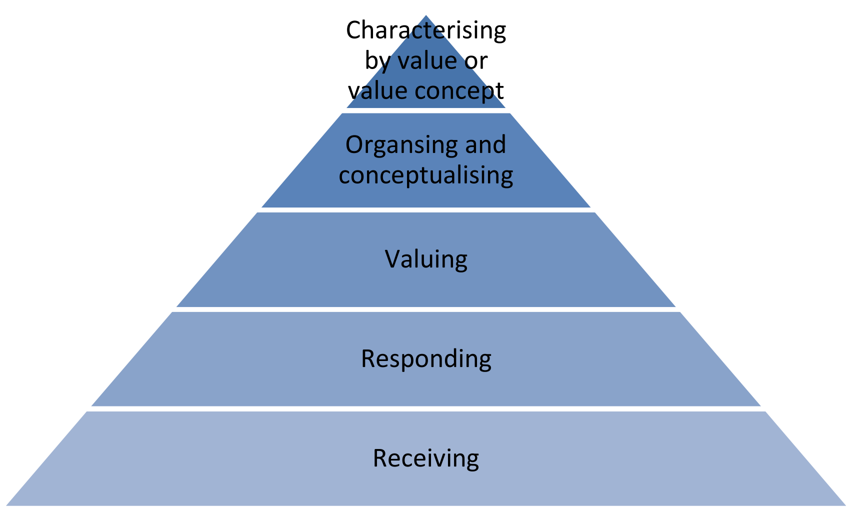

Figure 2: Bloom's Taxonomy – Affective Domain (adapted from Bloom *et al.*, 1956)

Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths and Wittrock (2001) updated Bloom's model of the cognitive domain to place greater emphasis on the creation of new knowledge (see figure below). In addition to the six levels of cognitive process, Anderson *et al*. introduced an additional dimension in the form of four types of cognitive process (factual, conceptual, procedural, and metacognitive). While it is not always presented as a hierarchy, the taxonomy suggested by Anderson *et al*. can be mapped to the Bloom hierarchy on which it is based, with 'Creating' replacing 'Evaluation' at its pinnacle. Aside from this change in emphasis, and the addition of a 'types' dimension, the most significant difference between the two taxonomies is perhaps the shift to using verbs to describe each of the levels. Bloom's 'Application' has, for example, become 'Applying'. This emphasis on action seems to suggest that the later taxonomy aligns more closely with constructivist theories of learning and thus more readily applied to learning from video games.

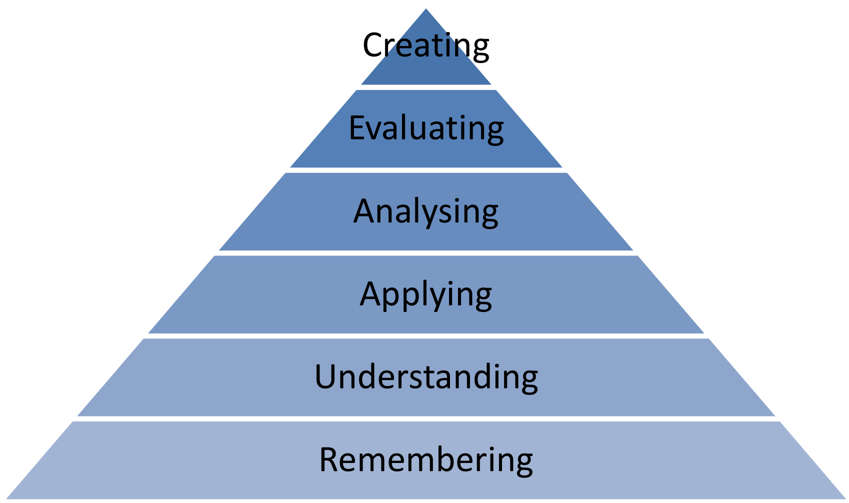

Figure 3: Anderson and Krathwohl's revision of Bloom's Taxonomy (adapted from Anderson *et al*., 2001)

One might express Anderson & Krathwohl's taxonomy in terms of engagement with video games as follows, beginning with the lowest level:

Level	Application
Remembering	Recall of control scheme and basic premise, setting and genre.
Understanding	Comprehension of game mechanics and required player interactions.
Applying	Ability to play the game and to progress.
Analysing	Recognition of patterns in enemy or NPC (non-player character) behaviour. Self-determination of appropriate goals.

Evaluating	Identifying flaws (such as bias or imbalance) in the game. Comparing the game with others in the same genre.
Creating	Writing about the game (reviews or guides to playing the game). Building new levels or mods.

While such a taxonomy of learning was not intended to describe a player's engagement with a game, it is clear that playing video games involves some sort of progression from understanding to application and, for some players, on to evaluation and creation. When such a learning taxonomy is applied to games in this way, a hierarchy of a particular form is suggested. One cannot get to the point of actually playing the game until one has reached the third level of cognition and, perhaps less surprisingly, it seems likely that a relatively small proportion of players will ever attain the top two levels, meaning the majority of those who play must sit in the middle of the hierarchy. Further, the application of the taxonomy above focuses on what the player learns about the game itself, not what they can learn from the game that might be applicable elsewhere. However, the further up the taxonomy the player moves, the more widely applicable their learning becomes. Being able to recall which buttons to press in a particular game is of no utility in a wider context, but as the player moves towards the top of the hierarchy, they begin to develop analytical and critical skills that might conceivably become relevant in other situations. Certainly, by the time a player is writing about a game, or modifying it in some way, they are honing transferable skills.

2.1.1 Graduate Attributes

Also referred to as 'generic attributes', graduate attributes – as the University of Glasgow and many other institutions designate them – are another way of identifying and, to some degree, quantifying the skills and competencies that students are said to develop in Higher Education, over-and-above those that relate directly to their degree subject. Nicol (2010) offers the following definition of the term: "…the skills, personal qualities, and understanding to be developed through the Higher Education experience so as to prepare graduates for life and work in the 21st century".

Graduate attributes are commonly aligned with the notion of the 'life-long learner' (Candy, Crebert & O'Leary, 1994): these are skills and capabilities developed over time, from childhood onwards. In formal education, particularly at university level, generic attributes such as critical thinking, problem solving, and the ability to self-organise, are highlighted as skills that enhance graduates' employability. If studying for a degree can help develop these skills, so the argument goes, then graduates will be better placed to deploy and develop them in the workplace.

The Candy *et al.* (1994) report for the Australian government identified the following characteristics of a life-long learner:

An inquiring mind

- a love of learning;
- a sense of curiosity and question asking;
- a critical spirit;
- comprehension-monitoring and self-evaluation;

Helicopter vision

- a sense of the interconnectedness of fields;
- an awareness of how knowledge is created in at least one field of study, and an
- understanding of the methodological and substantive limitations of that field;
- breadth of vision;

Information literacy

- knowledge of major current resources available in at least one field of study;
- ability to frame researchable questions in at least one field of study;
- ability to locate, evaluate, manage and use information in a range of contexts;
- ability to retrieve information using a variety of media;
- ability to decode information in a variety of forms: written, statistical, graphs, charts, diagrams and tables;
- critical evaluation of information;

A sense of personal agency

- a positive concept of oneself as capable and autonomous;
- self-organisation skills (time management, goal-setting etc.);

A repertoire of learning skills

- knowledge of one's own strengths, weaknesses and preferred learning style;
- range of strategies for learning in whatever context one finds oneself; and

- an understanding of the differences between surface and deep level learning.

As noted by Hager & Holland (2006), these characteristics are “heavily reliant on a range of generic attributes” and, indeed, this report seems to have exerted some influence on the subsequent development of graduate attributes, particularly in Australia and the UK. It is perhaps worth noting that many of these characteristics of life-long learning are to be found in the ‘best’ video game players, too. In particular, where information literacy (decoding information, using information from a variety of media) and personal agency (the sense of self-efficacy that games can provide, and the requirement that players manage their own goals and in-game resources) are concerned.

Moy (1999), describing what she terms the “key competencies journey”, suggests that generic attributes are most readily developed through “active and interactive learning”, placing emphasis on problem-solving and reflection so that “learners reflect on what has been learnt and the learning processes, as a critical aspect of competency development, self-awareness and the development of lifelong learning skills”. Moy also suggests that, in order to support the development of such generic competencies, learning tasks should be relevant and meaningful to learners. There is another parallel with the inherently interactive video game medium here, as those who play games most avidly will attest to their relevance and meaning.

The question of whether university courses are explicitly designed to develop generic attributes is perhaps not satisfactorily answered in the literature, despite what universities and other institutions might claim. Arguably the leading researcher in the field, Barrie (2004), noted that “university teachers charged with responsibility for developing students' generic graduate attributes do not share a common understanding of either the nature of these outcomes, or the teaching and learning processes that might facilitate the development of these outcomes.” Therefore, despite institutional best intentions, it may be the case that the lack of a shared understanding of graduate attributes, and how to cultivate them, is one barrier to their development in Higher Education. Similarly, Green, Hammer and Star (2009) note that graduate attributes can be difficult to develop due to the confusion that surrounds their definition and implementation, a problem exacerbated by institutional resistance and under-estimation of the resources required to embed related practices.

Ten years earlier, and using the term ‘personal transferable skills’ (PTS) rather than ‘graduate attributes’, Drummond, Nixon and Wiltshire (1998) identified a variety of further problems associated with embedding such practice in Higher Education, despite some considerable investment in PTS initiatives. They note that "effective skills development is difficult, if not impossible, to achieve in a system of teaching which is fundamentally based on lectures". They identified a lack of incentive for academics – for whom promotion and, indeed, continued employment, is dependent on research outputs and successful funding applications – to engage with new teaching practices, particularly where the teaching does not relate directly to the work on which their research career is based. The image Drummond *et al.* project is of small pockets of good work rather than institution-wide efforts, concluding that "isolated, *ad hoc* initiatives do not amount to effective approaches to development". Given the challenges associated with integrating graduate attribute development in research-driven curricula, a task which Drummond *et al*. describe as being "difficult to operationalise effectively", another approach they identify is that of a stand-alone module or course:

> *Parallel (or stand-alone) development involves skills being developed in freestanding modules, which are not integrated into the curriculum. Some universities have accredited such schemes, e.g. student tutoring and student development programmes. Students generally do not appreciate the academic value of standalone modules. There are advantages to this approach though – not least in that the value of skills development is made explicit, and in a modular framework it allows students to involve themselves in a more varied learning experience.*

Stand-alone courses bring with them resourcing issues and, as Green *et al.* (2009) note, there is evidence of "polarised student responses" to such additions to the curriculum. In an ideal situation, the development of graduate attributes, perhaps, should be embedded in university courses but there are undoubtedly challenges associated with doing so, particularly if the aim is to achieve parity across disciplines. Arguably, if video games are already capable of developing similar attributes in players, they can be used to facilitate relatively low-cost, student-centred graduate attribute 'courses'.

However, despite the issues associated with embedding graduate attribute development, de Corte (1996) argues that the best learning environments exhibit many features that relate directly to the development of generic attributes – features that Higher Education institutions can, and in many cases do, encourage. According to de Corte, such environments should, for example, provide a "good balance between discovery learning and personal exploration, on the one hand, and systematic instruction and guidance, on the other" while "allowing for the flexible adaptation of the instructional support to accommodate individual differences and stages of learning" and for "social interaction and collaboration". Not for the first time, the language used to describe an optimal learning scenario is directly relatable to the design of the best video games, many of which rely on just this sort of balanced approach to learning by exploration and systematic guidance to lead players of differing experience and ability through the game. Social and collaborative aspects of learning theory (and games) – aspects which are reflected in many institutions' purported graduate attributes – are discussed in more detail below, but it seems clear that there is an argument to be made in favour of using video games as a means of helping to develop graduate attributes.

A further issue to consider is that of the usefulness of the term "graduate attributes" (especially when applied across multiple subjects or disciplines), or, indeed, the value of the notion that such attributes exist, or are important, or are inextricably linked to Higher Education. The definition of a term such as 'graduate attributes' can be somewhat ambiguous, and prone to change over time. Haigh and Clifford (2011), for example, state that graduate attributes might be at the heart of what they perceive as a necessary shift to "focus on an agenda of personal responsibility, on individual and social interior attributes and to move away from its present focus on exterior systems". In other words, a shift towards attributes that relate to graduates' moral and social consciousness rather than skills that appeal to employers. Nicol (2010), on the other hand, suggests "critical evaluative experience" may foster the development of a range of different attributes, suggesting that critical thinking underpins much of what is currently considered to fall under the banner of graduate attributes and is thus worthy of particular attention.

The potential link between video games and employability is now being explored commercially with a start-up company, Knack[2], using specifically designed games to identify and recruit players with strong leadership and problem-solving skills (Hodson, 2015). The company has also patented the idea that their player-profiling technology could be incorporated into existing commercial video games, which, as noted previously, often require the player to demonstrate such skills in order to succeed.

2.2 Theories of learning

This section provides an overview of the educational theories that are most relevant to learning from video games, formally and informally. It draws on theories of education (that is, how pedagogic content is delivered or otherwise received, or the practice of teaching), which

[2] https://www.knack.it/ (accessed 29 June, 2015)

seem more prevalent in earlier works, and on theories of learning (how pedagogic content is understood, or how we learn), which gain greater prominence in later literature.

Initially, it seemed helpful to divide the literature into two broad categories: instructivist and constructivist. The instructivist model presents learning as the acquisition of knowledge and is probably the form of learning – or, at least, of teaching – that anyone who has been to school, college or university has experienced most often. It is typified by the didactic image of the teacher or lecturer at the front of the class, transmitting knowledge to their students. From Pavlov's behavioural conditioning (extrapolated to great effect in Aldous Huxley's 1932 novel, *Brave New World*) to Skinner's ideas about self-instruction and reinforcement (Holland & Skinner, 1961) through to work that followed (see Carroll, 1969; Carroll, 1989; Merrill, 2002), there is seemingly no great, unifying theory of instruction. Perhaps what binds together these ideas is their pervasiveness and the fact that – where formal education is concerned, at least – the instructivist approach dominates.

There are certainly those who have written extensively about models of instruction, even if no one name is particularly associated with instructivism. Gagné (1977) identified five main types of learning: verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes. In order to meet his "conditions for learning", Gagné suggested that each of these types must be addressed by a particular form of instruction. These "instructional events" included activities such as informing learners of the objective, providing learning guidance, providing feedback and assessing performance – all elements of instruction familiar from school and beyond. Gagné, together with Briggs (1974/2005), identified a suite of internal (to the learner) and external conditions that need to be met for each type of learning to occur. For example, learning of the type referred to as "cognitive strategies" might require the internal recall of relevant concepts, while the corresponding external condition might be the learner demonstrating a solution based on those concepts. Similarly, motor skills require both an internal memorisation of component chains and external practice to hone those skills. Intellectual skills are treated somewhat differently, as Gagné and Briggs break these skills into subcategories, each with its own type of "performance" – for example, understanding of a rule can be demonstrated by applying that rule. So, while the model of instruction offered by Gagné and Briggs was intended for use in a teacher-learner environment and, as such, is not immediately promising for the apparently more constructivist learning that games may support, there are comparisons to be made if the teacher or learning environment is replaced or supplemented by a video game. Understanding and applying rules, memorising and using motor components (game controls), or applying a solution to an in-game problem based on recall of similar problems and associated strategies are all phenomena familiar to those who play video games. It is striking, perhaps, that most games – certainly the better-designed titles – feature very limited instruction. Many games begin with a tutorial level that introduces the player to the mechanics and goals of the game. However, it is considered jarring, at least by modern game design standards to have the game stop and explain to the player how something works, for example by means of an on-screen message. Skilful writing and design can get round this problem by having, for example, a narrative reason for the player to be told what to do. Often the familiar trope of memory loss is used to justify why a friendly NPC (non-player character) is explaining the workings of aspects of the game world that should be routinely familiar to the player character, for example. From Software's *Dark Souls* series is infamous for providing little or no instruction to the player: aside from a few cryptic messages scattered around the beginning of the games, the player is forced to construct their own understanding of the game world. Other, apparently more simplistic, games such as *Super Mario Bros.* and *Super Meat Boy* use skilful level design to introduce concepts to players, such that they effectively discover them for themselves.

Laurillard (2002b) offers a dialogic model of instruction, termed the "Conversational Framework", which identifies the activities necessary to complete a learning task in a formal education environment. Her model characterises the teaching-learning process as an "iterative conversation". This basic concept, as Laurillard herself notes, is not new: there are echoes of dialogic instruction throughout modern learning theory (e.g. Vygotsky) and the idea dates back to at least to Socrates. Laurillard states that her Conversational Framework is "not normally applicable to learning through experience, nor to 'everyday' learning" (Laurillard, 2002a, p. 87) but in the second edition of *Rethinking University Teaching*, (2002a) the author includes educational video games as a form of adaptive media – alongside virtual environments and simulations – which may be modelled using the Framework. The figure below shows how Laurillard interpreted the Conversational Framework for a geology simulation designed to teach students about rock formations. As an example of adaptive media, not so far removed from a game, this interpretation offers an indication of how the Framework might be applied to an educational game, although, as Laurillard concedes, this simulation-based interpretation is not tremendously discursive.

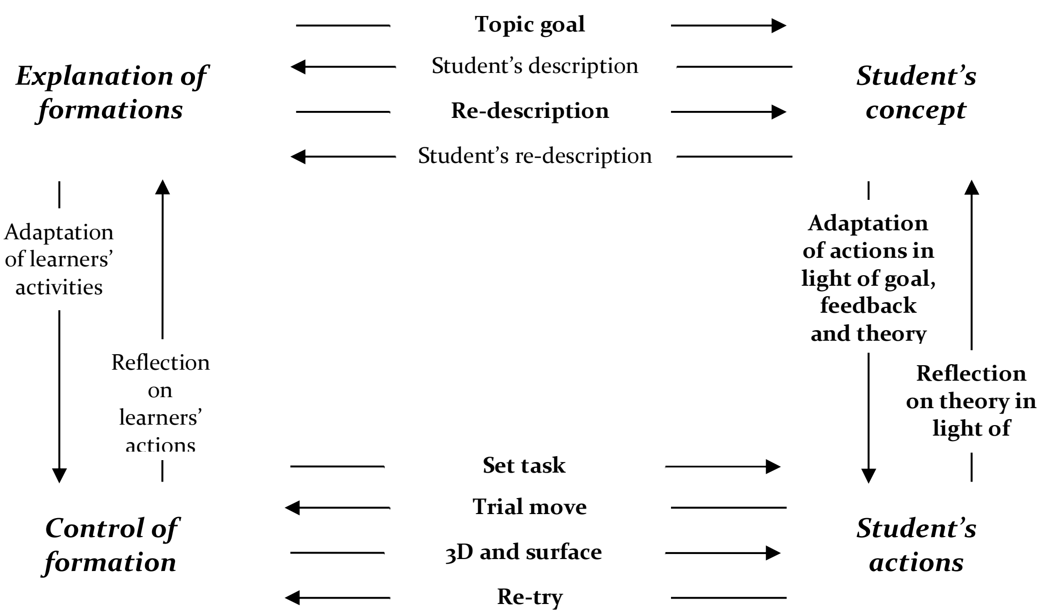

Figure 4: Interpretation of Laurillard's Conversational Framework for a geology simulation (Laurillard, 2002a)

The geology simulation is able to adapt the feedback given to a student based on their activities, but this is limited to the regurgitation of the same canned text that may have introduced the topic. It is tailored to the student's actions, to a degree, but it is not especially dynamic. This is one area in which video games can excel, as commercial titles are already capable of dynamically adjusting game difficulty in response to player performance (Hunicke and Chapman, 2004; Andrade, Ramalho and Santana, 2005). Games can also offer assistance to players after detecting a series of failed attempts to traverse an area (as in the *New Super Mario Bros.* releases from Nintendo).

Laurillard is broadly optimistic about the use of video games in formal education (although her focus is on educational titles rather than commercial games), noting that their strengths include "intrinsic feedback" (Ibid. p. 143), and the "real-time nature of the interaction, because this requires close attention and responsiveness from the user, whether it is a combative game, or an environment that changes over time". Laurillard also notes multiplayer games' potential for use as interactive, social environments, and that goals can be program-defined (i.e. set by the game), or player-defined as in certain open-world titles, or construction simulations. It is worth noting, however, that the first edition of Laurillard's book talked about intelligent tutoring systems (ITSs) with similar expectation. Here she cautions that educational games might be "another chimera", unlikely to live up to their pedagogic potential as a result of market forces – that is, there is very little money in educational games, compared to the multi-million dollar blockbusters that (used to) line the shelves at Woolworths. This is a common concern, and while games backed by the US military (as described in a later section), can match the production values of *Call of Duty* and games of that calibre the more fertile ground for educational titles is perhaps in the web or mobile space, where effective games can be developed on much more modest budgets. The other possibility, of course, is to appropriate existing commercial games for educational purposes (see Squire, 2004; Miller and Robertson, 2011) and harness the big games publishers' budget for pedagogic benefit.

Broadly speaking, the constructivist model suggests that learning should be rather more self-directed, with the learner more actively assembling or constructing knowledge rather than receiving it from the teacher, by completing tasks and thinking for themselves. The teacher is perhaps more of a facilitator whose role is to administer tasks through which the learner may construct their own meaning and, in this sense, constructivism might be considered a more individualistic approach to learning than its instructive counterpart might. Constructivism and related concepts and theories are discussed in more detail below.

However, it became apparent that the convenient classification of the literature into 'instructivist' and 'constructivist' camps was not entirely appropriate. Skinner, for example, also stated that "to acquire behaviour, the student must engage in behaviour" (Holland & Skinner, 1961, p. 389) which sounds rather more like an active process of learning than the passive picture that his broadly instructivist views suggest. Also, while there must be some instructional element to learning from video games (as discussed above), constructivism and its related concepts are, perhaps, more relevant to this thesis. Therefore, devoting equal attention to both schools of thought seemed inappropriate. Herein lies another issue encountered when trying to divide the literature into two crude categories: the term 'constructivism' does not *necessarily* incorporate ideas of 'learning by doing' or 'discovery learning', which seem relevant to games and certainly do not fall within the instructivist purview. Further, constructivism comes in many flavours, a point illustrated by the comparison of Piaget and Papert that follows. There are also learning theories and paradigms that do not readily fall into a single school of thought, and numerous other attempts to group and categorise views on learning.

Mayes & de Freitas (2006), for example, highlight three "perspectives on the nature of learning itself", actually based on the three views of educational design identified by Greeno, Collins & Resnick (1996), which considered each view in terms of designing learning environments, formulating curricula, and constructing assessments. Mayes & de Freitas, as part of an e-learning models desk study, present these three views as follows:

The *associationist/empiricist* perspective (**learning as activity**)

The *cognitive* perspective (**learning as achieving understanding**)

The *situative* perspective (**learning as social practice**)

From the *associationist* perspective, the focus is on "routines of activity for effective transmission of knowledge" (Greeno *et al*., 1996), aligning such views with instructionists such as Gagné. However, the associationist approach is not at odds with constructivism. Clear goals, feedback, and reinforcement are all thought to be advantageous or, as Mayes & de Freitas phrase it, "learning is the formation, strengthening, and adjustment of associations, particularly through the reinforcement of particular connections through feedback". Where this perspective can seem outdated is in its assumption that learning must take place in a "bottom-up" fashion, with small, less complex units of knowledge or understanding eventually, and sequentially, building towards an understanding of a more complex whole. However, as Mayes & de Freitas note, this is exactly the approach taken in the majority of today's e-learning resources.

The *cognitive* perspective, also referred to as the *rationalist* view by Greeno *et al.*, relies upon the development of an understanding of the learned material, drawing on cognitive tools such as memory, reasoning and problem-solving ability. According to Mayes and de Freitas, the "underlying theme for learning is to model the processes of interpreting and constructing meaning", such that knowledge acquisition may be viewed as the "outcome of an interaction between new experiences and the structures for understanding that have already been created."

The *situative* view, which Greeno *et al.* originally termed the *situative/pragmatist-sociohistoric* view, introduced the social aspects of learning, acknowledging the influence of "the social and cultural setting in which the learning occurs, which will also define at least partly the learning outcomes" (Mayes & de Freitas). This perspective sees the learner develop their own personal identity within a group, or community of practice, while engaging in learning activities that focus not only on the subject matter at hand (which might be a video game) but also on cooperation and communication. Social learning is discussed in more detail below, but one of the most significant facets of the situative view is in the "importance of context-dependent learning in informal settings". As well as social interaction, the situative view is dependent on an authentic context in which to carry out the practice of learning.

What follows is an overview of the learning ideas and concepts most applicable to game-based learning, with some analysis of the value of each.

2.2.1 Constructivism

Constructivism refers to the active process through which learners may themselves construct new knowledge, by applying existing knowledge to new problems. Describing what he terms "radical constructivism", Glasersfeld (1995, p. 18) states that "knowledge, no matter how it be defined, is in the heads of persons [...] the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience". Bruner (1960, p. 17) states that prior learning "renders later performance more efficient" through "what is conveniently called nonspecific transfer or, more accurately, the transfer of principles and attitudes". In this way, Bruner argues, such learning "consists of learning initially not a skill but a general idea, which can then be used as a basis for recognizing subsequent problems as special cases of the idea originally mastered".

Savery & Duffy (1995) characterise constructivist learning environments in terms of what they consider the "philosophy" of constructivism, but also offer a number of instructional principles that support this philosophy. Their philosophical propositions are as follows:

1. Understanding is *in* our interactions with the environment
2. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned
3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings

Savery & Duffy consider the first of these propositions to be the core concept of constructivism (their emphasis on the 'in'). Indeed, this this seems a neat summation of the idea, but the second and third components are also useful, and serve to illustrate constructivism's close coupling with the sort of learning games can stimulate. What is a game without some "cognitive conflict or puzzlement", after all? Related to this point, Savery & Duffy also note that "it is the goal of the learner that is central in considering what is learned", which aligns with another aspect of video games: that they – to varying degrees – often permit the player to set their own goals or, at least, attempt to tackle the game's challenges at their own pace. In their third proposition, it is interesting to note the importance that the authors place on social aspects of learning – these are discussed in more detail below, and their relevance to games considered.

As noted in the introduction to this section, 'constructivism' is not a clearly delineated concept, and nor can it be attributed to a single scholar. Alongside Dewey (1938) and Montessori (1949), Piaget (1956) and Papert (1980), for example, are two of the names most closely associated with constructivism in the literature. However, even their ideas about constructivism are not identical. Papert suggests the modified term 'constructionism' which, like the constructivism described by Piaget, builds on the concept of learning as "building knowledge structures" while also adding "the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sandcastle on the beach or a theory of the universe" (Papert & Harel, 1991). Piaget and Papert are both constructivists, then, but Papert is also something else and it might be problematic to assume that 'constructivism' carries the same meaning for all when applying it to video games, or any other pursuit.

A further issue associated with some of the seminal work produced on constructivism – especially that described by Piaget and Papert – is that it is very much focused on children and is mostly applied to adults only by extrapolation. This thesis is concerned primarily with video games' effects on adults, and so it should also be noted that Piaget's theories have been successfully adapted and applied to tertiary level education (e.g. Wankat & Oreovicz, 1993).

In gaming terms, one could see constructivism taking on one of several meanings. First, it might refer to the learning that occurs as a player turns their attention to the process of developing their own game, or perhaps more commonly, creating their own modification or extension of a game, or using built-in tools to construct new levels or in-game items. While the player here is undoubtedly drawing on their existing experience of playing video games – they must possess some understanding of the form and conventions associated with games before they may construct their own – this is a highly literal application of the constructivist concept, more akin to Papert's notion of constructionism (see also 'Players as producers' below). A more subtle interpretation might include the process of learning to play a game based on previous gaming experience, and on real world experience: games are conceived and designed in the real world, even if their settings or themes are otherworldly, and so our understanding of the world around us may also be used to inform our play. This idea may be taken further, and reversed; in learning about the world around us, may we not, in constructivist terms, draw upon experiences gained through video games? Interactions with other players, for example, may serve as an analogue for effective communication in the real world.

If learning through constructivist means relies upon prior experience, then the recollection, or retrieval, of memories associated with such experience is an important factor. Karpicke & Blunt (2011) state that "because each act of retrieval changes the memory, the act of reconstructing knowledge must be considered essential to the process of learning", demonstrating that "retrieval practice is a powerful way to promote meaningful learning of complex concepts". In showing that practicing retrieval is as effective, or more so, than elaborative learning techniques (such as the drawing of concept maps while studying source material) Karpicke & Blunt's work suggests that the act of recalling what we have learned is as important as how we store this information in the first place. It is conceivable that, at a low level, video games may also excel at providing players with reason to practice such retrieval, leveraging the same effects that Karpicke & Blunt demonstrate, in order to teach players how to play. When a new game concept is introduced – for example, a new skill or ability that your player character obtains – this new knowledge is not typically intended to be stored away for later use, to be examined by means of an in-game test at some point in the possibly distant future. Instead, the player is usually expected to start retrieving this knowledge almost immediately, and often repeatedly, until it becomes second nature. The player may have constructed their own knowledge by observing the mechanics of the new game concept – it is not necessarily spelled out for them – but it is in the repeated act of retrieval that they truly understand how to apply it.

2.2.2 Experiential learning

The Chinese philosopher Confucius is mistakenly assumed to have coined the following phrase, which, aside from its dubious origins[3], neatly summarises experiential learning:

> *Tell me and I will forget,*
> *Show me and I may remember,*
> *Involve me and I will understand.*

Dewey has been credited as the "modern father of experiential education" (Neill, 2005). Dewey was among the earliest of the modern writers to consider the conflict between what he considered the two extremes of education: the 'traditional', didactic, teacher-led approach versus the more progressive, less structured student-led approach (Dewey, 1938). For Dewey,

[3] A version of this phrase may originate with Xun-zi (Hsüntze ,312-230 B.C.) http://dakinburdick.wordpress.com/2012/03/14/tell-me-and-i-forget/ (accessed 2 November, 2013)

good educational design took into consideration the learner's place in society; how they might contribute to it, and how they – as an individual – experienced it. Every learner's experience will be different, and the best learning environments (and teachers) should be able to adapt to these differences. Dewey's followers and the experiential learning cycles they developed have perhaps been still more influential. Kolb's (1983) learning cycle and associated model of learning is the most widely cited of these, and builds directly on Dewey's work (and on that by Piaget):

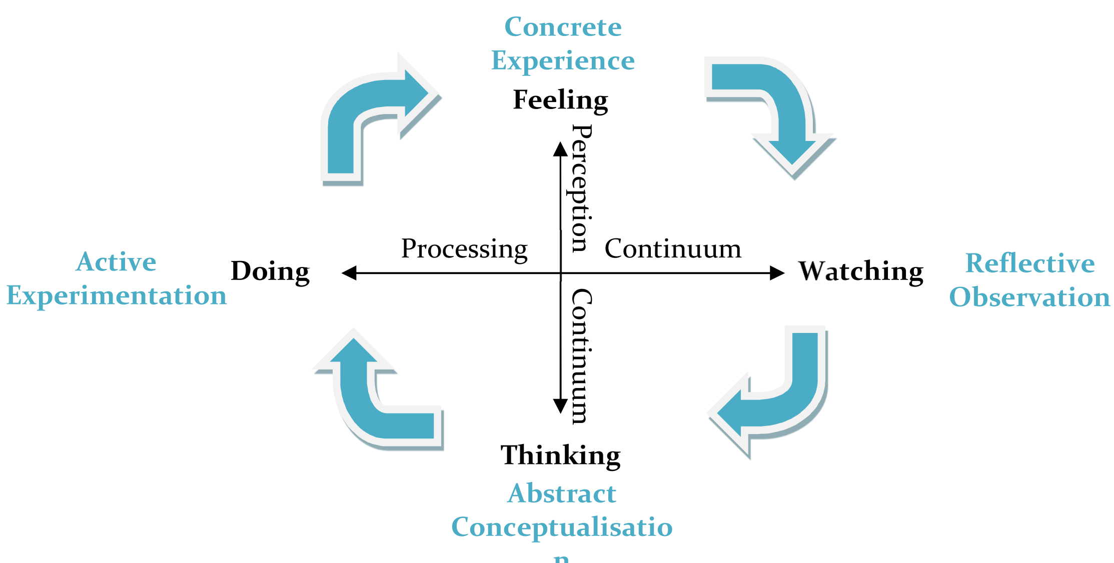

Figure 5: Kolb's Experiential Learning Model & Cycle (adapted from Kolb, 1983)

At the ends of both continuums are stages in the learning cycle, which the learner may enter at any point. Using video games as an example, the cycle might be illustrated as follows:

- Active experimentation (doing): Picking up a controller or mouse and simply playing the game.
- Concrete experience (feeling): Playing through the tutorial level or equivalent, following specific guidance such as in-game prompts.
- Reflective observation (watching): Thinking about what happened as you played the game, having observed what occurred in response to your input.
- Abstract conceptualisation (thinking): Consulting a game guide, wiki or online forum to determine (or formulate) possible strategies.

For effective learning to occur, Kolb states that a balance must be struck between the opposing ends of both continuums, for example, between active experimentation (having a go at playing the game) and reflective observation (thinking about what happened as you played).

2.2.3 Social learning

Like many theories of social learning, Lave and Wenger's (1991) communities of practice (which have a great deal in common with Gee's affinity spaces – see below) are also somewhat rooted in the constructivist camp. Wenger (2006) defines communities of practice as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly", that is, a manifestation of social learning. Such communities comprise three elements: a domain of knowledge, a community of people, and some notion of shared practice. The domain might be anything – including video games or a specific game – but the people involved must share an interest in that domain, and the shared practice must be appropriate to the domain at hand. Of particular relevance to this thesis is the idea that the community of practice need not to have formed with the intention of learning about a particular domain. Any learning that does take place can be entirely incidental.

In much of the more modern literature, it is often difficult to separate the social or, at least environmental, influence exerted on learning, in both formal settings and informal groups. Related to how Dewey places such emphasis on the learner's previous experience, Vygotsky (1930/1978) also suggests that how we learn is dependent on earlier learning and also on the cultural norms to which we are exposed. Moreover, Vygotsky sees learning as an inherently social process, dependent on interaction with teachers (or adults more generally – much of Vygotsky's work is concerned with learning in children) and peers. His suggested 'zone of proximal development' is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" (1930/1978, p. 86). The learner's zone of proximal development will evolve over time as they internalise and understand more complex ideas and, as such, one can see how this concept may be applied to adults – learning something new or more complicated than they have previously learned – as well as children.

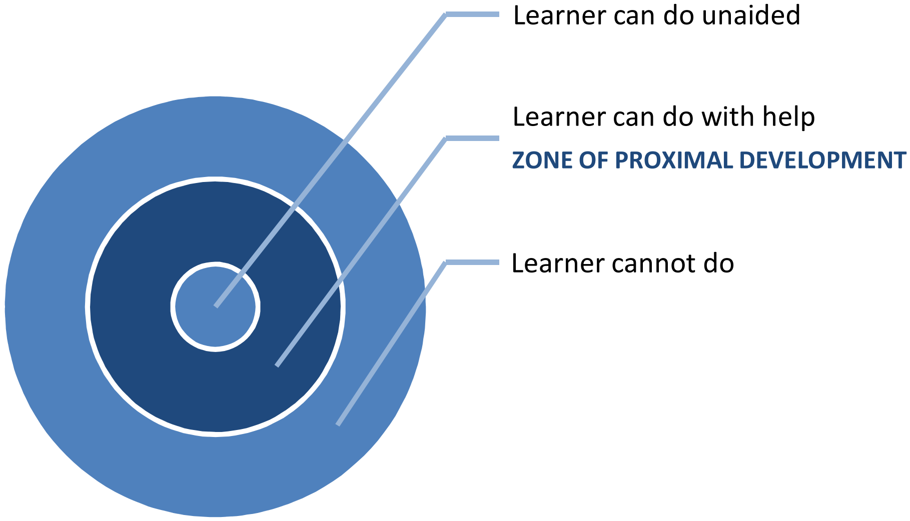

Figure 6: Vygotsky's Zone of Proximal Development (adapted from Vygotsky, 1930/1978)

In gaming terms, these social interactions might be with a more experienced player in the same room, a group of peers playing online, or, perhaps, an NPC providing instruction within the game. Indeed, when games fail to take into account the player's zone of proximal development, such in-game instruction can quickly become tiresome[4].

2.2.4 Scaffolding

Vygotsky's zone of proximal development leads naturally to the concept of 'scaffolding', a concept attributed to Bruner, who describes the need to ask a pupil "medium questions" (1960, p. 44) which are answerable, based on the pupil's current level of understanding, but which point to the next, more difficult concept. Scaffolding – sometimes referred to as 'instructional scaffolding' – has been defined as a "process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts" (Wood, Bruner and Ross, 1976). Interestingly, Bruner elsewhere uses the example of a game – albeit one played between an infant and their parent – to illustrate the concept:

> *The game consists of an initial contact, the establishment of joint attention, disappearance, reappearance, and acknowledgement of renewed contact. These obligatory features or the "syntax" of the game occur together with optional features, such as vocalizations to sustain the infant's interest, responses to the infant's attempts to uncover the mother's face, etc. These "non-rule bound" parts of the game are an*

[4] Navi, the player's in-game companion and guide throughout the otherwise venerable *The Legend of Zelda: Ocarina of Time* (Nintendo, 1998), is one example of the game designers arguably intruding on the player's zone of proximal development.

> *instance of the mother providing a "scaffold" for the child.* (Bruner & Sherwood, 1976, p. 280)

The concept of scaffolding is clearly visible in video games. For example, the concept underpinned the design of a game intended to teach undergraduate students about water quality (Barab *et al*., 2009). In this case, the "immersive world" provided by the game formed the scaffolding for learning, and the study indicated that students learning via the game-based approach performed significantly better on standardised tests than those who learned from a text book. Dubbels (2014) also found that students assigned to a group that used a video game to learn about STEM problems showed improved recall, comprehension, and problem solving skills over those students who were assigned solely printed learning materials. Furthermore, Wouters & van Oostendorp (2013) found that instructional support in game-based learning facilitates the acquisition of skills and knowledge, where 'instructional support' includes the scaffolding provided in-game (e.g. "system-generated hints and suggestions to focus attention") and that which is afforded by collaboration with others (e.g. "discussion often aiming at the explication of implicit knowledge").

Wood *et al*. (1976) take into account the social context of learning and also the role of a tutor, that is, the adult or expert in the room, responsible for the learners' progression towards a successful outcome. They continue: "scaffolding consists essentially of the adult [or expert] 'controlling' those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence. The task thus proceeds to a successful conclusion". The scaffolding metaphor also implies that as successful completion of the task nears, the scaffolds are gradually removed and the learner – as with a new building – is left to stand alone. In video games, the tutor may take many forms, from the occasionally irritating NPC that guides the player through initial concepts, to more subtle clues and direction peppered throughout the game by its designers. However, the scaffolding is plainly there to see for anyone who looks for it. It might be argued that the scaffolding in a good video game *should*, in fact, be all but invisible to the player and it is certainly the case that the best games keep the player just within their range of competence - see the discussion of Gee's (2003/2007) 'Regime of Competence Principle' below.

2.2.5 Mastery learning

Mastery learning or 'learning for mastery' is a concept most widely attributed to Bloom (1968/1971), who was critical of conventional schooling and its apparent failure to cope with differing levels of ability within a single class (see also Illich's 'Deschooling Society' (1971)). So, while Bloom estimated that over 90% of students had the potential to master a given topic, in reality a much smaller proportion of the class will fulfil this potential: "the problem of developing a strategy for mastery learning is one of determining how individual differences in learners can be related to the learning and teaching process" (Bloom 1968/1971). Mastery learning has much in common with the concept of instructional scaffolding, in that learners are provided with adequate assistance as they work towards mastering a topic. Mastery learning acknowledges that individual learners will require more or less time on each topic but, as Bloom suggests, the vast majority of learners can achieve mastery, should they be granted sufficient time and opportunity to do so. Everyone in a class is working towards achieving the same goal, but the instruction afforded each individual (or groups of individuals) is varied as required. Other key aspects of mastery learning are frequent assessment (Slavin, 1987) and prompt formative feedback (Guskey, 2007). While learners must demonstrate a certain level of mastery in the assessment associated with one topic before moving onto the next, each assessment results in useful, prescriptive feedback that the learner can use to improve their understanding and advance towards mastery.

The parallels between mastery learning and how video games are designed are quite obvious here. Most video games are designed to appeal to a wide range of players and must therefore take into account an equally wide range of abilities. There can be little doubt that the 40.23 million people[5] who bought the original *Super Mario Bros.* (Nintendo, 1985) did not demonstrate comparable skill in playing it but, despite this huge range of abilities, many, if not most, of these 40 million players were at least able to master the first few levels of the game. *Super Mario Bros.* is an extreme example – although, by virtue of being 'packed in' with most Wii systems, *Wii Sports* (Nintendo, 2006) has shipped over 81 million copies, according to Nintendo's own financial statements[6]. Therefore, with top-selling games regularly being sold to many millions of players it is reasonable to assume that the range of abilities for which games must cater is larger than any classroom. Further, a typical game requires the player to master a level before advancing to the next, and this quest for mastery is aided by almost constant feedback on the player's actions. This feedback may simply take the form of your on-screen avatar falling to their death due to the misappropriation of some in-game tool or a badly-judged leap, or it may be delivered by much more complicated means more akin to a

[5] According to the Guinness World Records (accessed via http://web.archive.org/web/20060317005503/http://www.guinnessworldrecords.com/content_pages/record.asp?recordid=52404 1 May, 2013)

[6] http://www.nintendo.co.jp/ir/pdf/2013/130131e.pdf#page=7 (accessed 8 August, 2017)

spreadsheet that details every aspect of the player's performance. Regardless of the form that this feedback takes, it is abundant, promptly delivered and frequently designed to help the player master the game.

2.2.6 Surface and deep learning

Marton and Säljö (1976) identified *surface-level* or *deep-level* processing as the two categories of conception by which students learned from reading passages of prose. This distinction between surface and deep approaches to learning has since become a widely accepted phenomenon which Haggis (2003) summarises as follows:

> *… quantitative, memorising and acquisition conceptions underlying a 'surface' approach (in which the student's intention is to memorise the text), and abstraction, understanding reality and developing as a person underlying a 'deep' approach (in which the student's intention is to understand the meaning of the text).*

The idea has since been elaborated upon: for example, both Entwistle (1987) and Biggs (1987) identified a third 'strategic' approach, wherein the learner may switch between surface and deep modes as appropriate.

These approaches to learning are concerned with the amount of knowledge obtained by learners, and extend beyond the mere memorisation of facts; it is for this reason that the concept of surface and deep learning may be relevant to this work. Indeed, Marton & Säljö (1997) identify six conceptions of learning that may be split into those that relate to surface learning and those related to deep learning, as shown in Figure 7 below. Marton & Säljö suggest that while the dividing line might sit between the third and fourth conception, the first and second conceptions are certainly associated with surface learning and the fourth and fifth (and, by extension, the sixth) conceptions are associated with deep learning. The third conception may also be considered as an intermediary between the two learning styles.

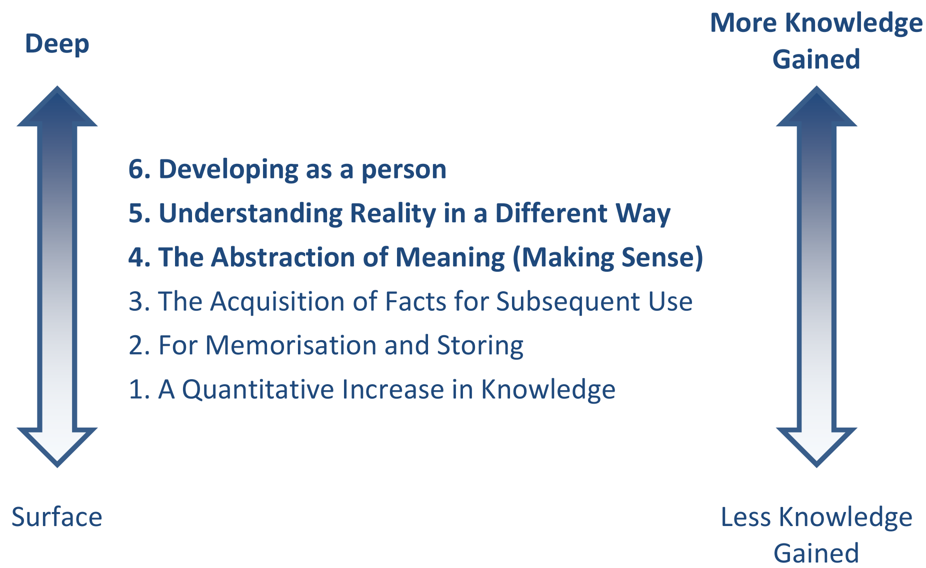

Figure 7: The Six Conceptions of Learning. Adapted from Marton & Säljö (1997)

Notably, the conceptions associated with deep learning are those that may be related to the ideas about student development that are encapsulated in the notion of graduate attributes. The implication here is that deep learning may be required to develop an individual's critical thinking, adaptability, and ethical and social awareness, and so on – to develop as a person. Furthermore, deep learning is often associated with active learning which, as described above, is thought (by Gee, and others) to be supported by games. There are also echoes of Bloom's taxonomy of learning (and Anderson and Krathwohl's revision thereof) in Marton & Säljö's spectrum of learning conceptions: the memorisation of knowledge is, broadly speaking, at the lower level of both theoretical frameworks, for example. If video games may offer a means of enhancing gradate attributes – developing students as people – then the educational literature would suggest that it is games' capacity to support deep, active learning which makes this possible.

2.3 Video games and learning

The connection between video games and learning is by no means universally agreed. Sensationalist and ill-informed commentators offer opinion on both sides of the argument but, for the most part, such contributions to the argument are nothing more than that: opinion. In 2006 Boris Johnson, then the UK's Shadow Minister for Higher Education, offered the following analysis of video game players:

> *They become like blinking lizards, motionless, absorbed, only the twitching of their hands showing they are still conscious. These machines teach them nothing. They*

> *stimulate no ratiocination, discovery or feat of memory — though some of them may cunningly pretend to be educational.* (*The Telegraph*, 28th December, 2006)

While video game enthusiasts were quick to decry Johnson's comments, they illustrate an important issue with video games' image, particularly among those who, like the former Minister, have never played them. However, while Johnson has little basis on which to make his claims about games' lack of utility for learning, those who argue the opposite frequently lack the evidence to support their own, equally emotive and largely unsubstantiated claims. As Connolly, Boyle, MacArthur, Hainey, & Boyle (2012) note in their review of the literature, more empirical evidence – derived from controlled studies – is required to provide more rigorous evidence of games' effectiveness.

One of the names most closely associated with the pro-games-for-learning argument is Marc Prensky, whose books (such as 2001's *Digital Game-Based Learning* and the 2006 *Don't Bother me Mom – I'm Learning!*) and other writings have established him as something of an authority on games for learning. He is the founder of the commercial company Games2 train[7] – which offers "serious training in a game environment" to clients including the U.S. Department of Defense and Microsoft – and has featured in many mainstream publications including the New York Times. Prensky is not, however, a researcher or academic. His populist ideas echo many of those to be found in the more academic tranches of game-based learning, and his writings have enjoyed the approval of established scholars such as James Paul Gee and Henry Jenkins. However, Prensky's enthusiastic arguments in favour of using video games in schools or as part of an "at home curriculum" (2006, p. 213) are still largely conjectural. Caution, therefore, is required when reading such material: Prensky and those with similar feelings and intuitions (including Steven Johnson, author of the 2005 book *Everything Bad Is Good for You*) are writers, not researchers, and citing their work, arguably, could weaken any argument in favour of games' positive effects on learning.

2.3.1 Serious games and 'edutainment'

For as long as there have been computers in classrooms, video games have been developed with education in mind; frequently branded as 'edutainment', the term neatly summarises the conflicting interests inherent in developing games solely for education. Too often edutainment titles have focused on the game at the expense of the educational content, or vice versa, resulting in games that are educationally worthy but cannot hope to engage the player, or somewhat enjoyable titles that sacrifice pedagogic value in the name of fun. As the late

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[7] http://www.games2train.com/ (accessed 8 August, 2017)

MIT-based scholar Seymour Papert suggested in an article entitled 'Does Easy Do It? Children, Games & Learning' (1998, p. 88), this "mating of education and entertainment" has produced "offspring that keep the bad features of each parent and lose the good ones".

There are, however, examples of educational games that are cited as successful implementations within the genre. *Oregon Trail*[8] by Don Rawitsch, Bill Heinemann, and Paul Dillenberger is familiar to several generations of North American students. Aimed at elementary school children, the game simulates the struggle faced by pioneers as they made the trek west to Oregon in the mid-19th century. Featuring brushes with dysentery and some of the harsher realities of pioneer life, *The Oregon Trail* paints a vivid picture of an historical setting and succeeds as an educational game, because children enjoy playing it (the on-screen message "You have died of dysentery" remains a popular meme and cultural reference point amongst former players). Learners are also immersed in a well-researched and engaging simulation that presents an opportunity to empathise with the historical characters, and think from their point of view, while exploring the geography of the infamous migration route. As noted by Castell, Jenson, & Taylor (2007) the educational content of such games extends beyond the simple question of "what the game is about". Originally developed in 1971 and published for the Apple II computer in 1978, versions of *The Oregon Trail* are currently available for Apple iOS (iPhone, iPad).

Other notable examples of educational games that have garnered praise or enjoyed continued success include:

Math Blaster.[9] An intergalactic adventure that aims to teach mathematics to school-age children, first launched in the US in 1987.

The Typing of the Dead.[10] Sega's unholy melding of the on-rails (i.e. the player does not control their character's movement) first-person perspective zombie shooter genre with a typing tutorial is, at the very least, a cultural curio.

Where in the World Is Carmen Sandiego?[11] Originally released by Brøderbund Software in 1985, this was a humorous geography-based adventure that led to series of sequels, a TV show, and frequent rumours of a movie adaptation.

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[8] http://www.oregontrail.com/ (accessed 8 August, 2017)
[9] http://www.mathblaster.com/ (accessed 8 August, 2017)
[10] https://en.wikipedia.org/wiki/The_Typing_of_the_Dead (accessed 8 August, 2017)
[11] http://www.carmensandiego.com/ (accessed 8 August, 2017)

Relatively small-scale, often web browser-based educational games continue to be developed today. In the United Kingdom, for example, public-funded broadcasters such as the BBC[12] and Channel 4[13] actively commission games for learning, aimed principally at primary and secondary school students.

Other game titles fall into something of a grey area in terms of classifying them as educational. Will Wright's *SimCity*[14] was first released in 1989 by Maxis and is a useful illustration of a game that, on paper, could be the exemplar of educational game design. It simulates, and asks players to understand, the complex interactions that drive a modern city: everything from energy and pollution, to taxes and civil disobedience (and giant monster attacks) is modelled in the *SimCity* games and, importantly, the experience is fun. Given that the game, in its various iterations, has sold millions of copies and spawned the even more successful *The Sims* franchise[15], it is conceivable that many players have learned from, or been inspired to learn by, Will Wright's city simulator. Another simulator, the serious game SimPort-MV2, has been used to teach Higher Education students about the decision making process that underpins a planned extension of the Port of Rotterdam (van Bilsen *et al.*, 2010).

Educational games are generally considered to fall under the umbrella of 'serious games', because they are developed for some purpose other than entertainment. Closely related to educational games are those titles developed to provide more vocational training and those that are intended to raise awareness of some specific issue, or improve aspects of the players' lives in other ways. Games for health, in particular, have received attention in recent years, with key examples including *Re-Mission*[16]: a game designed to help young people with cancer cope with their illness and, it is claimed, improve remedial outcomes. Other serious games with humanitarian intentions include *Darfur Is Dying*[17], directed by Susana Ruiz and produced as part of the Games For Change initiative[18] to raise awareness of the issues in the Darfur region of Sudan.

More controversial, perhaps, are games developed as propaganda or recruitment tools for the military, such as *America's Army*[19] — a free-to-download video game designed to recruit (and eventually train) young people for the US Armed Forces. *America's Army* stands out among

[12] http://www.bbc.co.uk/schools/gcsebitesize/games/ (accessed 8 August, 2017)
[13] http://www.channel4learning.com/ (accessed 8 August, 2017)
[14] http://www.simcity.com/ (accessed 8 August, 2017)
[15] http://thesims.com/ (accessed 8 August, 2017)
[16] http://www.re-mission.net (accessed 8 August, 2017)
[17] http://www.gamesforchange.org/play/darfur-is-dying/ (accessed 8 August, 2017)
[18] http://www.gamesforchange.org/ (accessed 8 August, 2017)
[19] http://www.americasarmy.com/ (accessed 8 August, 2017)

serious games as a result of its high production values: it was built using the commercial Unreal Engine[20] that also powers many of the last decade's top-performing and most critically-acclaimed blockbuster games, including Bioware's *Mass Effect* series, Rocksteady's *Batman: Arkham Asylum* and *Arkham City*, and Epic Games' *Gears of War* titles. Featuring rather less accomplished visuals and gameplay mechanics, *Quest For Bush* (Vargas, 2006) was released by the Global Islamic Media Front in 2006, and sees the player tasked with hunting down and killing US president, George W. Bush, and British Prime Minister of the time, Tony Blair. While this title is obviously considered controversial, particularly in America, it is worth noting that it is, in fact a 'mod' (modification) of a legitimately released US title, *Quest for Saddam*[21].

The GAGA Project ("Using games technology to develop graduate attributes") saw the development of a serious game to help prepare international students for study at the University of Abertay, by introducing that institution's graduate attributes (Lloyd, 2011). However, no empirical evidence of the game's efficacy has been published. Furthermore, this work involved the development of a game for the specific purpose of introducing certain graduate attributes: this thesis is concerned with the use of existing commercial video games.

2.3.2 Motivation

It is often implied that video games' ability to support learning lies in their power to motivate individuals (and groups thereof) to play them. As Gee (2008b) notes, "lots of young people pay lots of money to engage in an activity that is hard, long, and complex", and the appeal of video games does not seem to lessen with age. The generations who have grown up with games — and continue to play them well into their adult years — will attest to games' ability to motivate where their day job or other adult responsibilities do not. As noted previously, the average age of those who regularly play games is believed to be in the 30s: it seems reasonable to assume that games motivate people of all ages to play them.

The motivation to learn – for learning's sake – is perhaps more elusive. Self-determination theory (Ryan & Deci, 2000) is often used to explain the link between motivation and education, and is said to be "concerned primarily with promoting in students an interest in learning, a valuing of education, and a confidence in their own capacities and attributes" (Deci

[20] http://www.unrealengine.com/ (accessed 8 August, 2017)
[21] http://www.imdb.com/title/tt0400759/ (accessed 8 August, 2017)

et al., 1991). Garris *et al*. (2002) describe the motivated learner as follows, while noting that such learners are hard to find and even more difficult to create:

> *They are enthusiastic, focused, and engaged. They are interested in and enjoy what they are doing, they try hard, and they persist over time. Their behavior is self-determined, driven by their own volition rather than external forces.*

In the context of game-based learning, the nature of games' motivational properties is not so readily described, although there are clear echoes of Gee's words in the definition of a motivated learner offered by Garris *et al.* Broadly speaking, the psychology and education literature refer to two forms of motivation: intrinsic motivation, where the task at hand provides its own reward, and extrinsic, where the motivation is driven by the desire for external rewards such as money or prizes, or recognition from one's peers. On the one hand, video games appear to offer the ultimate intrinsic motivation, as players pick up and play games simply because they are fun (Amory *et al.*, 1999). Enjoyment, and thus motivation, can be derived from tackling the challenge inherent in a game or, at least, from the game's ability to provide diversion or distraction from other concerns. On the other hand, there are a number of aspects to gaming which complicate the issue, by introducing motivation that is clearly extrinsic. Chief among these aspects is the element of competition. Many of the most popular games of the last decade, from Nintendo's living room-bound *Wii Sports* to the online multiplayer of Activision's *Call of Duty* series, have thrived on players' thirst for competition and the wholly extrinsic motivation that beating a fellow player provides (Vorderer *et al.*, 2003). Competition is all the more compelling a motivator in an era when gaming 'achievements' (to use the Xbox or Steam nomenclature; on PlayStation the equivalent rewards are named 'trophies') are published online for friends to see.

However, Malone and Lepper (1987) suggest that intrinsic motivation is the more powerful force in terms of learning from and engaging with games. This idea is borne out by the more recent findings of Hainey *et al.* (2011) who studied the motivations of gamers at Higher Education level, while making distinctions between those students who played online or offline games, and those who preferred to play alone (single player) or with others (multiplayer). While differences were identified between these groups, overall the study found that an intrinsic motivation – challenge – was the top-ranking factor, while the rather more extrinsic motivation of recognition was least important.

Writing about what made early computer games (such as *Breakout*) fun, Malone (1981) suggested that the primary motivational factors are intrinsic, and comprise challenge, curiosity and fantasy. Malone & Lepper (1987) later updated this model to include a fourth individual factor, control, and three inter-personal factors: cooperation, competition, and recognition. As noted by Hainey *et al*. (2011), the presence of these same factors is equally important in the design of a good video game as in any learning environment. Thiagarajan (1996) identified five (conveniently alliterative) motivational characteristics of video games, in a vein similar to Malone & Lepper's factors. These comprise: conflict, which may incorporate both competition and cooperation with fellow players or game-based actors; control, working within the rules of the game; closure, or the ability to reach some end-point; contrivance, meaning the game is clearly 'just' a game; and competency, as the player's problem solving and other skills improve with practice.

Based on the work of Malone & Lepper and others, Garris *et al*. (2002) settled on six dimensions that may be used to characterise the motivational aspects of any game and "provide a common vocabulary for describing and manipulating the core elements of games for instructional purposes": fantasy, rules/goals, sensory stimuli, challenge, mystery, and control. Further, these six motivational dimensions are framed by what Garris *et al*. refer to as "the game cycle", which features repeated iterations of user judgements (self-determined levels of interest and engagement, enjoyment, and feelings of mastery), behaviour (sustained game play) and feedback (knowledge of results, as provided by the game). User judgements can also include feelings of confidence that, according to Bandura & Wood (1989), may transfer from an in-game setting to real-world scenarios where similar skills may be applied. Skills learned (and confidence gained) from leading a guild in the MMORPG *World of Warcraft*, for example, might prove useful in leading a team in a real-world work environment. Garris *et al*. also note that confidence may be gained by playing out scenarios within a game where there are no "real-world consequences of failure" (another point echoed by Gee – see below), allowing players to learn by experimentation in a risk-free environment. Finally, it is stated that while "feedback or knowledge of results is critical to support performance and motivation" the meta-analysis of Kluger & DeNisi (1996) suggests that feedback on some tasks can actually have a negative effect on performance.

Bartle (1996, 2003), originally looking at those who played games in the MUD (Multi-User Dungeon) genre, which he helped define, identified four basic player types:

- Achievers, who wish to act on – or leave their mark on – the virtual world by achieving goals defined by the game;
- Socialisers, for whom the virtual worlds offered by games are a medium through which they can interact with other players, often in the guise of some role they play within the game;
- Explorers, who wish to explore and understand the game world by interacting with it;
- Killers, who wish to act on – to kill, attack or otherwise antagonise – other players.

Bartle suggests that all of these player types must be provided with relevant gratification to motivate them, if they are to be attracted to a game. In some ways, there are echoes of Gagné and Briggs's (1974/2005) learner types here, each of which must be catered for in a successful learning environment. If gaming really is synonymous with learning, then perhaps we should be examining how we keep Bartle's 'killers' *et al*. satisfied in formal education.

While there is a general consensus in the literature that games' intrinsically (or extrinsically) motivational properties make them ideally suited for use in education (see Becker, 2001; Garris *et al*., 2002; Oblinger, 2004; Miller & Robertson, 2010), Whitton (2007) cautions against making such assumptions. Whitton notes that not everyone is motivated to play games, or to learn from them, and that the supposition that games are inherently motivating is probably propagated by factors of self-selection in gaming studies and researchers' personal interest in games. These are very valid points, particularly when considering the use of video games in formal educational, and in research such as this. Any conclusions drawn about the learning potential of video games, even if that learning is happening without the conscious acknowledgement of the player, must consider that games' power to motivate players is not universal. Further, one must consider the limitations of motivation as an argument in favour of games' usefulness for learning. An issue that the literature seems to avoid, to some degree, is that being motivated to play a game is, on its own, not enough. Many games, at least without additional context or scaffolding, do not lend themselves to useful learning.

2.3.3 Cooperation, collaboration and competition

Another key aspect of gaming that may warrant closer inspection in the context of learning is the collaborative nature of the experience, especially given the prominence afforded collaboration (and associated communication) in the graduate attributes considered here. Building on the process of 'collaborative problem solving' described by Nelson (1999), Wiley & Edwards (2002) identified the innovative use of existing technologies (HTTP, the World Wide

Web) by decentralised groups to collaborate and share knowledge and resources. The examples cited include the file-sharing application Napster and the still-popular, user-moderated technology news website, Slashdot. Applying these ideas to learning, Gee (2005a) describes a phenomenon he calls 'affinity spaces', or online groups that voluntarily gather to learn. The literature suggests that such groups exist in both the online and the real, physical world. One interesting, if somewhat anecdotal, example of where a real-world 'affinity space' grew up around learning from video games comes from Squire's (2004) efforts to teach social history to a group of under-performing teenagers using the historical strategy game *Civilization III* (often known simply as *Civ*). Squire provides an account of how a number of unengaged and disinterested high school students became involved in playing *Civ* as part of their social studies class (which many had already failed, repeatedly). A large proportion of these students was ultimately able to discuss their strategies, the strengths and weakness of ancient civilisations, and the limitations of *Civ* as a system, including the possibility of bias. At the culmination of Squire's efforts with a particular group of students, he ran a summer programme ('Civ Camp') where students volunteered to compete against their tutors, and each other, in a series of *Civilization* games. Squire and the other tutors later discovered that one of the students — who had initially dismissed the idea of learning from *Civ* — had organised a sleepover at his home the night before the tournament began. The purpose of this clandestine meeting was to plan, with the help of a world map and other 'academic' materials, how the students might defeat their tutors over the thousands of years of human history. They applied lessons learned from historical accounts, a newfound appreciation of geography, and an understanding of the game as a system to devise a strategy for winning. This ostensibly academic work was undertaken by the students of their own volition and in their own time, in stark contrast to the approach typically taken to homework assignments. Many of these students have gone on to embark on interesting, often academic, careers. That playing *Civilization* might have steered them on this course is a potentially useful example of how video games can inspire learning, but the small class size and somewhat atypical circumstances (the failing students involved had little lose by playing the game) mean that the results reported by Squire are not necessarily reproducible.

2.3.4 Players as producers

Video games already provide many opportunities for players to produce content, not just consume it (as suggested by Gee's 'Insider Principle'). Level editing tools, such as those found in Media Molecule's *LittleBigPlanet* series (2008-present) allow anyone to build and share their own game scenarios, for example. A plethora of mods exists for everything from Valve's

Half-Life (1998) to *Civ*, with game developers releasing software that facilitates the adaptation of their work by the player. On a basic level, any game or gaming platform that permits the creation of a character or avatar is providing players with the means to create, and to express themselves. Taking this notion further, there exists great potential for learning by creating or designing video games (Vos *et al*., 2011; Robertson & Howells, 2008; Khalili, Sheridan, Williams, Clark, & Stegman, 2011; Nilsson & Jakobsson, 2011) – perhaps the ultimate expression of Papert's constructionist sandcastles.

Video games also inspire players to develop their own content outside the games themselves. Recording and narrating or otherwise annotating game play sessions for delivery via YouTube or other video streaming services are a common phenomenon (known as Let's Plays), while players' contributions to gaming-related wikis may be considered near-academic in quality (Barr, 2014). Here, games are acting as the catalyst for players to practice and develop otherwise unrelated, but clearly transferable, skills such as video capture and editing, or writing wiki articles for an audience of fellow game fans. Of course, video games are not unique in inspiring extracurricular activity such as this, but the combination of their ubiquity (or, perhaps, their popularity), relative complexity and low barrier of entry (in terms of cost) make them ideal candidates for the focus of such endeavours.

2.3.5 Gamification

As a word, 'gamification' does not invite serious consideration of the concepts it encapsulates; however, better definitions of the term do provide an insight into what it might mean, and the potential usefulness of the idea.

Deterding *et al*. (2011) suggest that "gamification is an informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement". Meanwhile Kapp (2012, p. 10) defines gamification as "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" while it is "not the superficial addition of points, rewards, and badges to learning experiences". While such definitions are useful starting points, reducing the term to a short sentence does little to assuage the doubts of gamification's many naysayers, such as Ian Bogost (2011), who states:

> *...gamification is marketing bullshit, invented by consultants as a means to capture the wild, coveted beast that is videogames and to domesticate it for use in the grey, hopeless wasteland of big business, where bullshit already reigns anyway.*

The problem with the term 'gamification' or trite definitions thereof, is that can seem meaningless and empty, just as Bogost would have us believe. The use of rewards or 'badges' as they tend to be labelled by would-be gamifiers, is far from new: gold stars for good work have been a staple of many schools for decades. Others may argue that elements of gamification, such as leaderboards or points, are a distraction from the educational material, or that if your course's appeal relies upon some superficial bells and whistles such as those commonly associated with gamification, your course is fundamentally flawed to begin with. The greatest ire directed at gamification comes from the game community itself, including researchers such as Bogost again:

> *Game developers and players have critiqued gamification on the grounds that it gets games wrong, mistaking incidental properties like points and levels for primary features like interactions with behavioral complexity.*

However, in this assertion, Bogost is actually in agreement with the more thoughtful and experienced advocates of gamification. Kapp (2012, pp. 28-50) agrees that it is in the interaction between various game-like elements that gamification of learning becomes effective. Among these components, Kapp lists "abstractions of concepts and reality", "goals", "rules", "conflict, competition, or cooperation", "feedback", "storytelling" (citing the Hero's Journey as an example), "aesthetics" and even "reward structures", provided they are not used in isolation. Kapp also points out that many, if not all, of these ideas have been used successfully in some form or another in classrooms before they were ever assembled under this umbrella. Other proponents of these techniques actively avoid the term "gamification". Lee Sheldon (2012), in his book *The Multiplayer Classroom: Designing Coursework as a Game* prefers his titular "multiplayer classroom" label, possibly aware of the baggage that "gamification" has quickly acquired.

The effects of gamification within education are not generally well evidenced, with De Schutter & Abeele (2014) concluding that their gamification of a small class (N = 17) did not necessarily result in increases in students' intrinsic motivation. In their review of the literature describing empirical studies on gamification, Hamari, Koivisto, & Sarsa (2014) determined that the outcomes of gamification were potentially positive but that it depended greatly on "the context in which the gamification is being implemented, as well as on the users using it". An example of one such success may be found in Barata, Gama, Jorge, & Gonçalves (2016), wherein a three-year, long-term study of a gamified college course is described. The authors identified a number of different student types, based on their performance and engagement with the course, but concluded that the addition of gamification features had the overall effect of making the course more motivating and "easier to learn from". Taking a slightly less direct approach to the gamification of learning, Barr, Munro, & Hopfgartner (2016) suggest that the gamification of learning resources such as the university library can encourage student engagement, although the authors note that different groups of students react in different ways to such efforts.

Gamification is not limited to using game-like elements in education. Fitness and personal training regimes, and associated products, have also utilised the 'game like' notions of high scores, performance tracking and competition to motivate those who have an interest in exercise. Nike+[22] is an online tool from the sports equipment manufacturer that allows users to track their physical activity. By means of dedicated hardware, such as the wrist-worn 'Fuelband' or smartphone app, one's running and other sporting endeavours may be measured and recorded. Further, the tool allows users to set friends challenges, obtain badges for successes, and set personal goals.

While gamification has clear educational applications, it should be noted that the work described here is not concerned with gamification. Returning to Deterding *et al.*'s definition, the nature of this game-based learning intervention is not about using "video game elements in non-gaming systems" but, rather, about deploying fully-fledged video games in an educational context.

2.3.6 Learning from commercial video games

In *A Theory of Fun for Game Design*, Koster states bluntly that "learning can be problematic" (2005, p. 110). He highlights the human predilection for cheating or, at the very least, finding the easiest means of solving a problem; this he likens to solving an algebraic problem without writing out the proof, or 'showing your working'. Acknowledging that complex video games must teach the player how to play them – without losing sight of the need to provide a fun experience – Koster identifies three game design features that are essential if the player is to experience learning. First, games must feature a "variable feedback system", providing responses appropriate to the players' achievements. Second, the "Mastery Problem" must be addressed, by which Koster means that better or more experienced players should not be permitted to gain excessive advantage at the expense of inexpert players. Finally, "failure must have a cost" (2005, p. 122): if a player is unable to complete a level or advance beyond a particular point in the game, their next attempt must be treated no differently from the last,

[22] http://nikeplus.nike.com/plus/ (accessed 8 August, 2017)

failed attempt. To reward failure in a game by making the most challenging portions increasingly easy to master cheapens the experience and does little to prepare the player for the next challenge. By observing these rules, games are perhaps uniquely placed to induce the 'flow' state identified by Csikszentmihalyi (1991): an optimal state of mind that seems likely to produce conditions ideal for learning to take place, or at least, as Whitton (2009) suggests, a state that is "very similar to being highly engaged". Flow is also closely associated with video games, as Chen (2007) and others have discussed, and with education (Csikszentmihalyi, 1997). As Whitton herself notes, however, flow theory as defined by Csikszentmihalyi might not adequately describe all such occurrences of this "optimal experience" or deep engagement, citing Draper's (1999) modification of flow theory. Draper suggests that flow comprises two distinct types: u-flow, which is characterised by an *unconsciously* managed flow of actions (such as those required to drive a car), and c-flow, where total *conscious* attention to the task is required. It seems likely that this more complex view of flow actually better describes what players experience: most fans of video games can probably point to hours lost while 'in the zone', playing their favourite game. They can also, however, probably cite many examples of when they were not making any progress at all, pouring all of their conscious efforts into solving a particular puzzle, or defeating a particular foe.

The last of Koster's rules, that failure within a game should not be compensated for, is not always applied; or the rule is bent so subtly the player is unaware that the difficulty of the game is being adjusted to match their abilities. While it is generally accepted that games should increase in difficulty and complexity as the player progresses, many games offer players the opportunity to choose the level of difficulty they will face for the duration of the game at its outset (e.g. easy, normal, or hard; casual or expert). Some titles — Bethesda's *The Elder Scrolls V: Skyrim* being a recent example — actually allow the player to adjust the game's difficulty at almost any point in the proceedings. Competitive games such as Nintendo's *Super Mario Kart* have long made use of techniques commonly referred to as 'rubber banding'; these practices are designed to ensure that more experienced players, who naturally pull ahead of less capable participants in a race, are provided with fewer opportune in-game items (such as mushroom-based speed boosts or weaponised turtle shells). In this way, the elastic, notional 'rubber band' that represents the race order, with the front-runners pulling away from the stragglers at the back, snaps back into place and brings everyone back into contention by favouring struggling players. Going further still, dynamic difficulty adjustment algorithms (see Hunicke & Chapman, 2004) are used in games such a Valve's *Left4Dead* and Capcom's

Resident Evil 5 to adjust game content seamlessly in response to the player's calculated capability.

These approaches to dealing with different levels of aptitude offer an insight into the ways in which video games are designed to ensure that players remain engaged with the task at hand. Of course, most games should also offer a challenge to be truly rewarding. And, as with techniques used in formal education, such as segregating classes based on student ability, finding an appropriate balance that meets all needs or expectations is also a challenge: the Internet is rife with gamers bemoaning *Mario Kart's* rubber banding solution.

Steven Johnson's book *Everything Bad is Good for You: How Popular Culture is Making Us Smarter* (2005) features a typical – if anecdotal – example of learning from *SimCity*, wherein his seven year-old nephew quickly identified the benefits of lowering industrial taxes when trying to encourage economic growth. However, Johnson also identifies more subtle learning in video games that goes beyond the impressive but relatively straightforward understanding his nephew displayed after a few minutes of *SimCity*. He believes that the probing of a game as a system — discerning the rules of the game — is an intellectual endeavour, akin to the scientific method. Elsewhere, Johnson (2005b) refers to the link between video games and a psychological principle known as the 'regime of competence' — identified by Gee (2004) — that describes how games are, as Gee suggests, "pleasantly frustrating" (2008a, p. 8). This relates directly to Koster's reflections on game difficulty, or balance: players should feel they are being challenged but should not be taxed significantly beyond their means.

The parallels between game design principles and those adopted in formal education are apparent. Learners' desire for feedback on their progress, and the benefits of providing feedback that is both realistic and useful, is another area in which the best games already excel. In classrooms or other formal learning scenarios where there is a range of student ability, the learning needs of students at all points on the scale should be addressed. The idea that failure should have a cost, however, is perhaps more controversial when transposed to a classroom — no reasonable educator would seek to punish less able students — but when considered in terms of assessment, this idea gets to the very heart of why we examine or otherwise assess students. Perhaps more important in terms of learning outcomes, failure to learn *should* carry some cost in an educational context. If a university student has failed to pass the first year of a three or four year degree programme, it is perfectly acceptable to expect them to re-sit (and pass) their exams, in order to demonstrate that they are capable of understanding the more challenging material that will inevitably follow.

As noted previously, the potential for learning from commercial video games has not gone unnoticed, as exemplified by Squire's work with *Civ*. At the forefront of the scholarly exploration of video games as learning tools is James Paul Gee, Professor of Literary Studies at Arizona State University, who makes connections between good game design and good educational design in his book, *Why video games are good for your soul: pleasure and learning* (2005b). Gee (2004) examines how 'good' video games encourage players to learn the in-game mechanics and asks "why is a long, complex, and difficult video game motivating?" The answer, Gee believes, lies in the very fact that games are designed to teach us something and that this instructional experience taps into what he claims is a universal human desire to learn; certainly, we humans share a natural curiosity about the world with much of the animal kingdom. By studying the techniques developed by game designers to simultaneously engage and educate players on how to play the game or to discover more about the game world, some of the same approaches might be transposed to more conventional education. It is no coincidence that games are precision-tooled to promote player engagement: video game development is an often very costly commercial undertaking, and games must succeed at retail. This financial imperative leaves developers with two options: to continually simplify their games and make them so easy that no instruction is required to play, or to provide an effective but fun in-game learning experience that ensures the player is challenged but shrewdly so as to perpetuate their engagement.

Recent examples of commercial games being used to teach include Valve's Teach with Portals initiative[23], and the teacher-created *Minecraft* mod, MinecraftEdu[24]. Valve's initiative is based on their critically acclaimed *Portal 2*: a physics-based brainteaser, which sees the player solve a series of spatial puzzles using the innovative Handheld Portal Device, or 'portal gun', to navigate through increasingly complex rooms by creating holes in space, or portals. The Teach with Portals website features lesson plans that guide the player through principles such as simple harmonic motion and Hooke's law, parabolas and, terminal velocity. There are also opportunities to use the game to explore the concepts of character and setting, in terms of narrative and storytelling.

Adachi & Willoughby (2013), demonstrated by means of a four-year longitudinal study that playing strategy and role-playing games predicted self-reported problem solving skills among a sample of 1492 high school-aged participants. Adachi & Willoughby also noted that the

[23] http://www.teachwithportals.com/ (accessed 8 August, 2017)
[24] http://minecraftedu.com/ (accessed 8 August, 2017)

empirical evidence for the relationship between playing video games and the development of problem solving skills was limited. Subsequently, Shute, Ventura, & Ke (2015) have shown statistically significant gains in problem solving, spatial skills and persistence in a group of participants asked to play *Portal 2* for eight hours, compared with a group asked to play a suite of 2D puzzle games purported to improve such skills.

The literature, however, does reveal some conflicting evidence about the potential for video games to engage students. Egenfeldt-Nielsen (2007) conducted research in a similar vein to Squire's *Civ* work using another, more history-focused commercial strategy game, *Europa Universalis II*. While acknowledging Squire's results, Egenfeldt-Nielsen documents a high degree of student resistance to the very idea of learning from a game. He goes on to detail some of the problems he, and others, have observed with using video games to teach. As Kirriemuir & McFarlane (2004) noted in their review of the literature of the time, one of the major issues associated with teaching with games is that both the teacher and the student must learn how to play the game, which can create a difficult-to-overcome initial barrier to further learning. Egenfeldt-Nielsen goes on to describe a "Bermuda Triangle of incompetence, conservatism and limited resources" (2007, p. 149) that effectively stymied his efforts to teach with *Europa Universalis II*. In contrast, Squire — while acknowledging many challenges and offering solutions where possible — seems to have had a more positive experience, particularly in terms of student engagement.

2.3.7.1 Commercial video games in Higher Education

Aside from a few notable exceptions, such as the previously discussed work of Hainey *et al.* (2011), Higher Education (HE) is less well represented in the game-based learning (GBL) literature, with Whitton's *Learning with Digital Games: A Practical Guide to Engaging Students in Higher Education* (2009) standing alone as the only book dedicated to the topic at time of writing. Whitton presents a series of cases studies, based on her PhD thesis (2007), that illustrate both the use of existing commercial off-the-shelf (COTS) games such as *World of Warcraft* and the development of bespoke educational titles, and is cautiously optimistic about the usefulness of video games in HE. Tannahill, Tissington, & Senior (2012) discuss the use of video game in HE but merely summarise existing ideas – described by Gee and Squire in greater detail elsewhere – about what makes games suitable for educational purposes in general (motivation, systems thinking, constant feedback, etc.).

Elsewhere, Hobbs *et al.* (2006) note:

> *Current practice in Higher Education is moving away from didactic content delivery, the transfer of discrete, abstract, decontextualised concepts towards constructionist, student-centred models with increasing emphasis on the skills that support independent, self-motivated learning.*

That game-based learning fits well with the move towards greater constructivism in HE teaching and learning is a notion echoed by Connolly *et al*. (2004) who suggest that successful video games draw on a range of educational concepts including constructivism, situated learning, and problem-based learning (PBL).

2.3.7.2 Commercial video games and graduate attributes

Published after the work described below had been completed, Sourmelis, Ioannou, & Zaphiris (2017) conducted a review of the literature pertaining to MMORPG video games and the development of what the authors term "21st century skills". Using the KSAVE (Knowledge, Skills, Attitudes, Values, Ethics) 21st Century Skills framework (Binkley *et al*., 2012) to categorise such work, Sourmelis *et al.* found that playing MMORPGs has been associated primarily with communication (22% of papers reviewed) but also with other dimensions of the KSAVE framework, relevant to the work carried out here. These include Personal and social responsibility (14%), Critical thinking, problem solving, decision-making (6%), and Citizenship – local and global (5%). While MMORPGs are not used in this study (see discussion of pilot below), the authors concluded that more work in this area would be useful, particularly where important but under-represented skills such as problem solving are concerned. However, in their review of the literature, Perrotta, Featherstone, Aston, & Houghton (2013) found that problem solving was consistently found to be positively associated with playing video games, citing examples such as the work carried out by Yang (2012) with the *Tycoon City: New York* city-building game.

While their observations related to secondary-age school pupils, Bailey *et al*. (2006) suggested that communication skill – particularly that associated with collaboration – could be improved by playing commercial multiplayer video games. Some initial observations were also made in regards to the games helping to develop social skills and an "appreciation of ethical behaviour", which are aspects of other graduate attributes. As with the study carried out here, the games used by Bailey *et al.* included multiplayer shooters, such as *Unreal Tournament*.

2.3.7 Gee's 36 learning principles

James Paul Gee is an inspiration for this work. In *What Video Games Have to Teach Us About Learning and Literacy* (2003/2007) Gee describes what he terms "semiotic domains" as a means of ascribing meaning to anything from images and sounds to objects and other humans. He defines a semiotic domain more precisely as “any set of practices that recruits one or more modalities (e.g. oral or written language, images, equations, symbols, sounds, gestures, graphs, artifacts, etc.) to communicate distinctive types of meanings” (2007, p. 19). Among his examples, he includes Roman Catholic theology, cellular biology, and first-person shooter video games. If the reader is uncomfortable with the word “semiotic” Gee offers an alternative interpretation: “an area or set of activities where people think, act, and value in certain ways” with one such area being video games. He argues that to be literate merely in terms of reading and writing is insufficient in the modern day: we must be literate in a variety of semiotic domains other than those associated with the printed word. So, Gee argues, one can be literate in one or more video game semiotic domains (whether it be first-person shooter, real-time strategy, or platformer) and this literacy is developed according to 36 learning principles, which modern video games have the potential to exploit. The most pertinent of these principles are discussed here. The complete list is reproduced, in the order presented by Gee, in Appendix A.

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

While Gee presents his principles in no particular order of importance, this first idea highlights a key aspect of Gee’s thinking: that learning should be *active*. As discussed under ‘Theories of learning’ above, the utility of active learning is a widely-observed phenomenon: from the constructivism of Piaget (1956) to the experiential learning espoused by Kolb (1983), and Moy’s (1999) assertion that graduate attribute-like skills can only be developed through active engagement. Video games are designed to engage the player in active learning – increasingly so in the era of the disappearing player manual – in such a way that they grasp the games’ concepts and conventions by interacting with them. The critical aspect of this learning Gee grounds in the notion of “situated cognition”: the player assigns meaning to objects, characters and events in terms of how they manifest within the context of the game.

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

4. **Semiotic Domains Principle**
Learning involves mastering, at some level, semiotic domains, and being able to participate, at some level in the affinity group or groups connected to them.
5. **Metalevel Thinking About Semiotic Domains Principle**
Learning involves active and critical thinking about the relationships of the semiotic domain being learned to other semiotic domains.

Gee's semiotic domains, and, in particular, the affinity groups with which they are associated also have clear links with established learning theory such as Lave and Wenger's (1991) situated learning and communities of practice (see Gee, 2005a) and Vygotsky's (1930/1978) semiotic mediation. The emphasis Gee places on mastering such domains – even if they have been constructed around a video game – also suggests links with Bloom's (1968) learning for mastery. Video games certainly employ some version of mastery learning in their design. The player must generally master a level or area of the game before moving on to the next, but they may achieve mastery at their own pace: more able players can progress through the game more quickly, while less advanced players benefit from the constant feedback that the game provides, so that they can ultimately master it. Indeed, mastery learning is closely related to a number of Gee's principles, for example:

13. **Ongoing Learning Principle**
The distinction between learner and master is vague, since learners, thanks to the operation of the "regime of competence" principle listed next, must, at higher and higher levels, undo their routine mastery to adapt to new or changed conditions. There are cycles of new learning, automatization, undoing automatization, and new reorganized automation.
14. **"Regime of Competence" Principle**
The learner gets ample opportunity to operate within, but at the outer edge of, his or her resources, so that at those points things are felt as challenging but not "undoable."

As noted above, there are echoes of Bruner's (1960) scaffolding, Bloom's (1968) mastery learning, and Vygotsky's (1930/1978) zone of proximal development (ZPD) in these principles. Gee's regime of competence, at the edges of which the learner/player should be found, is almost synonymous with Vygotsky's ZPD. While Vygotsky's intended learning environment comprised a more traditional classroom with a teacher helping students to navigate their ZPD, Gee is suggesting that video games can (and do) fulfil this role, at least in terms of learning about the game itself. When the designers of a high-profile game ignore the regime of competence principle, they threaten to derail the whole endeavour: an excellent recent example is *Deus Ex: Human Revolution* (Square Enix, 2011). The game permitted – and often encouraged – the player to play entirely stealthily, avoiding direct conflict, and honing a very particular set of skills that did not involve big guns. It would then suddenly throw the player into a ballistic gun fight with an end-of-level boss where stealth was meaningless and big guns were a fundamental requirement if the player was to progress. So, rather than building on skills and competencies developed through previous interactions, the player's regime of competence was all but ignored, requiring them instead to master skills to which many players had hitherto not been exposed. The reviews for the otherwise well-received *Deus Ex* uniformly – and justifiably – lambasted these incongruous battles[25].

6. **"Psychosocial Moratorium" Principle**
   Learners can take risks in a space where real-world consequences are lowered.
15. **Probing Principle**
   Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on this basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking this hypothesis.
28. **Discovery Principle**
   Overt telling is kept to a well-thought-out minimum, allowing ample opportunity for the learner to experiment and make discoveries.

As relatively risk-free environments[26], video games allow players to experiment and develop not only an understanding of the game system but also the skills required to probe and hypothesise about the real world. Several writers have made this connection between games' apparent reliance on – and players' application of – the scientific method. Intuitively, it is easy to see how this idea makes sense, as one plays or observes another playing a video game wherein the player formulates strategies to progress, tries them out, and refines them as necessary. Steinkuehler and Duncan (2008) produced empirical evidence of games' (specifically the researcher-favourite *World of Warcraft*) ability to foster what they term "scientific habits of mind". It is interesting to note that one of the University of Glasgow's

[25] http://en.wikipedia.org/wiki/Deus_Ex:_Human_Revolution#Critical_reception (Accessed August, 2013). It has since come to light that the game's boss battles were not created by the game's primary developers but were, in fact, outsourced to a different development team.
[26] Due consideration, however, must be given to games with violent or sexual content that might be unsuitable for children, or the often unmediated online interactions that many titles facilitate.

stated graduate attributes is labelled "Investigative", with its transferable dimension described as "able to investigate problems and provide effective solutions"[27].

7. **Committed Learning Principle**

Learners participate in an extended engagement (lots of effort and practice) as an extension of the real-world identities in relation to a virtual identity to which they feel some commitment and a virtual world that they find compelling.

10. **Amplification of Input Principle**

For a little input, learners get a lot of output.

11. **Achievement Principle**

For learners of all levels of skill there are intrinsic rewards from the beginning, customized to each learner's level, effort and growing mastery and signalling the learner's ongoing achievements.

12. **Practice Principle**

Learners get lots and lots of practice in a context where the practice is not boring (i.e. in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success). They spend lots of time on task.

Each of these principles, it seems, is to do with how and why video games command so much of players' attention and effort. Motivation has been discussed already, but more so than the remainder of Gee's 36 principles, this subset might require some qualification when applied directly to games. What these principles assume is that the learner enjoys being a player, too – if video games are not for them, then these principles aren't simply irrelevant, they can be counterproductive. Place someone, who has not played games before, in front of a title that requires quick reflexes and a mastery of somewhat abstract controls, perhaps something as 'universal' as *Super Mario Bros.,* and they will not feel that for a little input they are getting a lot of output. It is not thought that Gee is asserting that all of these principles hold true for all games of all genres, and all people; rather, he is presenting a list of principles that *may* be observed in games and how players learn from them.

8. **Identity Principle**

Learning involves taking on and playing with identities in such a way that the learner has real choices (in developing the virtual identity) and ample opportunity to meditate on the relationship between new identities and old ones. There is a tripartite play of

[27] http://www.gla.ac.uk/students/attributes/ (accessed 5 November, 2013)

identities as learners relate, and reflect on, their multiple real-world identities, a virtual identity, and a projective identity.

9. **Self-Knowledge Principle**
The virtual world is constructed in such a way that learners learn not only about the domain but about themselves and their current and potential capacities.

These principles seem to suggest that learners can discover something about themselves, by reflection or by projection on to their in-game identity. In isolation, it may be argued that these principles lack value, but perhaps they become all the more powerful when considered in conjunction with principles 30-32, each of which is concerned with the learner/player thinking "consciously and reflectively" about a number of cultural models, as presented in the game. These may be models about the world, models about the player's own learning, or models about the semiotic domain(s) in which they operate. Gee states that learners/players enjoy a certain freedom in thinking about these models, because they can do so using any combination of his "tripartite play of identities" without "denigration" of their own identity or social background.

All of Gee's principles deserve attention: this list is an attempt to draw out those that seem most relevant to this work with graduate skills. Those principles that deal with literacy – reading video games as multimodal texts – are also important, as are those that deal with how games teach players to play them (e.g. the 'Bottom-Up Basic Skills Principle' and the 'Explicit Information On-Demand and Just-in-Time Principle') but this overview concludes with two, not entirely unrelated, principles.

35. **Affinity Group Principle**
Learners constitute an "affinity group", that is, a group that is bonded primarily through shared endeavors, goals, and practices and not shared race, gender, nation, ethnicity, or culture.

36. **Insider Principle**
The learner is an "insider", "teacher", and "producer" (not just a "consumer") able to customize the learning experience and domain/game from the beginning and throughout the experience.

The first of these principles seems to draw on established notions of communities of practice and social learning. It is perhaps an over-looked aspect of video games – certainly in the way they are perceived by those who do not habitually play them – but such groups do exist and now thrive as online forums, wikis, and guilds, where they might once have been confined to the office or playground. In this way, the 'Affinity Group Principle' is linked to the 'Insider Principle' – the learner/player is also an active producer, not simply a passive consumer, creating content in and around the game, often in collaboration (another graduate attribute) with other members of their affinity group. It may be argued that these two principles represent some of the most powerful potential in video games for learning, or at least a particular form of learning, and might offer a clue as to games' suitability as a framework for developing sought-after generic skills and attributes.

It is useful to consider how Gee's game-specific learning principles compare with others developed in more conventional educational settings. Chickering & Gamson (1987) offer seven principles of good practice in undergraduate education, of particular relevance to the Higher Education -focused work here:

1. Encourages student-faculty contact.

2. Encourages cooperation among students.

3. Encourages active learning.

4. Gives prompt feedback.

5. Emphasizes time on task.

6. Communicates high expectations.

7. Respects diverse talents and ways of learning.

Stating that "while each practice can stand on its own, when all are present, their effects multiply", Chickering & Gamson suggest that these principles employ six powerful forces in education:

- Activity
- Diversity
- Interaction
- Cooperation
- Expectations
- Responsibility

There are clear parallels between some of these principles and those espoused by Gee. In particular, cooperation, active learning, feedback, time on task, and diverse ways of learning are all key tenets of Gee's philosophy. Chickering & Gamson's principles share similarities with other work on good quality education. A 1995 report led by Colorado Governor Roy Romer, Chairman of the Education Commission of the States, identified the following attributes of quality undergraduate education, based on a review of the existing research (Romer, Ewell, Jones & Lenth, 1995):

Quality begins with an organizational culture that values:

- High expectations
- Respect for diverse talents and learning styles
- Emphasis on early years of study

A quality curriculum requires:

- Coherence in learning
- Synthesizing experiences
- Ongoing practice of learned skills
- Integrating education and experience

Quality instruction builds in:

- Active learning
- Assessment and prompt feedback
- Collaboration
- Adequate time on task
- Out-of-class contact with faculty

Again, there is considerable overlap with Gee's principles but one difference stands out. While both lists touch on the importance of "high expectations", an equivalent principle is missing from Gee's list. The other common difference is, understandably, related to contact with teaching staff, who are necessarily absent from video games. These differences seem linked primarily, then, to the environments in which the learning takes place (in a game versus in a college or university). It does not necessarily follow that games are characterised by low expectations (although, learning outcomes may be unexpected). What is more striking is just how much commonality exists between Gee's game-based learning principles and those that are held in high esteem in Higher Education.

2.3.8 Games' negative impact on learning

There are also reports of games being detrimental to learning. Allert (2004) conducted a study of students taking an introductory computer science course, to examine which learning styles and other factors contributed to academic success. Those factors that had a positive impact on student attainment were related to the importance of project work and, unsurprisingly, the amount learned. Factors for which there was only a small positive correlation comprised mainly of prior technical knowledge (programming languages, etc.). The factors with by far the strongest negative correlations, however, were "Days spent in tutoring center" and "Prior experience computer gaming". This is, perhaps, an especially surprising outcome given the computer-based nature of the course: Allert speculates that one reason for such a correlation might be that students with an interest in video games mistakenly assumed that an introductory computer science would relate directly to the creation of such software. Allert also speculates that games may simply have taken up too much of these students' time and attention, away from their studies. These data are important because they show empirically that video games can be associated with detrimental effects on learning outcomes (the results of the large survey of student gaming habits described in Chapter 6 below are also of interest here). While further research would be required to determine the exact cause of this correlation – and the cause may be quite innocuous, such as the students' misconceptions about course content – there exists very little quantitative data that supports a positive correlation between games and learning.

3. Research Context: Measuring Graduate Attributes

The previous chapter discussed means by which learning may be quantified or defined, and provided an overview of relevant theory and a summary of the literature relating to game-based learning. This material forms the broad basis of the work, which focuses on the relationship between commercial video games and graduate attributes. In this short chapter, the specific challenge of measuring such difficult-to-quantify attributes is discussed (see also Chong & Romkey, 2012), and potential measurements assessed.

3.1 General measures

While many institutions list a series of discrete attributes that their graduates should possess, there is a sense in which the graduate may be more than the sum of these parts, leading to a notion of what Coetzee (2014) refers to as "graduateness". Coetzee proposes a 'Graduate Skills and Attributes Scale' as a holistic approach to quantifying the attributes of a given graduate, based on a review of the literature and, perhaps more importantly, employer surveys. Administered by questionnaire, 64 factors of "graduateness" are addressed (e.g. "I find it easy to persuade, convince or influence others"), along eight dimensions (e.g. "interactive skills") and grouped into three domains ("scholarship", "global and moral citizenship" and "lifelong learning"). While such an approach is laudable in several respects – not least for its attempt to reflect employer priorities as well as the moral concerns highlighted by Haigh and Clifford (2011) – Coetzee's questions are rooted in the economic and management sciences and therefore reflect the specific concerns of that domain: how would such an approach work over multiple disciplines? Further, each of the eight dimensions – arguably important in their own right – are reduced to eight multiple-choice questions. In attempting to provide an overall measure of "graduateness" this approach lacks detail and falls short of its lofty aims.

Popular in the United States, the commercial Collegiate Learning Assessment or CLA+ is an open-ended test of analytic reasoning, critical thinking, problem solving, and communication skills. Praised by the U.S. Secretary of Education's Commission on the Future of HE[28] for promoting "a culture of evidence-based assessment in Higher Education" (U.S. Department of Education, 2006), the CLA was originally developed with the institution (not the individual student) as the object of measurement, although the latest CLA+ version now provides student-level metrics[29]. CLA+ aims to measure the "value added" by attending one HE institution versus comparable students at another such institution and may also be used to measure the impact of pedagogic interventions. The actual tests comprise open-ended essay-style questions, rather than multiple choice questions, wherein students are required to 'make or break' an argument, with more varied written tasks based on 'real-world' scenarios (see Klein *et al.*, 2007 for a detailed example of such a scenario). These latter tasks are inspired by written tests developed by Klein (1983) for lawyers sitting the California state bar examination in the US, a lineage that suggests such tests are, at least, considered useful by the US legal profession. The CLA+ is particularly appealing to HE institutions because, while it is made available at a cost, this cost is kept relatively low by administering the test entirely online. Further, the essay-style questions are assessed automatically by means of natural language processing software while 'real-world' performance tasks are graded in an efficient manner by remote, highly trained human beings. It is also of perceived value to universities because, as noted by Klein *et al*. (2007), the CLA+ claims to show an average improvement in the test scores of greater than one standard deviation between first year students and graduates. As

[28] Known as the Spellings' Commission after the US Secretary of Education (2005-2009), Margaret Spellings
[29] http://cae.org/performance-assessment/category/cla-overview/ (accessed 9 July, 2014)

with Coetzee's attempt at providing a holistic approach to assessing graduates, the CLA+ acknowledges that each of the skills, competencies, or attributes that we hope to find and develop in graduates does not occur in isolation from another such attribute. Indeed, the CLA+ might also appear more truly holistic than approaches such as Coetzee's, which essentially comprises a suite of multiple choice questions with groups of these correlated directly with a single attribute. As noted above, however, use of the CLA+, however, incurs a fee[30] that effectively rules out its use in this PhD work.

The Australian Graduate Skills Assessment Test attempted to measure the generic skills of university students with respect to five cognitive dimensions: Critical Thinking, Problem Solving, Interpersonal Understandings, Argument Writing, and Report Writing (Hambur, Rowe, & Luc, 2002). The test comprises a multiple-choice section and a section that requires a written response. The report by Hambur *et al*. on the validity of the measure is exceptionally detailed, and concludes that ongoing assessment of the test's validity is required as it is developed in conjunction with stakeholders. Despite the authors' reservations, the test has been constructed in a thoughtful and transparent way, making it very appealing for use in work such as this. However, only one sample set of questions could be located, with answers freely available online, which might have implications for a pre- and post-test experiment design. Furthermore, the written portions of the test would need to be marked individually and this is not feasible if the measure was to be used on a large scale here, even if a marking rubric were provided.

The Five-Factor Model (FFM) of personality presents personality traits in terms of five dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience (McCrae & John, 1992). The last of these, Openness to Experience does not correlate directly with any single graduate attribute discussed here but, rather, touches on aspects of more than one attribute. Perhaps most usefully, Openness to Experience has been shown to possess a positive correlation with tolerance of diversity and openness to embracing new cultures and (along with Agreeableness) a negative correlation with prejudice (Sibley & Duckitt, 2008). It may be argued, then, that a measure of Openness might offer a solution to the problematic measurement of the Ethically and Socially Aware attribute, discussed below. McCrae & John also note that Openness may be seen to be associated with "behavioral

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[30] David Gastwirth, Director for Higher Education Programs at the Council for Aid to Education (the company behind CLA+) indicated in a Skype call on 28th May, 2014 that the CLA+ could be administered for a cost of $35 (USD) per head, assuming that "remote proctoring" was not required. Gastwirth also noted that a relatively small cohort – such as might be expected here – would not be problematic: whereas the test was originally designed to operate at institutional level, comparisons could now be made between individual students.

flexibility" and "intellectual curiosity", which relate to the attributes Adaptable and Investigative, respectively. Given the ubiquity and maturity of the FFM and the apparent relationship between the Openness to Experience trait and a number of the attributes to be measured, it would be a useful undertaking to include a measure of Openness in the battery of tests developed for this work.

A number of measures related to the FFM exist, many of which build upon and refine previously developed instruments (see Goldberg, 1992 and Saucier, 1994). Thompson (2008) proposes the 40-item International English Mini-Markers measure (so named because it reduces the number of adjective markers from Goldberg's original 100), which shows good reliability and consistency across native and non-native English speaking cohorts. Usefully, each of the measure's 40 components may be related to a specific FFM factor and administration of the measure is straightforward, presenting respondents with the following instruction:

> *Please use the below list of common human traits to describe yourself as accurately as possible. Describe yourself as you really are compared to other people you know of the same age and sex, not as you wish to be. So, generally, is it accurate or inaccurate that you are…*

Respondents are asked to use a scale ranging from 1 (inaccurate) to 5 (accurate). Items related to Openness include, for example, 'Creative' and 'Unimaginative'.

Even more brief measures of the FFM exist, such as Rammstedt & John's (2007) 10-item version of the Big Five Inventory, referred to as the BFI-10 and distilled down from the original 44-item BFI-44 (John *et al.*, 1991; reproduced in John *et al.*, 2008). In fact, the authors of the BFI-44 also provide an 11-item version but recommend against its use in all but the most extremely time-limited situations[31] where, for whatever reason (e.g. to fit into an existing workload or larger battery of tests), respondents are unable to spend more than a minute or so completing the test. For the purposes of this work, a 44-item instrument is not thought prohibitively lengthy – a *circa* 40-item multiple choice test may be completed in around five minutes and may therefore be incorporated quite comfortably within a larger battery of tests. It is conceivable that the 11- or 10-item version might be used in a larger study where participants are asked to complete tests online without supervision, but, according to the

[31] https://www.ocf.berkeley.edu/~johnlab/bfiscale.php (accessed 2 January, 2015)

authors of both the BFI-11 and BFI-44, the longer tests provide more reliable results and are therefore preferable where time permits.

The BFI-44 differs from the International English Mini-Markers in terms of how items are presented. Whereas the latter presents respondents with single adjectives for each item, the BFI is presented as follows:

> *Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.* (John *et al.*, 2008)

Respondents are then asked to rate statements preceded by the text "I see myself as someone who…" on a scale from 1 (disagree strongly) to 5 (agree strongly). Example statements include "Is talkative", "Is curious about many different things" and "Likes to reflect, play with ideas".

It may be argued that the slightly longer statements used in the BFI-44 are more closely aligned with the language and meaning of the graduate attributes being examined here. It is thought that the slightly more verbose statements are less ambiguous than single-word items, and it is for this reason that this instrument was selected for this study to complement the more attribute-specific measures outlined below.

While participants in this study should not be overwhelmed by the testing involved, it may be noted that completing even a relatively significant number of tests (around ten are proposed here in total) a number of times over a period of many months is not an unreasonably time-consuming undertaking. More demanding, at least in terms of the time to be committed to the study by volunteers, is the potential requirement for playing video games under prescribed conditions over an extended period. However, where possible, more concise and easy-to-administer instruments were favoured over more complex, time-consuming measures. Suitably validated multiple-choice surveys, for example, are more practical to administer – and less daunting to complete – than more involved observational approaches.

3.2 Measuring individual attributes

The University of Glasgow identifies ten graduate attributes: Investigative, Effective Communicators, Independent and Critical Thinkers, Adaptable, Resourceful and Responsible, Confident, Experienced Collaborators, Subject Specialists, Reflective Learners, Ethically and

Socially Aware[32]. This list of attributes may be viewed within the context of the Scottish Higher Education Enhancement Committee (SHEEC)'s 2008-11 Enhancement Theme, 'Graduates for the 21st Century'[33]. As noted by Nicol (2010), the development of graduate attributes in Scotland has drawn heavily on work carried out by Barrie (2004; 2006; 2007) in Sydney and Melbourne and, as a result, the attributes extolled by Glasgow are broadly comparable to those found at other international institutions. Further, experiments relating to this work will necessarily involve University of Glasgow students, so it is expedient and appropriate that the Glasgow attributes are used to structure the work. Since Glasgow already purports to develop this list of attributes in its students, it should be possible to determine if video games offer any advantages for attribute development over-and-above existing University provision. The University of Glasgow attributes are documented in full in Appendix B.

These individual attributes, with the exception of Subject Specialists, are considered in more detail below. The omission of this attribute reflects its content-specific nature. Commercial games do not typically feature subject material that aligns closely with university curricula, although there are certainly aspects of individual games that draw on such content, and may be useful as a subject-specific teaching aid e.g. the *SimCity* series (Maxis, 1989-present) for Geography, or *Age of Mythology* (Microsoft Game Studios, 2002) for Classics. The purpose of this work is to determine if commercial games may be used to develop more generally useful skills and attributes in students.

3.2.1 Independent and Critical Thinkers

The literature reveals a variety of relevant measures that are concerned with individual attributes, such as critical thinking, developed independently of the relatively recent work on graduate attributes. Critical thinking tests are perhaps of particular interest, given the ubiquity of critical thinking skills (alongside communication and teamwork) in institutions' stated graduate attributes.

The importance of critical thinking is underlined by Nicol (2010), who states that "the underpinning requirement for all attribute development is the students' ability to evaluate critically the quality and impact of their own work". With this focus on critical evaluation in mind and drawing on the work of Kuh (2008), Nicol identifies a range of "high-impact

[32] http://www.gla.ac.uk/students/attributes/ (accessed 5 November, 2014)
[33] http://www.enhancementthemes.ac.uk/enhancement-themes/completed-enhancement-themes/graduates-for-the-21st-century (accessed 7 November, 2014)

assessment and feedback activities" which might be used to measure (and help develop) graduate attributes within Higher Education curricula:

- reflecting on and assessing the quality of their own work;
- engaging in peer review of each other's work;
- determining criteria to apply to their own work;
- identifying their own learning needs and setting their own learning goals;
- engaging in collaborative projects where they give each other feedback;
- creating problems or issues that they go on to address;
- reflecting on and evaluating their own learning to build a portfolio;
- devising their own module (for example, in collaboration with academic staff).

While these methods do not provide a usable tool or instrument for measuring critical thinking ability, they serve as a useful, Higher Education-focused lens through which to view and judge potential measures. Moreover, there is a strong emphasis on peer-assessment of critical evaluation that, in turn, helps to develop the critical thinking skills of the assessors.

Robert Ennis, who defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do" (Ennis, 1993) is responsible for the influential[34] and widely-used Ennis-Weir Critical Thinking Essay Test, developed in partnership with Eric Weir (Ennis & Weir, 1985) and intended for use with high school and college students. The test asks participants to read and respond to a letter ("The Moorburg Letter") written to a fictional newspaper editor in support of a proposal that concerns overnight street parking. The letter comprises eight numbered paragraphs that are intended to support the author's argument; however, each paragraph reveals some weakness in their reasoning and the participant is asked to evaluate each of these paragraphs in turn, as well as responding to the letter as a whole. Participants' ability to analyse critically the arguments contained in the letter are then graded by a person who is familiar with critical thinking (and has read the guidance supplied by Ennis and Weir). The test is intended to take around 40 minutes to administer (10 minutes for reading the letter and 30 minutes for composing a response). According to Ennis[35], grading of the test should take around six minutes per participant. The structured nature of the test – the participant is expected to formulate an individual response to each of the numbered paragraphs – and the discipline-agnostic content of the test make it a very promising candidate for assessing critical thinking ability as part of a larger experiment. In particular, the

[34] The Cornell Critical Thinking Test, for example, is based on this earlier work by Ennis
[35] http://www.criticalthinking.net/testing.html (accessed 25 October, 2014)

structure of the test means it may be readily adapted to online delivery, should the experiment be conducted remotely, or if there is a desire to retain and later analyse responses in digital form. The test is also freely available, allowing it to be used without restriction for research purposes. An equivalent of the Moorburg Letter might be developed for the purposes of this work, so that the same cohort may take the test twice (pre- and post-intervention). Half the cohort would take the original test pre-intervention and the newly developed equivalent post-intervention, with the other half taking the tests in reverse order, to help control for any inconsistency between the two versions of the test. However, the newly developed test would lack the credibility of the well-established Moorburg Letter, and there are significant concerns about the practicality of grading a large number of such tests, if they were administered on a large scale, online.

The Cornell Critical Thinking Tests developed by Robert Ennis with Jason Millman of Cornell University comprise two levels: level X for pupils at grades five to twelve (in the US) and level Z for grades ten to twelve. However, the 50-minute level Z tests are also intended for use with "advanced or gifted high school students, college students, and other adults" (Ennis, 1993). These tests require the administrator to purchase packs of testing booklets, in addition to an administration manual. For this work, a pack of test booklets was purchased for evaluation. Administration of the Cornell test is very straightforward, given its multiple choice nature, but this mode of assessment may also be seen as a limitation: plausible, if not 'perfect', answers are not accommodated. While the test booklets may be reused by producing one's own answer sheets (respondents would note their answers on a separate sheet, leaving the test booklet unblemished), the test manual suggests that "special answer sheets" may be purchased from the Critical Thinking Co., the owner of the test. It is thought that a suitable answer sheet may be developed and used without reference to the official sheets, as these amount to little more than 52 multiple choice items with the option to mark the answer as A, B or C. Having purchased the test booklets from the Critical Thinking Co., and read the associated manual, it is not believed that using one's own answer sheets is in breach of the licensing terms.

The California Critical Thinking Skills Test (Facione, 1991) is another multiple choice test, composed of 34 items and taking 45-50 minutes to complete, while a companion instrument, the California Critical Thinking Disposition Inventory (Facione *et al.*, 1994) may be completed in around 20 minutes, according to the authors. The former instrument takes the form of a comprehension exercise, in much the same vein as the Ennis-Weir test, while the latter instrument is intended only to measure a respondent's willingness to think critically, not their ability to do so. Both instruments are based on the so-called Delphi Report's consensus definition of critical thinking (also authored by Facione, 1990):

> *We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.*

These instruments are not freely available, however, and appear to exist primarily in commercial form[36]. So, while the multiple choice formulation of these instruments is initially appealing, their commercial availability and the fact that the test which actually measures critical thinking ability is presented in much the same manner as the freely-available Ennis-Weir test, means that they are unlikely to be used in this study. Other commercially available tests, such as the Watson-Glaser critical thinking appraisal (Watson, 1980) were not considered for this study, for similar reasons. However, the use of these tests should be re-evaluated if any future work focuses solely on critical thinking.

3.2.2 Investigative

While investigative skills are assessed explicitly as part of many school-level science courses and in certain other subject-specific domains such as History (Hillis, 2005) there is currently no recognised, general-purpose instrument for measuring investigative ability. The University of Glasgow states that investigative graduates are "able to locate, analyse and synthesise information from a variety of sources and media" and thus "able to investigate problems and provide effective solutions"[37]. It is perhaps unsurprising that the UK's security service, MI5, actively seeks employees with such skills and has, as a recruitment tool, developed an online test to "help you to assess your use of information and analytical skills"[38].

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[36] https://www.insightassessment.com/Products/Products-Summary/Critical-Thinking-Skills-Tests/California-Critical-Thinking-Skills-Test-CCTST (accessed 9 July, 2014)
[37] http://www.gla.ac.uk/students/attributes/yourattributes/investigative/ (accessed 17 November, 2014)
[38] https://www.mi5.gov.uk/careers/investigative-challenge.aspx (accessed 7 November, 2014)

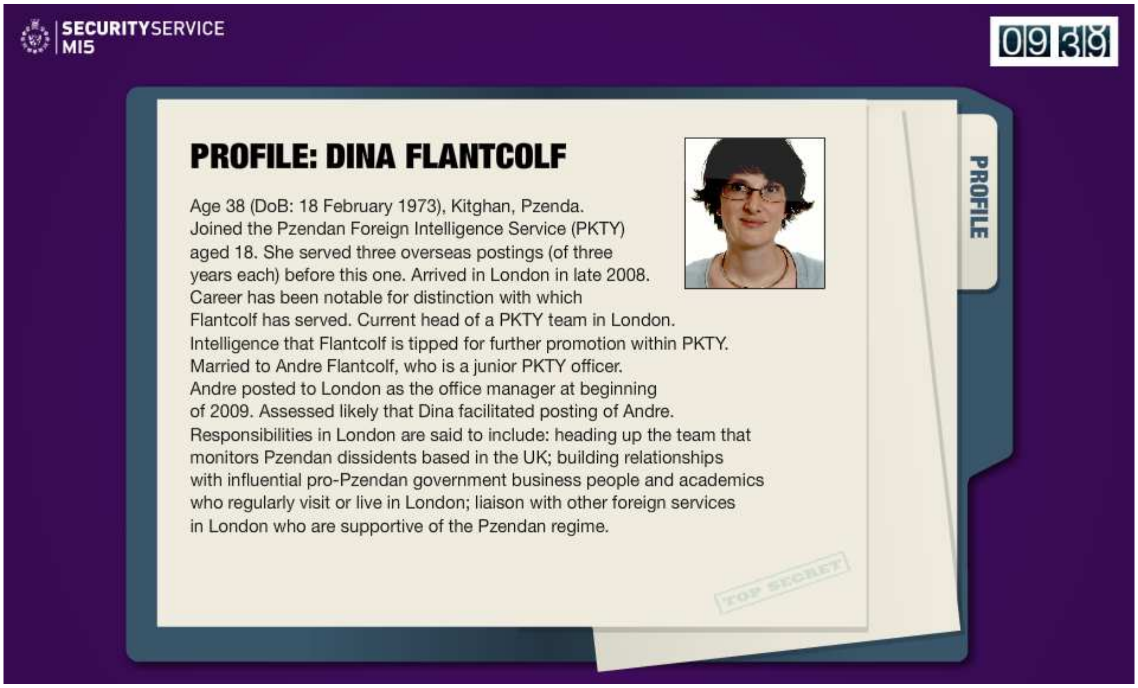

Figure 8: Example screen from the MI5 Investigative Challenge

The MI5 Investigative Challenge "is designed to broadly reflect some of the situations Intelligence Officers at MI5 are expected to deal with" and presents the potential applicant with a security-related scenario, described by means of a collection of text documents. Within a set period, the applicant is asked to make an assessment of the situation and answer four multiple choice questions. These questions are intended to reveal how well the applicant has analysed and synthesised the available intelligence, and translated this into security recommendations. With up to two points available for each answer (the best course of action is worth 2 points, other viable options 1 point), those who score highly are encouraged to apply for a position at MI5. While no validation of the instrument is available, that MI5 continues to use it may be seen as a warrant for its efficacy as an indicator of certain skills.

3.2.3 Effective Communicators

The Self-Perceived Communication Competence Scale (McCroskey and McCroskey, 1988) and the Communicative Adaptability Scale (Duran, 1992) are well-established empirical means of measuring self-reported communication abilities, while the SocioCommunicative Style Scale (McCroskey and Richmond, 1995) may be used by participants to measure their perceptions of other participants' communication behaviour.

The communication competence that the Self-Perceived Communication Competence Scale (SPCC) is intended to measure is defined by the authors as "adequate ability to pass along or give information; the ability to make known by talking or writing" (McCroskey and McCroskey, 1988). The scale comprises 12 items, intended to cover four common communication contexts (public speaking, one-to-one, in a small group, and in a large group) with three common types of "receiver" (stranger, acquaintance, and friend). For each combination of context and receiver, the respondent is asked to rate their communication competence on a scale of 1-100, where 100 is completely competent.

SELF-PERCEIVED COMMUNICATION COMPETENCE SCALE

Directions: Below are 12 situations in which you might need to communicate. People's abilities to communicate effectively vary a lot and sometimes the same person is more competent to communicate in one situation than in another. Please indicate how competent you believe you are to communicate in each of the situations described below. Indicate in the space provided at the left of each item your estimate of your competence. Presume 0 = completely incompetent and 100 = completely competent.

______ 1. Present a talk to a group of stranger
______ 2. Talk with an acquaintance.
______ 3. Talk in a large meeting of friends
______ 4. Talk in a small group of strangers
______ 5. Talk with a friend.
______ 6. Talk in a large meeting of acquaintances.
______ 7. Talk with a stranger.
______ 8. Present a talk to a group of friends.
______ 9. Talk in a small group of acquaintances.
______ 10. Talk in a large meeting of strangers.
______ 11. Talk in a small group of friends.
______ 12. Present a talk to a group of acquaintances.

Scoring: To compute the subscores, add the percentages for the items indicated and divide the total by the number indicated below.

Public: 1 + 8 + 12; divide by 3.
Meeting: 3 + 6 + 10; divide by 3.
Group: 4 + 9 + 11; divide by 3.
Dyad: 2 + 5 + 7; divide by 3.

Stranger: 1 + 4 + 7 + 10; divide by 4.
Acquaintance: 2 + 6 + 9 + 12; divide by 4.
Friend: 3 + 5 + 8 + 11; divide by 4.

To compute the total SPCC score, add the subscores for Stranger, Acquaintance, and Friend. Then divide that total by 3.

Figure 9: The Self-Perceived Communication Competence Scale (McCroskey and McCroskey, 1988)

The SPCC may be used without restriction for research purposes. McCroskey and McCroskey's data indicated that their college student respondents (N = 344) were most confident in their communication competency when talking to friends and in one-to-one contexts, as might be expected: one is usually more confident when speaking to a small group of friends than addressing a large group of strangers. The apparent reliability and free availability of the scale make it a candidate for measuring confidence in communication competence.

Duran's Communicative Adaptability Scale (1983; 1992) is another self-reported measure of communication ability, framed in terms of communicative adaptability, which Duran defines as "the ability to perceive socio-interpersonal relationships and adapt one's interaction goals and behaviours accordingly." Such adaptability depends upon both "cognitive (ability to perceive) and behavioural (ability to adapt) skills". The scale, as reproduced in Duran 1992, comprises 30 statements (e.g. "I feel nervous in social situations") that relate to the six dimensions (Social Composure, Social Confirmation, Social Experience, Appropriate Disclosure, Articulation, and Wit) of the "social communication repertoire". Respondents are asked to indicate the degree to which each statement applies to them, on a scale from 1 ("never true of me") to 5 ("always true of me") and the responses summed for each dimension. Certain responses (e.g. "I sometimes use words incorrectly") are reversed before summing, e.g. a 2 becomes a 4.

A salient feature of this scale, which makes it appealing for use in this context, is its focus on adaptability, as Adaptable is another of the University of Glasgow's stated graduate attributes. Indeed, Duran (1992) states that "the most basic form of communication competence is fundamental competence", defined by Spitzberg & Cupach as "an individual's ability to adapt effectively to the surrounding environment over time" (1984, p. 35). Hullman (2007) demonstrated that the CAS instrument could also be used as a measure of adaptability.

However, as McCroskey & McCroskey (1988) note, the insight provided by self-reported measurements is limited to that relating to the participants' self-perception and results are, therefore, confounded by the participants' self-confidence. In order to investigate actual communication competency, a tool that involves observation might be desirable, and such a tool may be used in conjunction with a self-reporting approach to correlate findings. However, self-report measures are used extensively in psychological research, and there is a prevailing wisdom that the best way to determine something about an individual is to ask them. Self-report measures are also favoured here due to the relatively fast and cheap nature of their deployment.

The SocioCommunicative Style Scale (Richmond & McCroskey, 1990; McCroskey & Richmond, 1995) is an initially promising instrument. It is designed to measure participants' perceptions of another individual's communication style in terms of assertiveness and responsiveness, and comprises a series of twenty personality characteristics to which respondents must assign a value of between 1 (strongly disagree that it applies) and 5 (strongly agree that it applies) in relation to a named individual. Assertiveness and responsiveness are deemed components that "make a substantial contribution to the prediction of communication and other social behavioural patterns" (Richmond and McCroskey, 1990). Items that relate to these two components are presented in random order throughout the instrument. However, two problematic issues were identified when this instrument was considered for use in the work described here. First, from a practical point of view, each experiment participant would necessarily be required to demonstrate their communication abilities, perhaps by addressing a group of their peers who would, in turn, be tasked with using the instrument to gauge the speaker's communication style. While this approach is perfectly viable, it is also potentially very time-consuming to arrange for all participants to be able to speak on a topic, and rather demanding of the participants. Other practical concerns include controlling for increases in familiarity within the group of participants: if, for example, the experiment was designed to include pre- and post-intervention testing, McCroskey and McCroskey's data (and, indeed, common sense) would suggest that participants' self-perceived ability to communicate would increase as they had got to know one another over the course of the experiment. Overcoming this problem would require an additional cohort of participants – uninvolved in the game-based experiments – to act as assessors, using the instrument to assess people with whom they have not developed a relationship. These practical issues are not insurmountable: they may be reduced down to concerns about the availability of suitable numbers of willing participants, and how much may be asked of them. However, a second, more fundamental issue is with the nature of the instrument: it is designed to measure two important components of communication but, as Richmond (2002) indicates, there is no 'correct' style: rather, better communicators are better able to adapt their communication style to reflect a given situation. The SocioCommunicative Style Scale, then, may be useful for detecting changes in communication style rather than measuring improvements in communication ability, assuming a practical and efficient means of administering the test may be devised.

3.2.4 Adaptable

The assessment of an individual's adaptability is hampered not only by the lack of an obvious, tangible measure but also by the ambiguity of the word itself. For the purposes of this work, the University's definition of the attribute's transferable dimension is instructive: "Demonstrate resilience, perseverance, and positivity in multi-tasking, dealing with change and meeting new challenges"[39]. The notion that being adaptable involves coping with the new

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[39] The structure of the University of Glasgow's Arts and Social Science degrees, which require first year students to study three different subjects, could be seen as a mechanism by which adaptability is encouraged or developed by forcing students to learn the concepts and conventions associated with three potentially quite unrelated disciplines.

and unfamiliar is echoed in the same attribute's personal dimension, described by the University as the ability to "respond flexibly and adapt their skills and knowledge to excel in unfamiliar situations".

With this understanding of what is meant by adaptability in the context of graduate attributes, a suitable measure of an individual's ability to adapt to new situations is required. While some tests actually use game-like simulations to assess adaptability-related competencies, for example, the PC-based radar-tracking simulation used by Bell & Kozlowski (2008), it may be argued that laboratory tests of this nature are somewhat unrealistic. Furthermore, such testing bears little resemblance to the real-world concerns or responsibilities of those being tested.

Situational judgment tests (SJTs) are "measurement methods that present applicants with job-related situations and possible responses to these situations", which have been used to gauge individuals' ability to adapt to certain job conditions since at least World War II (Lievens *et al.*, 2008). Most SJTs present respondents with descriptions of work situations and a number of alternative responses for each situation (Motowidlo *et al.*, 1990). The most appropriate responses are pre-determined by, for example, the respondent's supervisor (in a work environment), allowing an individual employee's performance to be measured against their employer's expectations. A limitation of most SJTs, however, is that they are closely coupled with the domain in which they are developed and how they relate to a highly specific scenario, often requiring those being tested to possess detailed subject knowledge. This limits the effectiveness of such tests in a broader, subject-neutral context.

Adam M. Grim's unpublished 2010 Master's thesis offers an account of a more generalised Adaptability SJT (ASJT). The test comprises a series of written work-based scenarios ("stems") for which the respondent must choose the course of action they would most likely take, from a list of five possibilities. In consultation with a panel of subject matter experts (SMEs), two versions of the instrument were developed, one drawing on critical incidents encountered in a military setting (tested with military personnel) and the other based on incidents that might occur in a more typical office environment (tested with call centre employees). Possible responses were rated by SMEs on a five-point Likert scale, where 1 corresponds to a highly non-adaptive response ("no behavior change, not a functional response, and actions will probably make the situation worse") and 5 is a highly adaptable response ("behavior change occurs and provides a response that will successfully resolve the problem"). Respondents' answers were then compared to the SME group's mean answer for each item.

Grim's approach is of interest for a number of reasons: this is a partially validated means of measuring adaptability that seeks to present respondents with recognisable situations, and has been designed with reference to the established work of Pulakos *et al.* and Ployhart & Bliese (discussed below). The measure is only partially validated because the means by which the validity of the test was assessed – asking respondents' supervisors to assess their job performance and adaptability – was not, in itself, a validated method. While it was demonstrated that the ASJT was capable of predicting supervisor ratings of adaptability, it was determined that, for a student cohort with limited experience of 'typical' workplaces situations, the use of an SJT of this nature was potentially flawed. Grim also suggests that revisions of the ASJT are required before it may be used more widely.

Pulakos *et al.* (2000; 2002) developed a taxonomy of "adaptive job performance" and an instrument, the Job Adaptability Inventory (JAI), designed to validate this taxonomy. Pulakos *et al.* (2000) initially identified six dimensions of adaptive performance, based on an analysis of the existing literature: Solving problems creatively; Dealing with uncertain and unpredictable work situations; Learning work tasks, technologies, and procedures; Demonstrating interpersonal adaptability; Demonstrating cultural adaptability; and, Demonstrating physically oriented adaptability. An initial study, examining a range of "critical incidents" (work-based events that required employees to demonstrate adaptive performance), sought to find empirical evidence for the existence of these six dimensions and, as a result, two additional dimensions were identified: Handling emergencies or crisis situations; and, Handling work stress. As one might expect, the study found that the requirement for adaptive behaviour varied with job type, and certain dimensions were of greater importance in certain types of job. Adaptive performance was found to be "multidimensional, encompassing a wide range of different behaviors" (Pulakos *et al*., 2000). The final version of the JAI instrument featured 68 items relating to the eight identified dimensions of critical incidents. Respondents were asked to rate the importance of, and time spent on, each of the dimensions and a criticality index calculated by doubling the importance rating, adding this to the time spent rating, and dividing by three (i.e. the importance rating was weighted twice as heavily as the time spent criterion).

This work is informative and represents one of the few empirical approaches to measuring adaptability within a work context. However, the JAI instrument seems better suited to analysing the nature of particular jobs or job families, and not individual adaptive performance. For example, on the 'Handling emergencies or crisis situations' dimension, the military police job family scored a criticality index of 3.74, versus a score of 0.30 for the research scientist family; 'Solving problems creatively' was scored 3.65 for research scientists but 1.63 for accountancy. These figures are highly credible, but not terribly useful for assessing or predicting adaptability. In a subsequent paper, however, Pulakos *et al*. (2002) present a range of "predictor and criterion measures to assess the eight dimensions of adaptive performance represented in the [2000] taxonomy". The authors refer to three adaptability measures related to experience, interest, and self-assessment. Some representative items for each measure are presented, which relate to the eight previously identified dimensions. For example, an experience item that relates to the 'Demonstrating cultural adaptability' dimension is given as "Making friends with people from different countries" with the respondent asked to rate the level of their experience of the item on the scale: 1 (never), 2 (once or twice), 3 (several times), or 4 (frequently or routinely). The self-assessment item for the same dimension uses a similar example of making friends with people from different countries but asks the respondent to answer using a different scale that relates to their self-perceived effectiveness: 1 (highly effective), 2 (ineffective), 3 (neither effective nor ineffective), 4 (effective), or 5 (highly effective). Finally, the interest item for this dimension is stated as "Learning the rules for appropriate social interaction in a different culture". The respondent is asked to rate their interest in the specified task using the following scale: 1 (I would dislike this task or situation very much), 2 (I would dislike this task or situation), 3 (I would neither like nor dislike this task or situation), 4 (I would like this task or situation), or 5 (I would like this task or situation very much).

The measures were successfully validated with military personnel by asking respondents' supervisors to assess independently their adaptive performance. While this approach suffers from the same limitations identified in Grim's study above, the work of Pulakos *et al.* was supported by funding from the U.S. Army and thus had the resources to pilot test the rating measures used by supervisors. They were also able to fine-tune the selected critical incidents such that they accurately mirrored situations that may be encountered by the respondents in their military roles (e.g. "making quick decisions under life-threatening conditions"). So, while the measures were validated with military personnel (in a manner similar to that used by Grimm), several of the selected predictors correlated closely with supervisor assessments of adaptive job performance, particularly those measures that relied upon a self-efficacy scale. However, as only representative items are published, these adaptability measures may not be used as part of this work: an email to the author requesting a copy of the complete instrument did not receive a reply[40].

Building on the work of Pulakos *et al.* (2000, 2002), Ployhart & Bliese (2006) suggest a self-report measure of adaptability based on their own Individual ADAPTability (I-ADAPT) theory. They define individual adaptability as "a reasonably stable, individual difference construct that influences how a person interprets and responds to different situations" and present the I-ADAPT theory as a nomological network of knowledge, skill, ability and other characteristics (KSAOs), performances, and situations. A potentially important distinction made by Ployhart & Bliese is between adaptability which is proactive or that which is reactive. The illustrative example provided by the authors is as follows:

> *…suppose an individual's behavior in a given situation is not producing the desired effect. Although the environment may not have changed, a more adaptive person will recognise this and change his/her behavior to change the situation in the intended manner… Adaptability is proactive when an individual perceives a need to change even though the environment has not.*

Based on the I-ADAPT theory, the I-ADAPT-M measure was developed with the practicalities of its use in mind, while addressing all eight of the dimensions identified by Pulakos *et al.* It is, therefore, relatively short (taking around ten minutes to complete) and is a self-report measure to "simplify administration and scoring, and to enhance applicability to multiple contexts". The measure has been tested and refined in collaboration with subject matter experts and validated by means of a confirmatory factor analysis. The 55-item survey asks respondents to indicate how well each of the items describes their preferences, styles and habits at work, and each item is aligned with a particular dimension of adaptability. For example, the item "I work well with diverse others" relates to cultural aspects of adaptability. The instrument is freely available for research purposes and, given the apparent maturity of the measure, I-ADAPT-M is an excellent candidate for measuring adaptability as part of this work.

3.2.5 Resourceful and Responsible

While no obvious measures exist for the responsibility aspect of this attribute, Zauszniewski *et al.* (2006) present a 28-item Resourcefulness Scale that measures resourcefulness along two dimensions: personal ("the ability to independently perform daily tasks") and social ("to seek

[40] Email sent to elaine.pulakos@pdri.com on 17th November, 2014

help from others when unable to function independently"). 16 of the 28 items relate to personal resourcefulness (e.g. "When faced with a difficult problem, I try to approach its solution in a systematic way"), with the remaining 12 designed to measure social resourcefulness (e.g. "When I am feeling sad, it helps to talk to other people"). Items are presented on a 6-point scale ranging from 0 ("not at all like me") to 5 ("very much like me") and respondents asked to indicate how descriptive each of the items is of them.

The scale was developed and validated in a two-phase study with chronically ill elderly patients. The authors found that the scale had acceptable internal consistency (a =.85) and state that it may be used with younger and middle-aged adults as well as the elderly. Permission to use the scale in this work has been obtained from Dr Jaclene A. Zauszniewski.

3.2.6 Confident

The University defines confidence in terms of the personal dimension: "possess excellent interpersonal and social skills fostered within an internationalised community" and the transferable dimension: "demonstrate enthusiasm, leadership and the ability to positively influence others". When approaching confidence as a distinct, measureable attribute, however, this definition is not helpful, as it does not indicate what is unique about this attribute. Interpersonal skills, leadership, and international awareness are all covered, to some extent, elsewhere and, while the form of confidence described here is creditable, the level of confidence that might be described as useful is somewhat subjective. It is conceivable, too, that an excess of confidence may be undesirable in an employee. Defining a simple measure of confidence, then, is problematic, as the level of confidence that might be considered ideal is not fixed.

If confidence was to be measured, and considered analogous to self-efficacy, then the ten-point General Self-Efficacy Scale (Schwarzer and Jerusalem, 1995) might be a suitable candidate instrument. While notions of self-efficacy are arguably associated with what one might generally term confidence, it is not a perfect fit for the University definition of the attribute. Removed further still from how the University definition may be interpreted, self-esteem is another trait that may be measured e.g. using the ten-point Rosenberg Self-Esteem Scale (Rosenberg, 1979) and considered somewhat equivalent to confidence. A potential limitation of both these self-rating measures is their attitudinal nature: confidence is arguably a phenomenon that is better measured through the observation of behaviour. However, simple self-reported measures are more practical to administer when resources are limited and volunteers are unlikely to be compensated for their time: constructing scenarios under which additional volunteers may be recruited to observe and rate other participants' confidence is beyond the scope of this work.

While neither of these measures represents an ideal fit for the somewhat prosaic University definition, their brevity – just ten items apiece – makes them interesting candidates for inclusion in the battery of tests, as they do not place significant additional demands on study participants. Another possible approach would be to include a question or short series of questions that simply ask participants to rate the confidence they place in the answers they have provided elsewhere in the battery of tests. However, such an approach does not necessarily allow for responses that more closely match the University interpretation of confidence than, say, the General Self-Efficacy Scale.

3.2.7 Experienced Collaborators

The University defines experienced collaborators in terms of the personal dimension: "are experienced in working in groups and teams of varying sizes and in a variety of roles"; and the transferable dimension: "conduct themselves professionally and contribute positively when working in a team". Beyond the confines of the University, however, collaboration is not so easily defined. As Wood and Gray (1991) note, the literature presents "a welter of definitions, each having something to offer and none being entirely satisfactory by itself". Further, much of the work on collaboration is concerned with conceptualising and measuring it at an organisational level (see, for example, Thomson, Perry, & Miller, 2009). This makes good sense, as it is only within (and between) organisations or, at least, groups of individuals, that collaboration may occur. For the purposes of this work, however, the focus is not on organisational policies and procedures but on individual attitudes and experience. Here, a possibly flawed assumption in the University definition is revealed: graduates are expected to have gained experience of working collaboratively (the personal dimension above) and, it is implied, that this experience results in conduct that is positive and professional (the transferable dimension). It does not necessarily follow, however, that mere experience of being forced to work as part of a group will develop a professional attitude in such situations. While some work exists on measuring attitudes to collaboration, the instruments used are too closely coupled to the setting in which they are administered, such as health care (see Hojat & Gonnella, 2011). Collaboration is closely related to communication, of course, and so measures of communication – coupled with some qualitative data collection, may be the only practical means of 'measuring' this attribute.

3.2.8 Reflective Learners

The University defines reflective learners in terms of the personal dimension: "set aspirational goals for continuing personal, professional and career development"; and the transferable dimension: "identify and articulate their skills, knowledge and understanding confidently and in a variety of contexts". This latter dimension seems very closely related to effective communication, discussed above. In particular, one of the measures identified for this attribute, the Self-Perceived Communication Competence Scale (McCroskey and McCroskey, 1988), is designed specifically to measure communication competence in a variety of contexts (from one-to-one conversation to addressing a group of strangers). As such, this scale may be used to gain some insight into the transferable dimension of reflective learning, as defined by the University. However, it is difficult to see how this aspect of the University definition aligns with what one might intuitively understand to constitute 'reflective learning'.

It might be possible to construct a test that attempts to measure reflective learning but it is difficult to see how such an approach may be developed and validated within the scope of this work.

3.2.9 Ethically and Socially Aware

The University defines being ethically and socially aware in terms of the personal dimension: "welcome exposure to the richness of multi-cultural and international experiences, opportunities, and ways of thinking"; and the transferable dimension: "have a practical and contemporary knowledge of relevant professional, ethical, and legal frameworks". The personal dimension might be interpreted as being equivalent to political correctness, but this is of limited use in terms of devising a robust measurement because what constitutes 'politically correct' ways of thinking may vary from person to person, between cultures, and over time. The University-approved personal dimension also places emphasis on *welcoming exposure* to varying experiences and cultures, rather than simply accepting them as valuable. The transferable dimension, which refers to knowledge of legal frameworks, is also unhelpful in this context as such knowledge is necessarily subject-specific: an architect needs to understand the legal obligations and liabilities associated with their profession but not those of a surgeon, for example.

While ethical and social awareness is not formally tested for in most universities, the Associateship of King's College (AKC) is a taught programme and associated award that "aims to promote intelligent, open-minded reflection on religious, philosophical and ethical issues"[41]. The AKC originated as the award given to all graduates of King's College, London, and is now an optional part of any King's student's curriculum. The modern AKC "seeks to foster an understanding of different ideas, beliefs, and cultures that can be taken into wider society", which is somewhat relevant to the University of Glasgow definition of ethical and social awareness. However, while the AKC is assessed (by means of a two-hour examination) it does not represent an ideal candidate for measuring the Ethically and Socially Aware attribute due to its reliance on taught material. The examination at King's is based directly on lectures delivered over the course of two semesters. Thus, while this is clearly a suitable and successful means of assessing students taking the AKC, it would not function as a general-purpose test of the degree to which students "welcome exposure to the richness of multi-cultural and international experiences, opportunities and ways of thinking". Indeed, the guidance provided to students at King's states that "as each AKC unit is unique, looking at past papers for revision purposes may not be very helpful", suggesting that the material taught each year is what is being assessed, rather some attitudinal aspect of the students.

Again, in the absence of a readily deployed quantitative measure, qualitative data may be collected from participants in relation to this attribute. The Big Five Inventory identified above might also be used to measure Openness to Experience as a proxy for ethical and social awareness.

3.3 Research design

The work will be structured as three distinct but inter-related studies: a pilot study, an experimental study, and a cross-sectional survey.

A small **pilot project** (Chapter 4) will be conducted to test the identified measures and the practicalities of running a controlled game-based experiment within the confines of the University. Based on the analysis of pilot data, up to three attributes will be identified for further study. Criteria for selecting the attributes (and measures) on which to focus will include consideration of any significant associations revealed in the observational data and the distribution of results data gathered during the pilot study, as well as practical concerns relating to their administration.

The effects of video game play on the selected attributes will then be studied by means of a controlled **experimental study** (Chapter 5), in which student volunteers will undertake a

[41] http://www.kcl.ac.uk/aboutkings/principal/dean/akc/AKC-Handbook/starting/values.aspx (accessed 21st January, 2015)

semester-long programme comprising game play sessions based on selected commercial video games. A randomly assigned intervention group will be asked to play the selected games under lab conditions, in addition to completing tests intended to measure their attribute attainment. A control group will be asked only to complete the tests, over the same period. Statistical analysis will be used to determine if there is a significant difference in attribute attainment between the two groups, and interviews with intervention group participants will be conducted at the end of the study to collect supporting qualitative data.

A **cross-sectional survey** (Chapter 6) will be conducted online to identify those attributes that appear most significantly associated with playing video games. An online survey is intended to attract a larger cohort of participants than is possible for an experimental study. The survey will take the form of a series of questions to collect data on exposure variables (age, sex, subject(s), year of study, game playing habits) followed by a number of online tests to measure graduate attributes. This cross-sectional survey will not be repeated: the intention is to determine if there is any *association* between higher graduate attribute scores and experience of playing certain commercial video games, as well as with year of study and other factors. Statistical analysis will be used to determine if there is a significant association between individual attribute scores and these factors.

In the case of both the experimental study and the cross-sectional survey, participants will be surveyed in advance in order to gain an insight into the games they play, in terms of preferred game genres, time spent playing (for example, per week) and preferences for multiplayer or solo play. Participation in both studies will be incentivised by offering a modest prize (an Amazon voucher) to randomly selected participants who complete all of the required testing.

Both qualitative and quantitative methods will be used, as appropriate. The justification for doing so is that quantitative data – for example, correlations between graduate attribute scores and year of study – are only part of the picture. As expressed in the secondary research questions, student *attitudes* to game-based learning are sought here, because their 'buy-in' is equally important to future initiatives if the quantitative results were to indicate graduate attribute gains. Furthermore, as noted in the Research Context chapter, quantitative measures do not exist for several of the University' graduate attributes, meaning that qualitative data is the most obvious means of gauging how these more elusive phenomena might be affected by the intervention. A mixture of quantitative and qualitative methods has been used in many instances of the educational research literature (see Devlin, Lally, Canavan, & Magill, 2013; Hess, 2013; Barendregt, 2011)

4. Pilot Study

Intended primarily to test the graduate attribute measures identified under Research Context above, a pilot study involving a small group of volunteer students was conducted over the course of a semester. Volunteers were recruited by email from with the researcher's subject area. The pilot was also intended to provide an insight into the practicalities of running game play sessions in a lab environment, for example, ensuring that a suitably networked and functional suite of gaming PCs or consoles may be operated within the University infrastructure.

For the pilot, no strictly formulated hypothesis was tested, but a general hypothesis may be expressed as follows, where the 'certain commercial video games' are those identified by a panel of experts (see below):

> H1: Playing certain commercial video games is associated with gains in [graduate attribute A] as measured by the relevant scale

The hypothesis is simplified here, as the pilot was intended to be largely exploratory. At the beginning of an eight-week programme, eight student volunteers were sought to take part in an initial survey of demographic information and gaming habits followed by a testing session using the measures identified above. Over the course of the programme, participants were invited to play selected games in the lab, on PC or PlayStation 3, for two hours per week. At the end of the semester, the graduate attribute tests were administered a second time and the results analysed in order to identify any significant gains (or otherwise) in graduate attribute attainment, and to identify any areas for improvement in the measures. As both testing sessions must be as similar in nature as possible, no games were played on either testing day, resulting in a schedule that comprised a meeting in week one to conduct initial testing followed by six weekly sessions to play specified games and a final meeting in week eight to re-run attribute tests. Weekly sessions were scheduled for the same two-hour slot each week. It was thought likely that requiring participants to maintain a reliable and consistent diary of their ongoing gaming habits (over-and-above those played under laboratory conditions) was unrealistic, while adding additional, unnecessary complexity to any subsequent analysis of graduate attribute data. Since it is the graduate attribute scores of individuals that will be compared and analysed, private game play habits are arguably already controlled for in the design.

4.1 Selected games

A group of experts (games researchers, developers, and journalists) was asked to suggest commercial game titles that might help develop each of the attributes to be studied. A range of suitable titles was thus identified (detailed below), based on the suggestions received and moderated by financial and practical constraints (primarily the hardware available to run the games: modestly specified Windows PCs and a small number of PlayStation 3 consoles).

4.1.1 Minecraft

Minecraft[42], from developer Mojang, is a procedurally generated sandbox game with construction, exploration, and survival elements. In single player mode, players are free to explore the world and collect ('mine') resources such as stone, wood and metal to create ('craft') a virtually limitless range of buildings, tools, and weapons. Multiplayer mode is similarly non-prescriptive in terms of what it permits (or requires) players to do: the main difference is that the world is shared, so players may choose to work together, often on very large collaborative projects (for example, recreating Denmark in its entirety[43]). Multiplayer games may be facilitated by a server, allowing large numbers of players to collaborate remotely, or, as in this case, enabled by means of sharing a screen and a local copy of the game. The group of experts suggested that *Minecraft* might fit with the Effective Communicators and Resourceful and Responsible attributes and, related to communication, it might be argued that the Experienced Collaborators attribute is also relevant, depending on how the game is played.

Student volunteers were split into pairs with a mixture of previous experience; for example, one highly experienced *Minecraft* player was paired with a complete novice; another pair comprised two complete beginners. As far as possible, this blend of experience was maintained throughout the pilot, in order to gain some insight into whether different combinations might interact in different ways. An alternative approach – to consider player experience as a variable to be controlled – might have suggested an attempt to pair players with similar previous experience of the game at hand. However, it was thought more interesting to be able to observe any differences in player pair dynamics and to attempt to recreate – albeit on a very small scale – the range of interactions that might occur in the real world.

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[42] https://minecraft.net/ (accessed 19 May, 2015)
[43] Minecraft: All of Denmark virtually recreated. (2014, April 25). Retrieved 19 May 2015, from http://www.bbc.co.uk/news/technology-27155859

The game was played in split-screen multiplayer mode, meaning each pair shared a screen and inhabited the same game world. Players were instructed to begin with the built-in tutorial world, which introduces the basic concepts of *Minecraft*, before creating and exploring a world of their own. A worksheet was provided to players, with a list of suggested tasks to be performed in collaboration with their partner. Tasks included a number of standard *Minecraft* activities, such as building a house (and a monster-proof one, at that), constructing a farm, and creating a set of armour. However, it was observed that this list of suggested tasks was largely ignored by players.

It may be observed that the progress made – however ill defined – varied from group to group. An obvious factor affecting progression was experience: the pair that included an expert player took to the task with some relish, with others experiencing varying degrees of frustration and, perhaps, even despondency. The expert-and-novice group also differed from the others in terms of how well the pair knew each other, with communication between the two made easier by their existing friendship. This communication could be characterised as a form of peer tutoring, with the expert player guiding the novice through the tutorial (and forgetting to complete his own tutorial tasks in the process). Indeed, it appeared as though the expert-and-novice pair was the only to truly collaborate, or make any meaningful attempt at completing the suggested tasks, their efforts culminating in the development of a mooshroom[44] farm and homely two-bedroom cave. Discrepancies in *Minecraft* experience and ability were a source of humour rather than frustration.

Two hours of play was simply not sufficient for the other groups to become familiar enough with the game – and perhaps each other – to collaborate on such impressive endeavours. That is not to say that the other pairs did not communicate at all, however. Occasional questions were asked of one another, while (not always successful) attempts to rendezvous within the game world were made. There was also one touching moment when a player came to their partner's rescue – wooden sword in hand – when she became the victim of a creeper attack. So, it may be observed that communication and collaboration occurred at all levels of experience, making *Minecraft* a good candidate for inclusion in the main experimental study.

From a practical point of view, a number of issues were encountered during the *Minecraft* session, however. These ranged from the relatively trivial challenge of using multiple wireless controllers with multiple PS3s in the same room (using wired USB connections made it more

[44] Cow-like creatures that share some characteristics with mushrooms, at least aesthetically.

straightforward to ensure that each controller was synced with the intended PS3) to the last-minute realisation that *Minecraft* requires a high definition display for split-screen multiplayer (thus rendering useless the large, but standard definition, screen intended for one of the groups). Technical issues are to be expected when video games are used in a research or teaching environment, of course, and none of those encountered on this occasion proved insurmountable.

What would prove somewhat more problematic, however, was reliance on the expected number of student participants attending the game-based exercises. Further, for exercises that require pair-based collaboration, an even number of participants is desirable. In this case, six of the expected eight participants took part, which, at least, resulted in each player having an available partner. Running a project such as this over an eight week period inevitably results in some participants being unable to attend all of the scheduled sessions, and raised the question of how this should be dealt with for the remainder of the pilot, and in the subsequent study. If two participants are unable to attend a pair-based exercise, for example, then it may be possible to schedule an additional session for these two to run through the exercise. However, what if a single participant misses the session, leaving one attendee without a partner on the day and the missing participant without a fellow straggler with whom to catch up? Another solution might be to devise exercises that are – as far as possible – equivalent to those carried out in the lab environment but which may be carried out at home. Aside from the challenge of ensuring the equivalence of the alternative task, access to the required game software and hardware must also be considered. A student may borrow a copy of *Minecraft* and attempt to work through some task in the game's online multiplayer, for example, but only if they have access to a PS3 at home. This solution, of course, is not ideal, as the controlled, comparable nature of the participants' experiences would be lost.

Figure 10: Playing *Minecraft* cooperatively

Focusing on the Effective Communicators attribute, the following question was posed to the volunteers in an informal post-play discussion: how important a part did communication with your partner play in your *Minecraft* experience? In general, those who responded to this question identified unfamiliarity with the game (or, at least, the PS3 controls) as a barrier to getting the most out of the experience. Two hours was insufficient for beginners to become familiar with the controls and the basic concepts of the game. However, there was a consensus that communication in a game such as *Minecraft* played an important role in that it facilitated collaboration, confirming the supposition that the game might also provide a means by which players might become more Experienced Collaborators. A more subtle point made by one of the participants was that, even if little progress was made within the game, the shared experience might be sufficient to instigate a conversation with a fellow player, acting as a kind of 'ice breaker'.

4.1.2 The Walking Dead

In the third week of the pilot, student volunteers were asked to play the first episode of Telltale's critically acclaimed *The Walking Dead* game[45]. Suggested by the expert group as a game that might relate to the Ethically and Socially Aware attribute, the question explored on this occasion was: could playing games such as *The Walking Dead* provide a means of exploring (and, perhaps, developing) our ethical and social awareness?

[45] https://www.telltalegames.com/walkingdead/ (accessed 19 May, 2015)

Figure 11: Telltale's *The Walking Dead* may be played collaboratively, despite its ostensibly 'single player' nature

An adaptation of the comic book by Robert Kirkman, Tony Moore, and Charlie Adlard, *The Walking Dead* is a narrative-driven game that asks the player to decide how to respond to a series of character interactions and in-game events by choosing from up to four possible dialogue options. The time allowed to make a decision is limited and the implications of each choice affect – to a greater or lesser degree – how the story unfolds. Much has been made of the game's emphasis on moral or ethical choices: some of your decisions will have serious implications for the characters around you, and those choices are often difficult to make in the zombie-infested heat of the moment.

Figure 12: An example of the decisions presented to players of *The Walking Dead. Source: https://venturebeat.com/community/2014/03/11/why-video-games-are-not-a-waste-of-time/*

While *The Walking Dead* is a single-player game, students played in pairs and were left to decide between them how control of the game should be meted out. As with *Minecraft*, an attempt was made to pair players with differing levels of experience of the game. Such is the popularity of *The Walking Dead*, however, that most of the volunteers had played the game before. Fortunately, this did not appear to deter the players, or detract from their enjoyment of the experience. The learning curve for the game is relatively shallow and, with just a few controls to master, first-time players were not at a loss if they wished to control the game. Meanwhile, those who had played it previously appeared to enjoy the experience of making decisions collaboratively or simply observing (and discussing) the choices made by their partner.

From a practical point of view, this was a very straightforward exercise. A minimal worksheet was produced, comprising little more than basic instructions for launching the game. The only technical issue related to having two instances of the game being played in the same room, meaning that one pair could potentially overhear dialogue and other 'spoilers' from the other instance of the game, if they were at different points in the story.

The post-play discussion began by asking how each pair determined who should take control of the game, and if any negotiation of roles took place. For this small group, the sharing of control was not a contentious issue, with each pair dividing into controller and observer roles quite naturally, and without acrimony. Generally, the less experienced player was given the controller, although one such player was content to pass control to their more seasoned partner when faced with certain, challenging action-oriented portions of the game.

Asked whether *The Walking Dead* provided a "means to explore themes of society, despair, survival and morality"[46], there was widespread consent that the game was certainly capable of conveying (and, perhaps, instilling) despair. More usefully, perhaps, there was also discussion about the nature of the society in which the game was set – most of the first season of the game takes place in rural Georgia – and whether events may have unfolded differently in, say, a suburb of a metropolitan city where guns might be (somewhat) less prevalent.

The significant moral choice in the chapter played, which sees players choose between saving one of two characters, was the source of much discussion and disagreement. Broadly speaking, this choice might be reduced to one between a conventional 'moral' decision to save a child and a more pragmatic decision to save a character that may prove more useful in terms of survival. There was no consensus within the group about whom to save, but all were content with the decision they made. This sort of shared experience did appear to provide a useful starting point for meaningful discussion, albeit in largely hypothetical terms: the game, it was felt, provided a framework within which the player might explore moral choice, but the

[46] The Good, the Bad, and the Moral: An Exploration of Ethical Questions in the Gaming World (2012, October 10). Retrieved 9 March, 2015 from http://www.popmatters.com/feature/163392-the-good-the-bad-and-the-moral/

choices made did not necessarily reflect those that each player would make in an equivalent real-life situation.

The discussion also provided some evidence that players were thinking critically about the motives of the characters they encountered and the conflicting, incomplete information the game provides about the characters' backgrounds (cf. the Independent and Critical Thinkers attribute). Lee, arguably the main protagonist in this season, is first seen handcuffed in the back of a police car, but his moral standing remains – for this chapter, at least – somewhat ambiguous. Certainly, it may be argued that this short experiment with *The Walking Dead* reveals games' potential for providing rich, shared experiences that may form the basis of useful, reflective discussion of moral and ethical issues in a classroom environment (albeit one in which all of the students are over the age of 18, in the case of this particular game).

Questions remain, however, about the effectiveness of such an approach. First, one must ask if playing a game offers any advantages over having a group of students read a novel or watch a film and discussing these texts. It could, however, be argued that games such as *The Walking Dead* do offer something more in terms of the shared experience and the way in which the responsibility for every decision is placed firmly on the shoulders of the player(s). It is hardly novel to suggest that interactivity is one of the medium's most salient features but the decision-making basis of the gameplay in *The Walking Dead* does result in a series of rapid-fire debates about moral and ethical choices that is not characteristic of other media. Further, despite its single-player nature, The *Walking Dead* offers myriad opportunities for collaboration and debate between multiple players (or 'player-observers'). Moreover, as the lively group observed discussion here suggests, decisions made within pairs of player-observers may subsequently be challenged and debated at group level as each pair has partaken in a shared, but subtly different, experience.

A further issue to consider is one of scale and, thus, cost. Games and, more significantly, games consoles on which to play them are generally more expensive than copies of classic novels, for example. Even if resources are shared, the logistical challenge of having a large class play games such as this in pairs is not trivial. Add to this the commonly cited concerns about the use of technology in learning (technological obsolescence; maintenance and repair; accessibility) and the use of video games to teach ethical and social awareness is perhaps not a straightforward solution. However, the glimpse of potential seen here in this brief experiment suggests that games could provide an engaging (and fun) means of exercising skills that, arguably, traditional didactic teaching methods do not always support.

4.1.3 Gone Home

The Fullbright Company's *Gone Home*[47] might be described as a first-person interactive story or adventure (the designers term it a "story exploration video game") wherein the player, assuming the role of a young woman returning to her family home after a yearlong absence, explores an apparently abandoned house. In doing so, the player may uncover a number of storylines, the most significant of which relates to the protagonist's younger sister. There are no explicit goals and interaction is relatively limited – such games are occasionally, and somewhat derogatorily, referred to as "walking simulators" – with plot developments uncovered by reading discarded letters and examining ephemera such as concert ticket stubs and television viewing guides.

Gone Home was generally very well received – it currently boasts a Metacritic rating of 86[48] – but the title has irked some who feel it challenges their personal definition of what constitutes a video game. The pilot volunteers certainly included a small number of those who were not enamoured with the game, but the majority of players did appear to become engrossed in the game's elusive narrative.

Figure 13: One of the small scraps of information the player may uncover in *Gone Home*. Source: http://fullbright.company/gonehome/

This situation is illustrative of another of the problems that can arise when using a prescribed game within a formal learning environment: not everyone is going to like it. Squire (2011, p. 117), for example, documented similar problems, where some proportion of the class in question is not interested in playing video games. It is also important to recall that the

[47] http://fullbright.company/gonehome/ (accessed 20 May, 2015)
[48] http://www.metacritic.com/game/pc/gone-home (accessed 20 May, 2015)

students involved here have volunteered to take part in a game-based study and all have at least some interest in video games.

Gone Home is very much a single-player experience and, as such, the game was played individually, and then discussed as a group. More accurately, the game was discussed by two separate groups. It is possible to 'complete' the game – to uncover the final secret and see the credits roll, at least – in significantly less than two hours and those participants for whom the game held little allure raced through the experience as quickly as possible, finishing the game long before the remainder of players. A brief post-game discussion with these participants (who were among the most experienced, gaming-literate pilot participants) revealed that they were bored by the experience and used their gaming literacy – their understanding of certain video game tropes and conventions – to reach the game's conclusion without exploring any of the accompanying narrative. A second group discussion was conducted towards the end of the two-hour play session, with those participants who had taken more time with the game.

Figure 14: *Gone Home* was played individually, then discussed as a group

The intention was to examine whether playing such a game might help hone players' investigative skills, as the player is required to locate and synthesise information from a range of in-game sources in order to determine what has happened. As such, the game might be related to the Investigative and Independent and Critical Thinkers attributes, as well as, perhaps, the Effective Communicators attribute. However, any communication that might take place through the game is necessarily a one-sided affair: the game designers may hope to communicate with the player, but there is no facility for players to respond. Rather, if such a game was to develop any communication skills in the player, these skills would be limited to those concerned with listening and understand what another is attempting to communicate to them – important skills, nonetheless.

The extent to which players felt as though the game's creators were communicating with them was generally rather limited, recalling Jonathan Blow's comments in *Indie Game: The Movie* (Pajot & Swirsky, 2012), wherein the designer revealed that he had hoped to speak to his audience through his game, *Braid*, but that this conversation had not really taken place. The idea that *Gone Home's* exploratory gameplay could help develop investigative skills was met with somewhat greater enthusiasm. However, broadly speaking, those players who enjoyed the game to a lesser extent also saw less value in its investigative aspects. Those players who became invested in the game's narrative, and were thus motivated to piece together the story from the clues scattered around the abandoned house, did suggest they felt their investigative abilities were being exercised.

One participant did make an explicit link between the game and the use of certain investigative skills, commenting that:

> *...in the game, you are aware that every detail is intentionally included to add layers to the story and you naturally assume that every object encountered may be significant in some way or another.*

Highlighting the need to apply critical thinking within the game, the same participant continued:

> *...you have to focus your attention on some details whilst disregarding others in your systematic examination of the house and contents. As there is much to draw on, the player has to critically analyse what information is useful at each stage to help progress the narrative...*

With the student participants' comments in mind, it was thought useful to obtain the game developers' perspective on the game, to determine if they intended for the game to function as more than pure entertainment, if they might have expected players to develop skills such as those described as graduate attributes here. To this end, a short interview was conducted by email with one of the game's developers, Karla Zimonja.

Gone Home developer interview

The interview began by asking Zimonja if the designers of the game had set out to communicate with the player:

> *I would say that we hoped to communicate with players in that we hoped to create a low-pressure environment in which they could feel comfortable to investigate (but which nevertheless had a little bit of impetus, so that the player would not feel bored, etc.) Hopefully the players got the message that it was safe to take their time and fully explore (which is not always something that people feel they have permission to do in a game). Additionally, it could be said that an important message is 'you can drive your own experience', since pacing is up to the player, as well as individual investigatory behaviours, and the amount of thinking/pondering on events and artefacts.*

Zimonja also suggests that the game communicates more subtly with its players:

> *I'd say that more textual communication included things like 'women are interesting people', 'teenagers have real feelings', etc., but hopefully those are more along the lines of conclusions it'd be nice if players came to, as opposed to messages to hammer home.*

Zimonja was then asked if the developers thought that playing *Gone Home* might help improve skills in those who play it, such as investigative or critical thinking skills. While acknowledging that the house in *Gone Home* was not entirely realistic, and therefore, perhaps, not an ideal environment in which to hone "real life" investigative abilities, Zimonja was more enthusiastic about the prospect of the game helping to develop other skills:

> *It would be nice if that were the case! It's hard for us to really know this for sure, as far as we know no studies have been done, but we hope there's several things that can be learned here.*

More specifically, Zimonja suggests that *Gone Home* might have a role to play in developing new players' gaming literacy:

> *Firstly, there's the basic FPS* [first-person shooter] *control fluency; we have heard from a few people that they had never played a first person game before, but in the course of playing* Gone Home *they gained enough skill to go on to play other first person games (*Portal *was specifically put forth as the next game by one or two people). This is super important to us! Accessibility is and has been one of our primary goals. It means a lot to us to allow people to experience games they felt too intimidated to try before, since obviously a lot of first person games involve a lot of other proficiencies than just navigation and interaction with objects. But developing*

> *that skill and then being able to look to, say,* Portal*, and instead of 'WHAT IS ALL THIS SHIT I HAVE TO DO' being able to say 'okay, I understand this movement and aiming paradigm, now the challenge is just (just!) to understand portals' is such a great ability to be able to give people.*

Zimonja also sees opportunities for the game to develop more transferable skills. The requirement that players think critically, and work things out for themselves, is actually central to the game's design:

> *Secondarily, I feel as if there should be a certain amount of critical thinking that* Gone Home *could help develop, sure. We definitely tried to not fill in all the blanks, fictionally, but instead to allow room for the player to make the mental leaps themselves. This investment of mental work is much more enjoyable (since learning is fun, and working to understand a thing is super rewarding and satisfying when you succeed) and interesting than just giving the information would have been. I would also argue that just the practice at working to understand fictional characters is a worthy skill source – it could make players more likely to make a go at understanding more difficult works, in whatever medium. It's hard to just jump in to* Oryx and Crake [a science fiction, or "speculative fiction", novel by Margaret Atwood]*, or basically any good sci-fi (for example) without that skill.*

Finally, Zimonja summarises the game's intellectual appeal:

> *I think it's unusual enough to experience a game that requires mental effort, laying aside the idea of puzzles. In* Gone Home *the player's job is to seek, to learn, and to understand. It's a very different mental state than hammering on a puzzle. That feeling itself might make players more interested in seeking out other works to invest themselves in.*

It is interesting to note that Zimonja, speaking for the developers of *Gone Home*, does feel the game has something to offer in terms of developing players' critical thinking skills, more so than investigative skills. It is also apparent that the developers did, to some degree, hope to communicate something to the player, although this ambition is, perhaps, less obvious than that which would see *Gone Home* improve novice players' "basic FPS control fluency". That the game might act as a gateway to more traditional action-based games with similar but more complex controls is entirely plausible, although of relatively little relevance when assessing games' usefulness for developing transferable skills. It is conceivable that, if games were to be used more widely to develop certain skills, then a title such as *Gone Home* might provide an entry point for those unfamiliar with conventional games control schemes, and thus open up more gaming possibilities. There are also potential links with the Adaptable attribute here.

4.1.4 Never Alone

Never Alone (*Kisima Ingitchuna*)[49] is a BAFTA award-winning game created by Upper One Games in collaboration with Alaskan Native storytellers and elders. The game draws heavily on the traditional lore of the Iñupiat people and is intended as the first in a series of "world games" that the developer hopes will "draw fully upon the richness of unique cultures to create complex and fascinating game worlds for a global audience".

As with *Gone Home*, it could be argued that the makers of *Never Alone* are using the game to communicate with the player; to tell a story. *Never Alone* is also intended to provide players with a unique insight into the ethics and culture of the Iñupiat people. Furthermore, the game may be played cooperatively, requiring effective communication between players as they traverse the Alaskan landscape together, one player assuming the role of an Alaskan girl, named Nuna, and the other an Arctic fox. As such, the game was thought to be of potential relevance to the Ethically and Socially Aware attribute (which suggests that graduates should "welcome exposure to the richness of multi-cultural and international experiences"), as well as the Experienced Collaborators and Effective Communicators attributes.

Figure 15: Cooperative play in *Never Alone*. One player uses a controller, the other the keyboard.

[49] http://neveralonegame.com/ (accessed 21 May, 2015)

The post-game discussion was structured around the following questions:

- To what extent are the makers of *Never Alone* communicating with you, the player?
    - How much do you feel you learned about Alaskan native culture?
- Did the opportunity to learn about this culture add to your enjoyment of the game?
- If you were able to play the game cooperatively, did doing so exercise your communication and collaborative skills?

As a recent release, *Never Alone* was the first game that none of the project volunteers had played before, and it was well received across the group. Most players took the time to watch the documentary footage and interviews with the Iñupiat elders that intersperse the game. Furthermore, engaging with these materials was generally deemed to have been interesting and worthwhile: the players learned something of Alaskan native culture as they played and, in at least one instance, garnered gameplay hints from the interview material. Those players who habitually skipped the videos were driven by a desire to complete more of the game than their peers but conceded that, had this element of competition been absent, they would have taken the time to digest the educational video content. Indeed, the relatively unobtrusive nature of the video material, coupled with a strong underlying game concept, was thought to create opportunities for learning about Iñupiat culture without compromising on fun. The group agreed that the approach taken by the developers here could be replicated with other cultures.

Those who played cooperatively did communicate to some extent, but found that one character (the fox) had more to do, at least in the opening hour or so of the game, meaning that the player controlling the other character (the small girl) was less actively engaged in proceedings. It was clear, however, that the less involved player enjoyed providing commentary on his collaborator's performance.

Therefore, it might be said that the game's developers and their Iñupiat collaborators communicated successfully with the players – at least those who engaged with the video material – but that, perhaps, communication between cooperating players was less critical to the game's success. The participants involved here certainly came away having enjoyed the game and feeling that they had learned something of another culture.

As with *Gone Home*, the developers' point of view was sought. To this end, an interview was conducted by email with the game's lead designer, Grant Roberts.

***Never Alone* developer interview**

Did you, as the designers of the game, set out to communicate with the player? If so, what did you hope to communicate?

> *Yes, absolutely -- you can't make a game without having some kind of communication with the player, after all. We set out to communicate with the player in many ways, but foremost among them was our effort to share, celebrate, and extend the culture of the Alaska Native people with a new audience. We accomplished that through years of creating the atmospheric visuals that were found in the final game, from the howling winds of the eternal blizzard to the ethereal danger of the Aurora People.*
> *It was also very important to communicate the values of the Iñupiaq people to the player. The three core values that we focused on (after much collaboration with the Iñupiaq community) were intergenerational exchange, resilience, and interdependence. Intergenerational exchange was communicated in the game through Nuna's relationship with her elders, and outside the game by local co-op being available for players of widely different demographics and skill levels. We communicated the value of resilience by showcasing the aforementioned environment of the Arctic, as well as the gradually escalating difficulty over the course of the game experience. Interdependence was represented by the friendship between Nuna and Fox, in addition to the companions' relationship both with the land around them and with the world of the helping spirits that is always around us. Local co-op also helped to communicate the value of interdependence to the player outside of the game.*
>
> *And of course, we had to communicate gameplay elements to the player. The eternal blizzard, in addition to being aesthetically amazing, is a hazard that the player always has to worry about by bracing against its effects, or by finding shelter. Its wind is not always harmful, though -- and when the player had to use it to proceed, we had to properly communicate its timing and strength.*

Did you feel you succeeded in communicating with your players?

> *For the most part, yes. The response to* Never Alone *has been overwhelming both from the press and from everyday players of the game. That's partly due to all the ways we succeeded at communicating that I mentioned earlier, but the most successful element of* Never Alone *is arguably the Cultural Insight videos that are*

unlocked over the course of the game. That was a way for us to communicate the reality of the Alaska Native people -- that they're a living people and a living culture -- directly to players in video form. And while we're tremendously proud of the entire game, including the Cultural Insight videos, our next project will attempt to weave the core values of the culture even more seamlessly into the experience of the game instead of requiring the player to step out of the moment.

We also could have had more two-way communication with our players. The scale of our external playtesting effort was as large as we could comfortably make it as a relatively small independent studio, but we would have delivered a better game if we'd been able to solicit feedback from a much wider swath of the community.

Do you think that playing *Never Alone* (particularly in co-op mode) may help develop skills in those who play it, such as communication or collaboration skills?

Definitely. Making a local co-op game allowed us to provide a deeply collaborative experience for players. Nuna and Fox have to work together (thanks to that core value of interdependence) to solve puzzles and ultimately succeed in their quest. We saw this a lot at conventions and in on-site playtests: strangers chatting with each other as they dodged fireballs from the Manslayer, fathers and daughters experimenting with ways of dodging polar bear attacks, and much more. We succeeded in fostering communication between the two players of the game, and look forward to the opportunity to feature that even more strongly in future projects.

How did you find the balance between gameplay and learning?

Our primary goal was to make Never Alone *fun to play. After all, if the game wasn't fun, then all of the communication we set out to do wouldn't have found an audience. So whenever we were faced with the choice of learning versus gameplay, we tried to make the gameplay come first. As an example, when we first implemented the Cultural Insight videos, they automatically played when the player unlocked them. We put a lot of effort into them (which shows in the finished product), so we wanted to make sure that the player didn't miss them. However, we quickly realized that if the videos interrupted the gameplay experience, the player would think of them as an intrusion instead of a window into a culture. So we made the viewing experience optional.*

That was a common theme during the development of Never Alone*: "if it isn't fun, no one will care"*[50]*. As the development team, we were caretakers and students of an incredibly rich culture, so it was critical that we treat it as something to be experienced and enjoyed -- not endured.*

4.1.5 Journey

Journey's developers, thatgamecompany, describe the game as "an interactive parable, an anonymous online adventure to experience a person's life passage and their intersections with other's."[51]

The other players are anonymous (and it is not made clear that the other figures the player encounters in the game are, in fact, other players) and communication is possible only by means of a musical chime. Once the player has established that they are playing alongside another player, the pair may choose to complete the journey together. If one of the players has played the game previously, they may act as something of a guide, using this subtle non-verbal communication to indicate the optimal path, or to warn of impending dangers.

Figure 16: The subtle cooperative experience of *Journey*. Source: http://thatgamecompany.com/games/journey

Journey was selected on the basis that it might relate to the Reflective Learners attribute, but there are clear links to the Effective Communicators and Experienced Collaborators attributes. The game is also a potentially moving experience, perhaps as a result of its reflective tone and intimate – if non-verbal – communication: according to *Journey's* lead designer, Jenova Chen,

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[50] This is also the title of a talk Roberts delivered to the Computer-Human Interaction Forum of Oregon in April 2015. See http://www.chifoo.org/index.php/chifoo/events_detail/if_it_isnt_fun_no_one_will_care (accessed 22 May, 2015)

[51] http://thatgamecompany.com/games/journey/ (accessed 22 May, 2015)

it is not uncommon for players to cry at the climax of the game, with three of their 25 games testers being moved to tears at its conclusion (North, 2013).

Due to time and hardware constraints, not all of the pilot participants played *Journey*. *Journey* requires an Internet connection to the PlayStation Network (PSN) to facilitate the game's unique multiplayer component. As network traffic to and from the PSN is blocked by the institutional firewall, a tethered mobile phone was used to provide Internet access: this approach would not scale well. The game offers a very personal experience, such that participants preferred to play alone (albeit in collaboration with an anonymous online companion). Further, since it is possible to complete the game within the two hours allocated to the pilot sessions, it was thought useful to allow at least one participant see the game through to its conclusion. One participant did complete the game, and was moved to write a blog post about her experience[52]. In her post, the player describes the nature of the communication that took place, noting that she and her fellow player could "'sing' to each other as a token of friendship and appreciation". Despite the limited nature of the communication, the participant went on to state:

> *I would say that we were communicating mostly by sticking to each other and waiting for one another, and while it might not seem much, I believe through this we demonstrated patience, trust, gratefulness and even friendship, although the mentor-mentee relationship was more prevalent.*

This "mentor-mentee relationship" was observed on more than one occasion throughout the pilot study, with the peer tutoring that occurred during the *Minecraft* session providing another example, albeit one in which both mentor and mentee were physically present in the same room. Reflecting on the experience, this participant identified the opportunity to assume the role of mentor as a potential reason for re-playing the game:

> *I realised that I would quite enjoy playing it again and again myself, driven by the thought of maybe someday being the one helping someone new to the game discover its beauty.*

4.1.6 Portal 2

Valve's *Portal 2* is described by the developer as "a hilariously mind-bending adventure that challenges you to use wits over weaponry in a funhouse of diabolical science"[53]. The game was

[52] A Journey for Two (3 April 2015). Retrieved 22 May 2015 from http://videogames.arts.gla.ac.uk/a-journey-for-two/
[53] http://www.thinkwithportals.com/ (accessed 14 April, 2015)

identified as a candidate game for developing the Experienced Collaborators attribute (although, as is the case with other selected games, the Effective Communicators attribute is also relevant here), as it features a particularly robust and inventive cooperative mode. From a practical point of view, it is also worth noting that the cooperative portion of the game allows for split-screen play, meaning two people can play together on the same machine without the need for a solid internet connection to the PlayStation Network (again, problematic due to the presence of an institutional firewall).

The first pair of pilot participants to play *Portal 2* together both possessed some previous experience of the game, but in one case, on PC rather than PS3. This lack of familiarity with the console-based controls immediately led to frustrations with the control scheme that no amount of communication could address (in fact, the nature of the inter-player communication at this point might have been rather unhelpful). Issues with the PlayStation controller aside, communication quickly became an integral part of play. In this case, the more experienced player took the lead and directed the less experienced player, using a mixture of verbal and visual cues to orient the latter within the game's three-dimensional space. Ultimately, this pair made limited progress together, and interpersonal frustrations became apparent. The following exchange was typical:

> Participant X: *Does argument and disagreement still count* [as communication]*?*
>
> Participant Y: *You tried to kill me!*
>
> Participant X: *I warned you.*

A subsequent pair of player participants, however, demonstrated how communication – if not impeded by barriers such as unfamiliar control schemes and limited patience – was vital to progressing in the game. Using the same mixture of verbal and visual communication, this pair quickly and efficiently worked their way through the puzzles presented by the game, although not without the occasional moment of mischief – one player was observed deliberately crushing his teammate using an elevator.

Figure 17: Split-screen cooperative play in *Portal 2*

Inspired by the peer tutoring behaviour observed in earlier sessions, players with differing amounts of experience of the game at hand were paired. Such disparities in experience can certainly result in an interesting dynamic and create the need for significant communication. However, when the disparity is too great, cooperation may quickly give way to frustration and, ultimately a breakdown in communication between players, rather than creating opportunities to exercise and develop such skills.

This points to a more general consideration when planning to use commercial video games in a formal learning environment: it may be important to ascertain students' familiarity with the games and plan groups or pairs accordingly. Based on observations made over the course of this pilot project, the experience gap between a pair of players may be significant if progress through the game does not require explicit collaboration (as *Portal 2's* puzzle solving does). A game such as *Minecraft*, where 'progress' is largely defined by the individual player, and players – even when inhabiting the same game world – are free to work alone if they wish, provides a more relaxed environment for collaborative play. The least satisfactory combination might be a pair of players with no experience of the game (or gaming, more generally) between them. When players spend the majority of the session wandering aimlessly or struggling to grasp the controls, there is little opportunity for meaningful play, and inter-player communication may be limited to short bouts of 'the blind leading the blind'.

4.1.7 Papers, Please

Described by its developer as a “dystopian document thriller”[54], *Papers, Please* is another BAFTA-winning game that was selected as a candidate for developing the Ethically and Socially Aware attribute. However, the Independent and Critical Thinkers attribute is almost certainly relevant here (and, arguably, others such as the Adaptable attribute might also be exercised by the game).

The player is cast as an immigration officer, deciding whom to let in and whom to turn away from the border of the fictional former communist state of Arstotzka. The player performs this role by critically (and increasingly quickly) assessing the documentation presented by each potential immigrant in light of the ever-changing rules and regulations imposed by the state. As well as exercising critical judgement and dealing with change (which is where the Adaptable attribute is relevant), the player is presented with an opportunity to reflect on the ethical and social consequences of their in-game actions. This reflection occurs not only in terms of the lives of the fictional immigrants and existing citizens of Arstotzka (terrorist attacks are a distinct possibility, should the ‘wrong’ person be permitted access to the country) but also in terms of the personal price to be paid by the family of the player’s character. Failure to meet state-imposed quotas for processing immigrants results in reduced pay and, ultimately, a choice to be made between paying fuel bills or buying life-saving medicine for a family member.

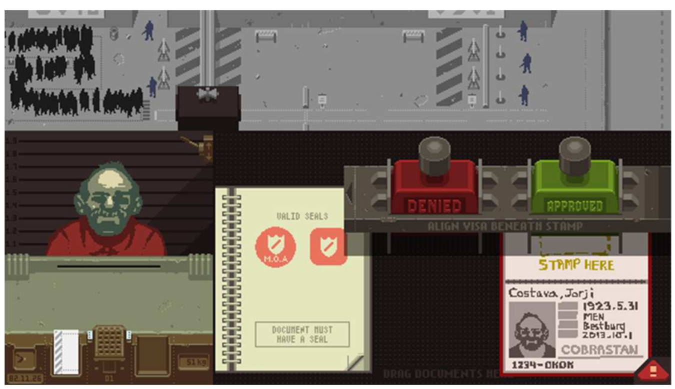


Figure 18: Players must analyse evidence presented in *Papers, Please* and respond accordingly. Source: http://papersplea.se

Like *Gone Home*, *Papers, Please* is a game that divides opinion: not everyone who plays it enjoys the experience, and some question whether it is really a game at all. *Papers, Please* was not played by all pilot participants, again due to its single-player nature, and time and hardware constraints. However, the game’s unique blend of focus on social and ethical issues

[54] http://papersplea.se/ (accessed 29 March, 2015)

with gameplay that requires critical thinking make it a strong candidate for inclusion in any subsequent study.

4.2 Results

The purpose of the pilot project was to trial the selected measures and to gain experience of administering such a study in order to understand the associated challenges and refine the selected methods. As a pilot project, with a small sample size and no control group, the data cannot be used to prove or disprove any formal hypothesis; they can, however, be described in a number of potentially useful ways.

For each measure, the change in score on the associated tests was recorded, for each participant, over the course of the eight-week study. The following tables summarise the results for each of the attribute-specific measures, including the calculated 95% confidence interval[55]. The 95% confidence interval of 2.5 to 12.2 for differences in Communicative Adaptability Scale scores, for example, indicates that the mean change in results may be expected to fall between 2.5 to 12.2 in 95% of cases, should the experiment be repeated. So, that the confidence interval, in this case, does not fall below zero would support an alternative hypothesis that “the ‘true’ population mean is not equal to zero”.

[55] Confidence interval calculations assume a normal distribution, i.e. a bell curve where data tends to be symmetrical around a central value with no skew left or right; with a larger sample size, a more accurate understanding of the distribution may be obtained.

Table 1: Communicative Adaptability Scale scores (pilot study)

Participant	Week 1	Week 8	Difference
U	104	113	9
V	110	116	6
W	94	99	5
X	102	114	12
Y	97	109	12
Z	105	105	0

Min	0.0
Max	12.0
Median	7.5
Mean	7.3
95% confidence interval	2.5 to 12.2

Table 2: Self-Perceived Communication Competence Scale scores (pilot study)

Participant	Week 1	Week 8	Difference
U	77.50	90.83	13.33
V	73.33	89.17	15.83
W	69.42	65.00	-4.42
X	56.67	72.08	15.42
Y	58.33	69.17	10.83
Z	60.00	66.67	6.67

Min	-4.42
Max	15.83
Median	12.08
Mean	9.61
95% confidence interval	1.57 to 17.65

Table 3: I-ADAPT-M scores (pilot study)

Participant	Week 1	Week 8	Difference
U	214	199	-15
V	197	214	17
W	182	212	30
X	190	197	7
Y	178	215	37
Z	205	202	-3

Min	-15
Max	37
Median	12
Mean	12.2
95% confidence interval	-8.6 to 32.9

Table 4: Resourcefulness Scale scores (pilot study)

Participant	Week 1	Week 8	Difference
U	66	65	-1
V	61	82	21
W	62	64	2
X	85	81	-4
Y	90	108	18
Z	57	69	12

Min	-4
Max	21
Median	7
Mean	8
95% confidence interval	-3.0 to 19.0

Table 5: Ennis-Weir Critical Thinking Essay Test scores (pilot study)

Participant	Week 1	Week 8	Difference
U	13	12	-1
V	17	20	3
W	5	11	6
X	21	18	-3
Y	20	19	-1
Z	19	13	-6

Min	-6
Max	6
Median	-1
Mean	-0.33
95% confidence interval	-4.8 to 4.15

Table 6: MI5 Investigative Challenge scores (pilot study)

Participant	Week 1	Week 8	Difference
U	4	4	0
V	6	5	-1
W	6	5	-1
X	6	3	-3
Y	6	5	-1
Z	3	7	0

Min	-3
Max	0
Median	-1
Mean	-1
95% confidence interval	-2.1 to 0.15

While individuals' scores were tracked over the period of the experiment, the data may also be described in more general terms. The correlogram below indicates the degree to which each of the scores correlates with the other scores, for the test scores of six participants on two occasions (testing in week one and in week eight); i.e. the correlogram describes twelve 'observations' of each test.

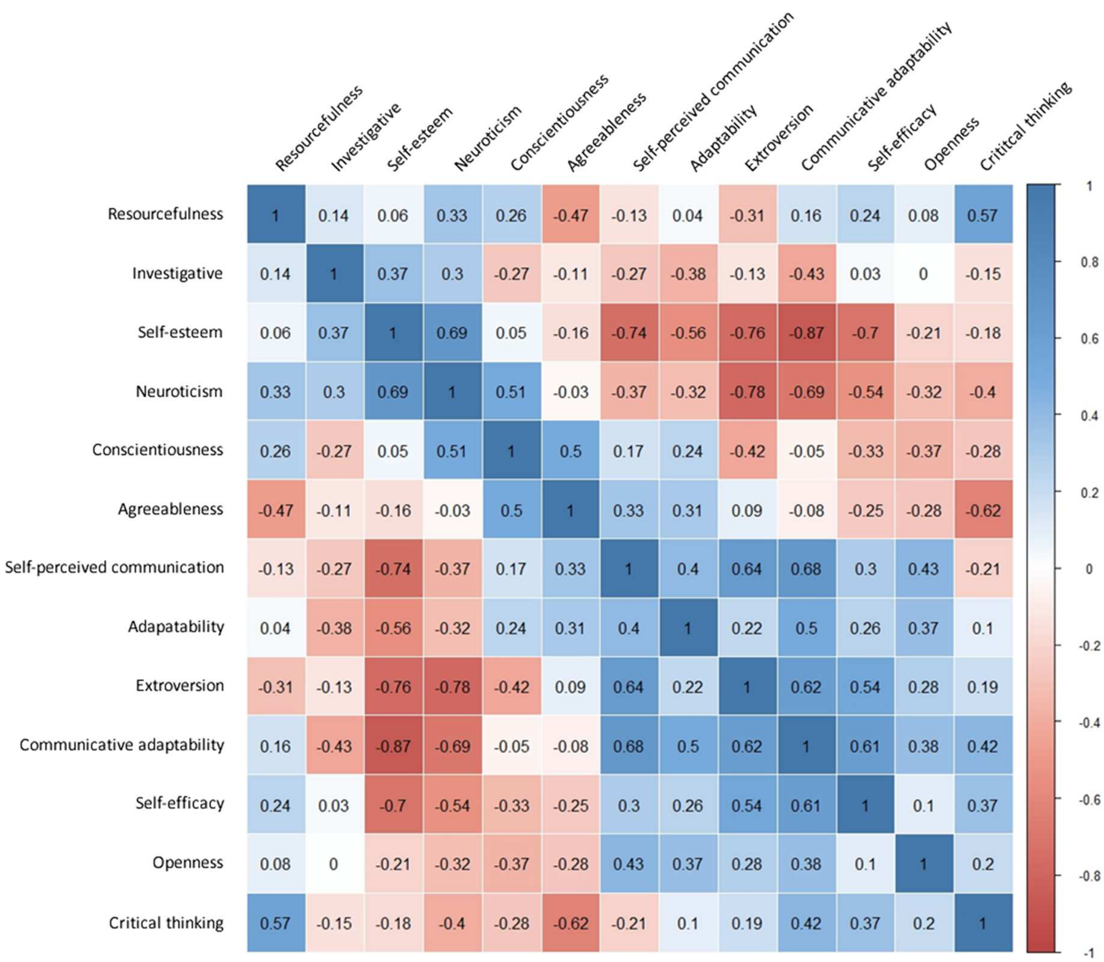


Figure 19: Correlogram comparing scores in the 13 tests conducted, as observed in six individuals at two time points. Correlation coefficients are Pearson's r. Variables were clustered based on their co-variance, and are ordered based on this clustering.

The correlogram summarises the strength of the correlation between each test by means of a number (the Pearson r-correlation Coefficient[56]), with +1 (darkest blue) indicating a perfect positive correlation between two tests, 0 (no colour) showing completely random co-variance between tests, and -1 (darkest red) showing a perfect negative correlation between tests. For example, higher scores for self-esteem (as measured by the Rosenberg Self-Esteem Scale) were

[56] Pearson r-correlation Coefficient – University of Strathclyde (n.d.) Retrieved 22 April 2015 from http://www.strath.ac.uk/aer/materials/4dataanalysisineducationalresearch/unit4/pearsonr-correlationcoefficient/

associated with lower scores on extroversion (as measured by the Big Five Inventory), with a strong negative correlation (-0.76). Meanwhile, critical thinking test scores (the Ennis-Weir Critical Thinking Essay Test) were higher when resourcefulness scores (Zauszniewski *et al.*'s Resourcefulness Scale) were higher, with a moderately strong correlation of +0.57. Scores are ordered such that "'similar' variables are positioned adjacently, facilitating perception" (Friendly, 2002).

The correlogram below provides an alternative means of visualising the data as a whole, with every test score plotted on the graphs that comprise the upper diagonal.

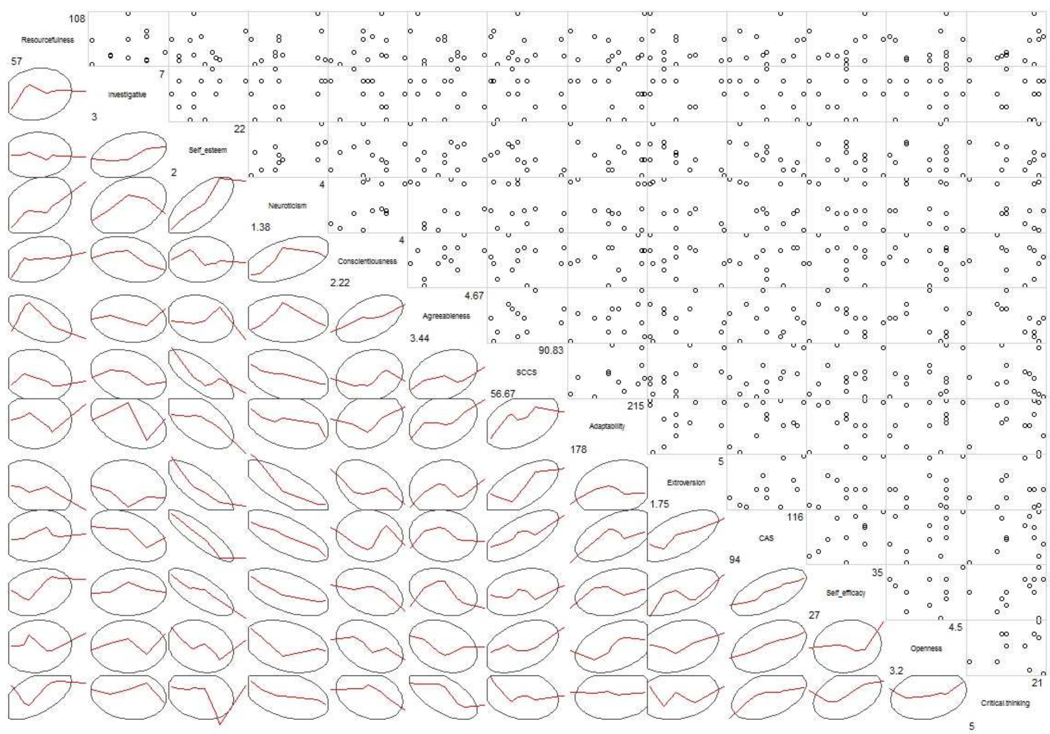


Figure 20: Correlogram comparing scores in the 13 tests conducted, as observed in six individuals at two time points. Scatter plots (above diagonal) show all observations. Line of best fit (Loess function) with confidence ellipse shown (below diagonal).

On the graphs that comprise the lower diagonal of this correlogram, an upward trajectory is indicative of a positive correlation; a downward trajectory shows a negative correlation. The ellipse that surrounds each line of best fit is similar to a 95% confidence interval; straighter, steeper lines indicate a stronger relationship between the two tests, while the tighter the ellipse is to the line, the better the data fits that line. The shape of the ellipse, therefore, represents the degree to which the observed test scores may be due to chance; a tighter shape indicates that the observed scores are less likely to have occurred by chance.

By examining the correlation between tests, it is possible to assess the validity of the tests (are the correlations between tests intuitive?) and to ascertain if there is redundancy in asking subjects to complete so many tests (are some of the closely correlated tests measuring the same attribute?).

4.3 Discussion

Bearing in mind the limitations described above, the pilot study was informative about the usefulness of the selected measures. Mean values of both communication measures were observed to increase between baseline and repeat testing. 95% confidence intervals for change in mean communication scores did not cross zero, suggesting this was not a chance occurrence. The pilot study design – no control group, and very small sample size – does not test the hypothesis that playing commercial video games improves measures of graduate attributes, but this finding is consistent with such a hypothesis, and motivates a further, hypothesis testing, controlled study. Although the other measures did not show significantly different change between the two time points, this is not unexpected with a small sample size, and neither proves nor precludes an effect of commercial video game playing on these measures. The pilot study has also provided useful information about the distribution of these measures' results that will help inform the design of the subsequent study.

In addition to the calculated confidence intervals, the correlations between each measure used in the pilot, as depicted in the correlograms above, provide another means by which the usefulness of the measures may be assessed. The correlation between the two communication measures is moderately strong ($r = 0.76$), which, as they are intended to measure aspects of the same attribute, indicates good validity but also, potentially, suggests that there is an element of redundancy in using both tests. The Rosenberg Self-Esteem Scale produced some of the strongest correlations with other measures, including a moderately strong positive correlation ($r = 0.69$) with neuroticism (as measured by the Big Five Inventory) and strong negative correlations with both communication measures (-74 for the Self-Perceived Communication Competence Scale and -0.87 for the Communicative Adaptability Scale). Whether or not these correlations are intuitive is perhaps open to debate. It is conceivable, for example, that individuals with high self-esteem may also be more neurotic than those with low self-esteem (although this is counter to the findings of the 2001 study by Robins *et al.*, which found that high self-esteem individuals were emotionally stable). A more interesting question is whether high self-esteem should be associated with better communication skill (or, more precisely, with self-perceived communication skill); Ellis and Taylor (1983), for example, found a positive relationship between verbal communication (as rated by recruiters tasked with interviewing student participants) and self-esteem. It does follow, however, that extroverts might find themselves to be capable communicators, in line with the moderately strong positive correlation between extroversion and the two communication measures (0.664 and 0.62). This positive relationship between extroversion and self-perceived communication skill has been demonstrated elsewhere, for example by Opt and Loffredo (2003), who showed that extroverts tend to have a more positive “communicator image” than introverts do.

Other notable correlations include the moderately positive (0.57) correlation between critical thinking ability and resourcefulness, which contrasts with the negative (-0.62) correlation between critical thinking and agreeableness. While it is difficult to say with certainty that these correlations ring true – and the measures, therefore, are valid – it is certainly plausible to imagine a less-than-agreeable critical thinker, and to imagine that critical thinking and resourcefulness are not mutually exclusive. Returning to self-esteem, the strong negative correlation (-0.76) with extroversion is, at first glance, counter-intuitive; however, on reflection, it is perfectly plausible that low self-esteem may underlie extroverted behaviour.

In summary, there is little in this brief analysis of correlations between measures that cannot be reasonably explained, and therefore raise concern about the validity of any particular measure (over-and-above those concerns raised by the 95% confidence intervals). As the only attribute to have two tests dedicated to its measurement, communication skill was, perhaps, likely to be best served by this pilot. However, the strong co-variance of the two measures, as well as the broadly intuitive correlation with other measures, suggest that communication skill should certainly be included in any subsequent work, and may even become the focus of the larger study. If the focus was to shift thus, then it may be argued that the redundancy apparent in administering two communication measures is less of an issue. Rather, it may be beneficial to use the measures concurrently, as a means of monitoring validity of the recorded scores and to allow for a richer understanding of communication skill, as the measures differ somewhat in the aspects of communication they are designed to quantify.

From a practical point of view, the pilot project proved instructive and highlighted a number of challenges and concerns that must be addressed in any subsequent study. Chief among these concerns – and by no means unique to this work – is the issue of volunteer recruitment and retention. As noted above, no control group was recruited. An experiment group of eight volunteers was sought, and seven recruited; however, only six of these completed all of the tests in time to be included in the study (due to overseas travel at the end of the semester).

Without a control group, the study did not test the effect of the intervention (i.e. the game playing sessions): it merely, as noted above, provided a trial run of the exercise, and some indication of the measures that should be employed. However, on reflection, the flawed approach taken to recruitment can be identified and addressed in relation to any subsequent experiment: too few prospective participants were contacted in the first instance, and the response rate over-estimated. Further, the students contacted about the study were not only drawn from a small number of classes, but also from Honours-level (third or fourth year undergraduate) classes. By the second semester, when the pilot was conducted, students at this stage in their academic careers are preoccupied, quite justifiably, by dissertations and final exams. However, this narrow focus was, to some extent, deliberate: conscious of the need to recruit a potentially much larger cohort for the subsequent study, level one and two students – who might be expected to have less pressing academic concerns – were excluded from recruitment, with a view to preserving these students for the larger study. For the main study, a much broader, College-wide recruitment drive will be undertaken, targeting level one and two students exclusively. An additional advantage of recruiting non-final year students is the likelihood that they will remain on campus – and thus be readily available for any follow-up activities, such as further testing or interviews – for at least another year after the initial study has been completed. Logistical concerns aside (a greater number of participants will place greater demands on the limited hardware and software available for gaming sessions, should an identical approach to that taken in the pilot be adopted), it is essential that the main study attract and maintain a large cohort of volunteers, if meaningful statistical analyses are to be performed on the data.

A methodological issue identified during the pilot, which should be addressed before the larger study is begun, concerns the more labour-intensive (non-multiple choice) measures. These measures, most notably the Ennis-Weir critical thinking test (the Moorburg letter) and the MI5 test, arguably require more concerted participant effort to complete. The Moorburg letter, in particular, appeared to frustrate pilot participants, most noticeably when asked to complete the test a second time in week eight. It was observed that participants appeared to spend less time on these tests when encountered a second time, and audible sounds of exasperation from the cohort only added to the suspicion that the tests were not given participants' full attention, and that they were completed quickly, without due care and consideration. Such a response is, perhaps, to be expected – the imagined author of the Moorburg letter is quite a tedious character – but the effect is almost certainly to depress post-test scores. A majority of participants scored less well on both the aforementioned tests on the second sitting and, while it is difficult to ascribe this fall in tests scores to the observed fall in participant commitment for certain, there is cause for concern here. As noted under Research Context above, it may be possible to ameliorate this effect to some extent by devising an equivalent "Moorburg letter" so that participants do not encounter the same task twice, but the concern here is that the equivalent letter is not entirely comparable to the well-established and oft-used original, thus undermining the whole endeavour. Furthermore, it may be desirable to test participants in the larger study a third time to determine if any observed gains are lasting, thus requiring yet another equivalent task.

Technical issues encountered during the pilot were infrequent and relatively slight (as described under 'Games played' above). This was largely due to straightforward factors: familiarity with the chosen platforms (PC and PS3) and most of the games, and, where there were unknown factors, such as the restrictions imposed by the University's IT infrastructure, extensive testing of configurations was undertaken in advance. The related issue of scalability aside, the pilot study did not reveal any significant technical difficulties associated with the approach taken.

The pilot, therefore, has been instructive. However, it also revealed a number of areas for further consideration, and questions that must still be addressed before conducting a larger study. The nature of the control group may need to be explored: it may not be sufficient to recruit a group of students that broadly reflects those involved in the study (in terms of gender, age, year of study, subjects studied, etc.). Instead, a control group perhaps should be asked to play trivial games, e.g. computer-based solitaire, for a duration equivalent to that spent by the experiment group playing the selected games. On the other hand, a randomised controlled design, whereby participants are randomly assigned to either a control group or to a game-playing intervention group, would control for many of the variables not addressed by the pilot (for example, game play habits outside of the study).

The pilot was also intended to help refine the choice of measures to be used in the main study. The use of two communication instruments might be considered a duplication of effort, for example, and while the pilot has shown that there is a strong positive correlation between the two ($r = 0.76$), it was thought that the main study should still include both measures. Not only is it suggested that communication skill is one of the attributes most readily affected by game play, the measures' co-variation suggests good validity while the definition of both measures suggests they are tapping into slightly different aspects of communication. Furthermore, the instruments are relatively short and easy to complete. The unconvincing results produced by the critical thinking and investigative instruments, however, suggest that these attributes are not readily measured in a study of this kind.

Therefore, it is the multiple choice instruments used to measure communication, adaptability, and resourcefulness that will be deployed in the main experimental study.

Reflecting on the pilot, a number of other modifications to the design of the main experimental study were identified. First, while informal post-game discussions were conducted with pilot participants in most cases, these discussions were not structured or recorded in order to facilitate subsequent analysis. The conversations were helpful, however, in gauging the students' attitudes to the study, and provided the illustrative examples used in the discussion above. The main experimental study, then, will include some more formal qualitative data collection, perhaps in the form of post-intervention interviews or focus groups. Second, the fixed time slot for participation in the pilot study was problematic for students with other commitments, and resulted in some participants missing some sessions (including, for one participant, the final testing session where post-intervention attribute attainment was measured). Therefore, any subsequent study should include more flexible opportunities for participation. A more flexible drop-in approach might, however, preclude the use of games such as *The Walking Dead* as this sort of linear, highly narrative-focussed game does not lend itself to being played in short bursts at random points in the story. No additional software requirements – for example, the need to develop bespoke data collection systems over-and-above the facilities offered by Google Forms – were identified in the course of the pilot.

5. Experimental Study

Building on experience gained from the pilot, the main component of this research was a controlled intervention experiment, which involved a cohort of University of Glasgow students playing specified games under controlled conditions over a period. Participants' graduate attribute attainment was tested at several points over the course of the study, with the first battery of tests (pre-test) administered immediately following an initial survey of game play habits. This testing was followed by a semester-long programme (approximately eight weeks) of game play comprising drop-in sessions with specified games in a lab environment. The semester concluded with a final batch of graduate attribute testing (post-test) and interviews with participants.

Since graduate attribute test scores were compared on a participant-by-participant basis, this pre- and post-test design controlled for differences between individual participants; however, it did not control for confounding outside influences. Perhaps the most obvious of these outside influences (over-and-above the process of personal development one might expect of an individual over time) is the effect that attending university is supposed to have on all students: University of Glasgow graduates are expected to have developed the range of attributes detailed above as an ancillary (or perhaps primary) outcome of their degree. For this reason, a randomly assigned control group was tested on the same schedule, comprising students who match the intervention group in terms of demographic background, degree subject, and year of study as closely as possible. A heterogeneous cohort was sought, with participants selected from more than one year of study to help control for the potential effects of a longer university career on graduate attribute attainment. A randomised control design was the aim here, to control for as many variables as possible.

For this study, it was determined that participants should be randomly assigned to one of two groups:

- An intervention group that would be asked to complete a battery of online tests at regular intervals and play selected video games under lab conditions.
- A control group who would be asked only to complete the tests at the beginning and the end of the semester.

As noted in the discussion of the pilot project above, it was thought useful to include more formal qualitative data collection in the experimental study and, to this end, interviews with intervention group participants were conducted at the conclusion of the study. Interviews –

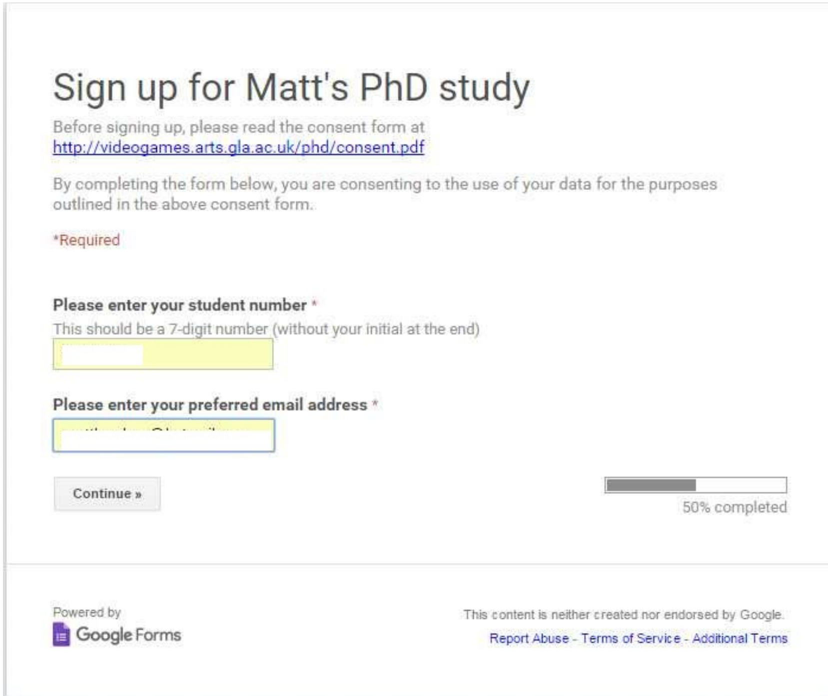
rather than focus groups – were considered the more practical means of collecting such data, largely because the drop-in structure of the study resulted in students completing their participation at different times. Furthermore, it was thought desirable to obtain data from each participant on each attribute under consideration, which might have been difficult to ensure in a focus group discussion.

While the constraints of a controlled experiment are one of this approach's greatest advantages (all participants play the same games under the same conditions, allowing for results that are more comparable), there is little doubt that playing games under such circumstances is not representative of the conditions under which they are normally played. However, this does not necessarily reflect poorly on the use of such experiments if the intention is to ascertain the utility of video games in a university lab environment e.g. in a 'graduate attributes class'. Certainly, the controlled experiment design, in this context, seems less problematic than it might, for example, if the object was to determine the behavioural effects that playing violent video games might have on children. Here, the laboratory environment and ethical considerations mean the experimental setting is entirely divorced from the reality of games being played by children in their own homes. For the purposes of this study, and bearing in mind the constraints imposed by a time- and resource-limited PhD programme, the advantages of an experiment in terms of controlling for certain variables outweigh concerns about the authenticity of the environment in which the games are played (ecological validity is addressed under 'Lab configuration' below).

5.1 Methods

5.1.1 Recruitment

Student participants were recruited to the study by means of an email invitation with a link to an online form. The email was targeted at year one and year two students in the College of Arts and explained that the study may involve playing video games and completing surveys. The email indicated that participants who completed all assigned tasks would be entered into a prize draw for the top prize of a £50 Amazon voucher at the end of the semester. Potential participants were told that they may be randomly allocated to one of two groups but were not given any advance indication of what the tests might be intended to measure.



Sign up for Matt's PhD study

Before signing up, please read the consent form at
http://videogames.arts.gla.ac.uk/phd/consent.pdf

By completing the form below, you are consenting to the use of your data for the purposes outlined in the above consent form.

*Required

Please enter your student number *

This should be a 7-digit number (without your initial at the end)

Please enter your preferred email address *

Continue »

50% completed

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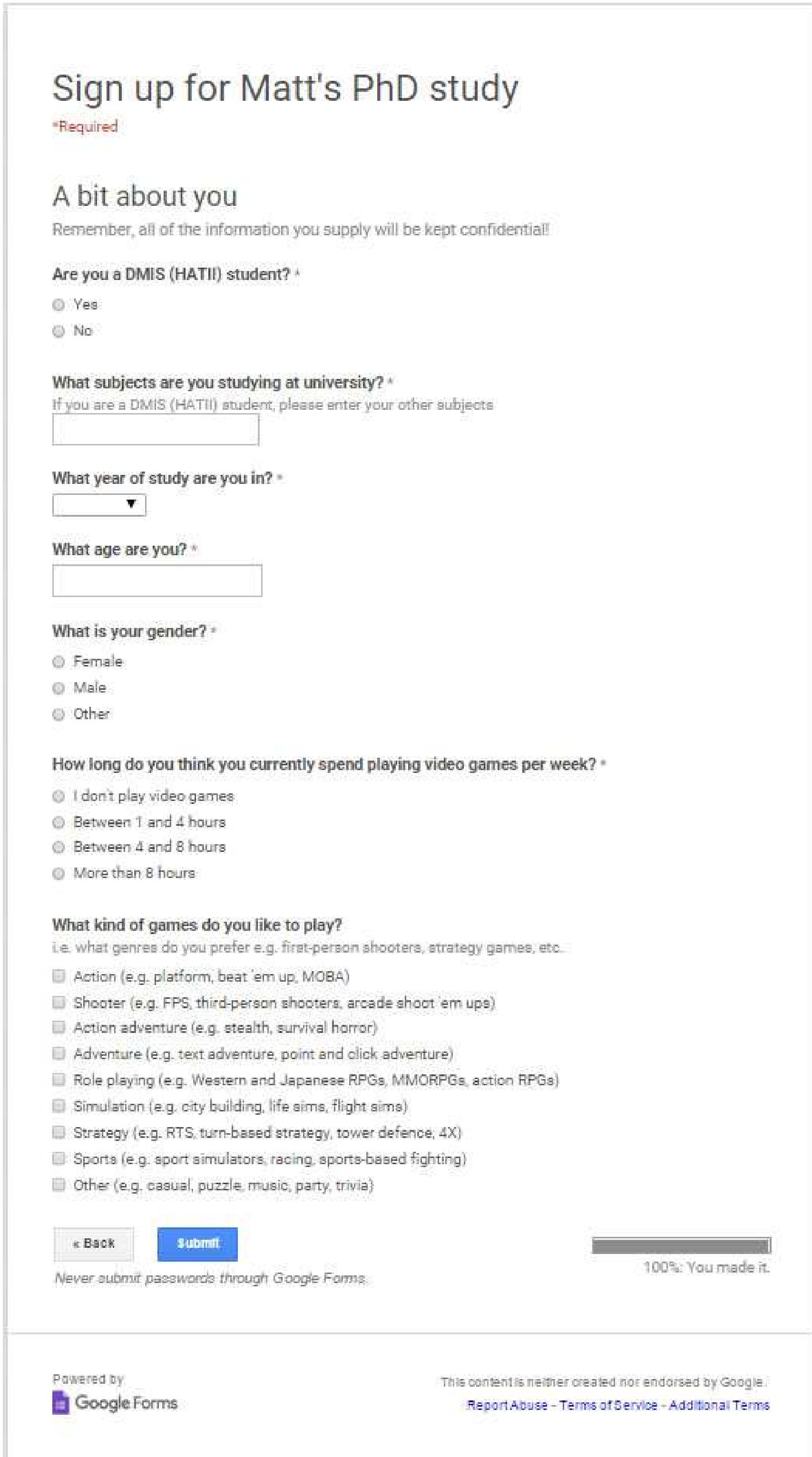

Sign up for Matt's PhD study

*Required

A bit about you

Remember, all of the information you supply will be kept confidential!

Are you a DMIS (HATII) student? *

- Yes
- No

What subjects are you studying at university? *

If you are a DMIS (HATII) student, please enter your other subjects

What year of study are you in? *

What age are you? *

What is your gender? *

- Female
- Male
- Other

How long do you think you currently spend playing video games per week? *

- I don't play video games
- Between 1 and 4 hours
- Between 4 and 8 hours
- More than 8 hours

What kind of games do you like to play?

i.e. what genres do you prefer e.g. first-person shooters, strategy games, etc.

- Action (e.g. platform, beat 'em up, MOBA)
- Shooter (e.g. FPS, third-person shooters, arcade shoot 'em ups)
- Action adventure (e.g. stealth, survival horror)
- Adventure (e.g. text adventure, point and click adventure)
- Role playing (e.g. Western and Japanese RPGs, MMORPGs, action RPGs)
- Simulation (e.g. city building, life sims, flight sims)
- Strategy (e.g. RTS, turn-based strategy, tower defence, 4X)
- Sports (e.g. sport simulators, racing, sports-based fighting)
- Other (e.g. casual, puzzle, music, party, trivia)

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Figure 21: Online forms used to register participants for the experimental study

The online form asked participants for some basic demographic information, including age, gender, and subjects studied. In addition, participants were asked to estimate the frequency with which they played video games and to provide an indication of the genres of game they preferred, if they played them at all. Genre classifications were based on those listed on the relevant Wikipedia page[57], which draw upon those suggested by Adams (2009). While the information found on Wikipedia can sometimes be disputed, its reliance on the crowd for contributing and verifying content helps ensure that the selected terminology is broadly accepted.

5.1.2 Selected games

Several of the pilot games (*Portal 2*, *Gone Home* and *Minecraft*) were used again in the main experimental study with further titles introduced to address those attributes which appeared most promising (particularly Effective Communicators). While the games selected were subject to the same constraints as before, an additional consideration was the quality of the games. A poor quality game is of little utility here: well-received titles are more likely to be representative of those that players would choose to play on their own time, and a particularly poor game is likely to impact negatively on the participants' willingness to engage in the study. While game quality is somewhat subjective, aggregated review scores by sites such as Metacritic[58] are used by industry and consumers alike to determine a game's excellence (see Graft, 2011). Metacritic scores – which convert the scores awarded by critics to games, films and music into a convenient, if opaquely calculated, percentage value – are not without their critics (see Dring, 2010) but they undoubtedly provide an easily quantifiable means of determining the relative merits of a game. For the purposes of this study, no game with a Metacritic score of less than 80 was considered, with scores ranging from 82 (*Lara Croft and the Guardian of Light*) to 95 (*Portal 2*).

Three games trialled in the pilot were not used in the larger study. *Journey* is a PlayStation exclusive title, meaning it was not available for play in the Windows PC-based lab. *Never Alone*, while well received by several pilot participants, divided critics and received a Metacritic score of 72, falling beneath the threshold set for inclusion in the larger study. The game is far from being without merit but this aggregate review score, combined with the relatively taxing technical requirements of the game that made it more challenging to run in the lab environment, led to its exclusion on this occasion. Finally, Telltale's *The Walking Dead* was omitted on largely pragmatic grounds (the first season of the episodic adventure currently holds a Metacritic score of 89). As the most narratively driven game in the pilot, it was not well-suited to the larger study's drop-in structure (see Lab Configuration below) if it was to be

[57] https://en.wikipedia.org/wiki/List_of_video_game_genres (accessed 26 September, 2015)
[58] http://www.metacritic.com/ (accessed 26 September, 2015)

played collaboratively. The emphasis on story means that joining a game at some mid-way point would be to miss important plot developments and contextual subtleties of the characters' actions. Furthermore, no satisfactory instrument was identified to measure the Ethically and Socially Aware attribute, which the game was primarily considered to develop. When these factors were considered as a whole, it was thought more useful to use the slot that may be occupied by *The Walking Dead* to explore the use of alternative titles that might more readily be used to develop measurable attributes such as communication.

A brief description of each of the games that were played in the main experimental is provided below.

5.1.2.1 Borderlands 2

Borderlands 2 is a cooperative role-playing first-person shooter game developed by Gearbox Software, which allows up to four players to "team up with other players for online co-op goodness"[59]. Importantly, the game also allows for LAN-based multiplayer, meaning the cooperative elements functioned within the university infrastructure and did not require an internet connection.

The game also permits players to drop in and drop out as required – a participant who arrived after others had already embarked on a mission could straightforwardly join the team without being forced to wait for the beginning of the next mission, or requiring the others to start again from the beginning. One player, however, must host the game, to which the other players then connect. This arrangement had implications for the study if the host player – usually the first to arrive – was compelled to leave the lab before the remainder of their team. In practice, this was not a hugely problematic issue: in such circumstances, the host must simply remember not to log off when they leave, allowing the others to keep playing. Their place was occasionally taken by newly arrived participants and with university classes scheduled on the hour, this sort of fortuitously timed occurrence was not as rare as one might have expected. The only issue was that the lab computers' useful stopwatch feature (see Lab configuration below) was rendered obsolete if two participants shared a single session login. The user logs would also have been affected, but it was thought that continuity of play was the more important concern for ensuring ecological validity. If more than one participant remained, the erstwhile host's machine could simply be left idle, the game running without player intervention, but if the departure of the host resulted in another participant being left

[59] http://www.gearboxsoftware.com/games/borderlands-2 (accessed 25 March, 2016)

to play alone, the lab facilitator – also the researcher in question – stepped in to fill the void. This course of action may have had a subtle impact on the outcome of the study (see Limitations of the study below) but, again, continuity of play and, crucially, the availability of another player with whom to communicate and cooperate was deemed more important to the validity of the study than concerns about with whom the participants were playing.

Figure 22: Players combine forces to take on a pair of 'Bullymongs' in *Borderlands 2*. Source: http://gearboxsoftware.com

In *Borderlands 2*, the players work together to obtain loot and weaponry while defeating a range of foes against a colourful, if violent, cartoonish backdrop and attendant story. A variety of play styles are supported through the choice of character classes presented to the player, ranging from a tank-like "Gunzerker" to a stealthier assassin. The emphasis is very much on cooperation and, as such, there are no overtly competitive elements, although players receive points for completing missions that they may use to 'level up' their character.

While the opening portion of the game walks the first-time player through the controls and gameplay mechanics, printouts summarising the control scheme were posted around the lab to help familiarise less PC gaming literate participants with the keyboard and mouse controls.

5.1.2.2 Minecraft

Minecraft is discussed in more detail in the Pilot Study section above. However, for the larger study, a slightly different approach was taken, with a *Minecraft* server created to facilitate player cooperation in a persistent world that permitted all participants to share the same space. This is in contrast to the PlayStation 3 version of the game used in the pilot, which was configured only for two-player split screen cooperation.

Figure 23: Players cooperate on some construction work in *Minecraft*. Source: http://minecraft.gamepedia.com.

In the lab used for the larger study, the game server was left running indefinitely, with participants logging in from their individual workstations as and when they arrived in the lab. The persistent game world meant that structures constructed by players, along the lines of that seen in the above figure, could be used and extended (or, indeed, destroyed) by anyone, and returning players were not required to start from scratch each time. Tools and other resources could be stowed away for later gaming sessions, for example, and the basic geography of the world became familiar to participants. The persistent, shared nature of the world also provided greater scope for more ambitious collaborative efforts, given the larger pool of collaborators and increased cumulative duration of play.

Based on the experience of the pilot project, where a list of suggested collaborative tasks to perform was summarily ignored, no attempt was made to impose a structure on the nature of any collaboration. Participants were generally observed to engage in *ad hoc* cooperative endeavours, such as the construction of a mountaintop lair and the creation of a chest intended to store communal supplies. However, with no game-enforced requirement to do so, not all participants engaged in meaningful collaboration. Some would explore the world by themselves, albeit occasionally conversing with others in the same world, while others would play in pairs that reflected real-world relationships, interacting very little with other participants.

As with *Borderlands 2*, a printed summary of the basic controls was made available to participants and, again, if only one participant was present in the lab at a given time, the researcher would join them. *Minecraft's* server-based configuration, however, did alleviate concerns associated with *Borderlands 2* about who was hosting the game. With a *Minecraft* server, the game continued even if there was nobody there to play it.

5.1.2.3 Portal 2

Valve's *Portal 2* also featured in the pilot study and is described at greater length above. As with *Minecraft*, however, the game was played on PC rather than PS3, due to the greater number of available computers. This required a slightly different configuration, and a degree of ingenuity to overcome the lack of an internet connection, due to the game's reliance on the online Steam service to facilitate matchmaking between prospective co-op players (see Technical Issues below). Participants were asked to play *Portal 2* in pairs (again requiring the participation of the researcher in the event of a single participant, or an odd number of participants) and provided with printed instructions on how to host or connect to a cooperative game. The configuration of the game allowed players who had already completed a number of the cooperative levels to skip ahead to subsequent stages and thus minimise repetitious play.

5.1.2.4 Lara Croft and the Guardian of Light

While the cooperative, isometrically presented *Lara Croft*[60] was suggested by the panel of experts, it was not used in the pilot due to time and financial constraints. However, given the game's emphasis on cooperation to solve puzzles and progress, it was deemed useful to include in the main experimental study. The game is something of a departure from previous titles featuring the eponymous heroine, which are traditionally branded as *Tomb Raider* games and typically feature a third-person perspective and single-player gameplay. For the *Lara Croft* games developed by Crystal Dynamics, a fixed isometric view of the action is presented and the game is intended to be played with a friend. One player assumes the role of the gun-toting Lara while the other plays as Totec, a Mayan warrior who comes equipped with a spear that is useful for creating impromptu ladders and bridges.

[60] http://www.laracroftandtheguardianoflight.com (accessed 26 March, 2016)

Figure 24: Players must work together to traverse the obstacles presented in *Lara Croft and the Guardian of Light*. Source: http://laracroftandtheguardianoflight.com

Cooperative players share the same screen (although online co-op is an option in most versions of the game) and for this study both players were given a games controller similar in design to that used with the Xbox 360 games console. This arrangement was intended to provide a more convenient means of cooperative play than crowding two players around a shared keyboard, and preliminary testing suggested that the controllers provided a more intuitive means of controlling the game.

The game's design clearly encourages verbal communication between players, often taking the form of one player solving the puzzle at hand and explaining to the other player what is required of them. Of course, if the solution to the puzzle is plain to both players it is still beneficial, and sometimes essential, for the players to communicate their intentions. The figure above provides a simple example of the cooperative nature of the gameplay, where Lara has used her rope to create a precarious-looking bridge for Totec to cross the spike-filled pit below. Once Totec has crossed, he will be required to create a bridge for Lara to follow him by throwing his spear into the wooden planks that adorn the wall behind the pit. Only Lara possesses a rope and only Totec can throw spears – spears too weak to support the weight of the hulking warrior himself – meaning that this and numerous other obstacles may only be traversed by means of carefully planned teamwork. Discovered resources such as treasure, health, and ammunition must also be shared, requiring a degree of fast-paced negotiation between players. While the demise of a player's on-screen avatar results in little more than a brief inconvenience, there is an element of competition introduced by a point system that rewards players for their individual success in collecting artefacts and dispatching enemies. These points accumulate over the course of a chapter and are displayed at its close. However, a player's death – however inconsequential this may be in terms of overall progression – robs that player of all the points they have accrued up until that point. This dynamic does not lessen the fundamentally cooperative nature of the game but it does add some small significance to the quick-fire negotiations that mediate the allocation of spoils such as health.

A chapter select feature allowed players who had previously visited the lab to pick up the game at approximately the point they left off, but this facility was dependent upon the presence of a sufficiently advanced game save file on the players' chosen computer. For example, if a player had completed the third chapter of the game in their first lab session and they wished to pick up the story at the beginning of chapter four, they had to ensure they selected a computer that had previously been used to advance to least the end of chapter three. In order to ensure that participants enjoyed as much flexibility as possible when it came to selecting where they began their game – even if the computer they'd previously used was occupied – a reasonably advanced save file was copied to all of the computers, thus unlocking the first few chapters for all participants. A related issue arose from the mismatch of participant progress, however. As a strictly two-player affair, the two participants must agree on where to begin and a player new to the game is unlikely to wish to start their adventure halfway through one of the later chapters because of their fellow participant having already logged an hour and half of gameplay in a previous lab. Therefore, the further advanced player in such pairings was usually required to replay the opening chapters of the game in order that the new player could experience them. This was necessary because it is in the initial portion of the game that the mechanics are introduced and explained, and subsequent chapters are naturally more challenging than those that precede them. So, while communication and cooperation were still required to proceed, the experience of the more advanced player in such situations was undoubtedly altered and, based on observed body language and commentary, the experience was rendered somewhat less fun by the repetitious nature of play.

As one of the more recently released titles used in the study, *Lara Croft* also placed some of the greatest strain on the limited technical capabilities of the comparatively aged computers. The associated challenges are discussed under Technical Issues below.

5.1.2.5 Warcraft III

Released in 2002, *Warcraft III: Reign of Chaos*[61] was the oldest game used in the study. The rationale for its inclusion was based on its strategic multiplayer mode, which may be played over a local network without an internet connection. While *Warcraft III* was not mentioned specifically by the panel of experts, a number of its derivatives were, namely, the ubiquitous *World of Warcraft*[62] (*WoW*) and *Dota 2*[63]. These are quite different games, belonging to different genres: *Warcraft III* is a Real-Time Strategy (RTS) game whereas *WoW* is a Massively Multiplayer Online Role Playing Game (MMORPG) based on the lore of the RTS series which preceded it; *Dota 2* is a Multiplayer Online Battle Arena (MOBA) game and sequel to a mod of *Warcraft III*. However, certain shared elements – the online cooperation of *WoW* and the strategic combat of *Dota 2*, in particular – made *Warcraft III* an interesting candidate for inclusion in the study.

Warcraft III is played on a three dimensional map with up to four races (Orcs, Humans, Night Elves, and Undead) vying for domination. Each player controls one of these races and must collect resources – gold and lumber – to develop and construct buildings, units and weaponry with the ultimate aim of obliterating their opponents from the map. The multiplayer mode of the game supports team play, meaning that participants in the study could work together (even as different races) to defeat a computer-controlled adversary. Unlike *Lara Croft*, many different multiplayer configurations are supported, from the previously described two-versus-one scenario through to any combination of human and computer teams. The computer-controlled adversary may also be handicapped somewhat to accommodate inexperienced human players.

[61] http://us.blizzard.com/en-us/games/war3/ (accessed 26 March, 2016)
[62] http://us.battle.net/wow/en/ (accessed 26 March, 2016)
[63] http://blog.dota2.com/ (accessed 26 March, 2016)

Figure 25: A Night Elf (turquoise) encampment comes under Human (blue) attack in *Warcraft III*. Source: http://us.blizzard.com/en-us/games/war3

Participants were instructed to play cooperatively (i.e. on the same team) in pairs or groups, with one player hosting the game, and instructions on how to configure a suitable LAN game were provided. If enough participants were available, competitive play was permitted (for example a team of two participants against another two) but cooperation was encouraged. As with *Borderlands 2*, care was required to ensure that the player hosting the game did not bring play to an abrupt end by logging off unexpectedly but this issue was more easily managed with *Warcraft* due to its match-by-match structure. With a little planning and foresight, the hosting of games could be managed in such a way that there was little significant disruption to play while a new host was found. Slightly more problematic was the issue of one participant being defeated while their ally clung on indefinitely in their fight against the computer's forces. Such occurrences were relatively rare – allied teams are likely to share in one another's fate, with defeat at the hands of the computer eradicating both players in quick succession – but if one player was prematurely ejected from the game, the remaining player or players were encouraged to bring their campaign to a swift conclusion.

In some respects, the RTS genre – which the *Warcraft* series helped define – is perhaps the least accessible of the genres employed by the study. Certain participants, specifically those who had played the game, or its sister series, *Starcraft*[64], relished the opportunity to take part in LAN-based RTS skirmishes. For others, however, the game's amalgam of unique fantastical units and associated strategies proved initially baffling and the required two hours of gameplay was more of a chore than a pleasure. As such, *Warcraft III* was probably the most divisive of the titles used in the main experimental study. However, the promise of playing something entirely different the following week – namely *Team Fortress 2* – and the enthusiasm of the more RTS-literate players helped see less devoted participants through the task.

5.1.2.6 Team Fortress 2

Valve's *Team Fortress 2*[65] is the multiplayer-only sequel to a popular mod of the 1996 first-person shooter, *Quake*. While it does feature in-game purchases – players may opt to buy particular upgrades and other content – the core game is free-to-play, making it an attractive option for use in a study such as this. The free-to-play tag is often synonymous with lower quality titles; however, the game was also critically well received, with a Metacritic score of 92. Crucially, multiplayer games may be hosted on a central server, again avoiding the need for an internet connection to facilitate matchmaking.

Gameplay in *Team Fortress 2* is, as one might expect from the title, team based. Players may join the game at any time by dropping in to the current match and side with either the RED ('Reliable Excavation & Demolition') team or the BLU ('Builders League United') team. The player may opt to let the computer choose their side, in which case they are automatically allocated to the team with fewer players. Similar to *Borderlands* 2, players may select from a range of character classes that allow for experimentation with different play styles, ranging from the slow but formidable Heavy to the elusive Spy. An interesting feature of the game is the optional inclusion of 'bots'. These are computer-controlled team members that use occasionally crude artificial intelligence to help achieve their team's objective. Bots may be added to either team on an *ad hoc* basis by the server administrator and this technique was used in an attempt to balance teams when participants left the lab. Their effectiveness was somewhat limited, however, primarily because not all of the maps available in the game

[64] http://eu.battle.net/sc2/en/ (accessed 30 March, 2016)
[65] http://www.teamfortress.com/ (accessed 30 March 2016)

support this feature: bots added to an unsupported map simply run on the spot where they spawn at the beginning of the level and do little to assist their human team mates.

Figure 26: BLU versus RED combat during a Capture the Flag game in *Team Fortress 2*. Source: http://wiki.teamfortress.com

The structure of the game sees the competing teams thrown into conflict on a time-limited or objective-based map. When a team meets the victory conditions – or time runs out – the next map is loaded and a new objective pursued. Each map operates in a pre-determined game mode, such as Capture the Flag, Payload, or King of the Hill, with the objective of each mode explained by means of a short video shown at the beginning of play. In Capture the Flag mode, for example, both teams are tasked with stealing a briefcase of intelligence from the depths of the opposing team's base and transporting it back to their own, with the briefcase standing in for the titular flag. By default, the winning team is that which captures the enemy intelligence three times. Players must therefore decide how much emphasis to place on defence of their own intelligence versus making an offensive move to capture the enemy's briefcase, with different team members assuming different roles as agreed. A full list of game modes is available on the *Team Fortress 2* Official Wiki[66].

Regardless of game mode, the team-based gameplay means that communication is critically important. At a basic level, communication may comprise little more than desperate pleas for

[66] List of game modes. *Team Fortress 2 Official Wiki*. https://wiki.teamfortress.com/wiki/List_of_game_modes (accessed 30 March, 2016)

assistance when an enemy agent gains the upper hand. However, a successful team will communicate in a more sophisticated manner to convey strategies and status updates, often under the direction of a *de facto* leader. Although it was not used extensively in this study, the game supports private text-based communication between teammates, should there be a desire to communicate more covertly in a shared space such as the lab.

The conventions and mechanics of *Team Fortress 2* are firmly rooted in the sort of online gaming that attracts particularly dedicated players, with terms such as 'Capture the Flag' or 'King of the Hill' carrying meaning for players of numerous online shooters. However, the cartoon aesthetic and accessible design of Valve's game meant that its appeal was not as limited as might have been feared. Inexperienced participants were observed to be somewhat bewildered by the game, struggling not only to operate their allocated weapon effectively but also failing to grasp the geography of the game's constantly changing maps: cries along the lines of "I don't even know where I am!" were not uncommon. However, for the most part, participants did appear to enjoy the game on the basis of its frenetic and often comedic tone, and as a result of the team-based structure. The range of roles afforded by the game's various character classes also encouraged players to find a niche in which they were comfortable. As indicated by several participants during their post-intervention interviews (see below), it was possible to assume the role of a lowly grunt – responsible, perhaps, for pushing the payload in certain missions – and still gain satisfaction from being part of the team while other, more experienced players assumed more complex duties. Further, as observed with previous games, more confident players were on hand to assist and mentor those who were new to the domain of online shooters, particularly if they were on the same team.

5.1.2.7 Papers, Please and Gone Home

Both *Papers, Please* and *Gone Home* are described in more detail in the preceding account of the pilot study, and they were deployed in much the same manner here. These single player games differed in nature from the majority of the titles used in the larger study, which emphasised cooperation and communication in a multiplayer environment. While there is an argument to be made for the authors of these more intimate, personal games using their work to communicate with the player, the focus is not on communication in the sense implied by the university's definition of Effective Communicators. However, both games may be viewed as requiring the player to exercise critical thinking, and to demonstrate resourcefulness and adaptability. These latter attributes were among those intended to be measured by the instruments used in the larger study, while it was thought useful to discuss the possibility of these games' being used to develop less tangible attributes – particularly Ethically and Socially Aware – with the participants in the interviews that followed. These games were combined into a single final task, with participants asked to play an hour of each.

5.1.3 Lab configuration

The configuration of the gameplay labs was modified from that used in the pilot, with the primary aim of improving participant retention by providing a more flexible timetable. As such, the labs operated on a drop-in basis, open for students to come and play the specified games between the hours of 9am-5pm every Tuesday, Wednesday and Friday (bar a single week of the semester when pre-existing travel plans interceded). The flexible drop-in structure also partially addresses a common criticism of laboratory-based video game studies, where an arbitrarily defined time limit on play does not mirror the circumstances under which players normally play games (Egenfeldt-Nielsen *et al.*, 2008, p. 233). While participants were asked to log 120 minutes of play on most games, time management was their responsibility, meaning they could choose to play for "just five minutes more" or leave when they had a class to attend. As the logs demonstrate (see Figure 28 below), participants did occasionally opt to play for longer than the prescribed period, either because they were simply immersed in an enjoyable experience, or because it is more natural to stop playing at a suitable juncture in the game, for example, at the completion of a level or mission. In this sense, the lab was arranged to provide better ecological validity than would have been afforded by imposing a rigid temporal structure on proceedings. No player welcomes being told to stop when they are in the middle of a game they are enjoying, and many players – particularly those less accustomed to lengthy sessions of video game play – might find being asked to endure two hours of an unfamiliar game prohibitively tiring.

Task one

- Play 2 hours of **Borderlands 2** in co-op mode
- Complete the surveys indicated

Task two

- Play 2 hours of **Minecraft** in multiplayer mode
- Complete the surveys indicated

Task three

- Play 2 hours of **Portal 2** in co-op mode
- Complete the surveys indicated

Task four

- Play 2 hours of **Lara Croft and the Guardian of Light** in co-op mode
- Complete the surveys indicated

Task five

- Play 2 hours of **Warcraft III** in multiplayer mode
- Complete the surveys indicated

Task six

- Play 2 hours of **Team Fortress 2** in multiplayer mode
- Complete the surveys indicated

Task seven

- Play **one** hour of **Papers, Please** in story mode
- Play **one** hour of **Gone Home**
- Complete the surveys indicated

Figure 27: Game-based tasks, as presented to participants

In total, seven tasks were set for participants in the experimental group, comprising the eight games described above. A periodically updated list of tasks was displayed in the lab, with new tasks added on an approximately weekly basis. Most tasks involved the participants playing a prescribed game for two hours, with the exception of the final task that comprised an hour each of two comparatively short single player titles that differed from the more open-ended multiplayer games of tasks one to six.

Image removed due to confidentiality issues

Figure 28: Log used to capture participants' gameplay time in the experimental study

As noted above, the labs operated on a drop-in basis. As such, participants were permitted to play the games as and when it fitted with their existing schedules, provided they logged the requisite number of minutes of play time on each task. Time played was logged by participants on exiting the lab (see Figure 28), and play sessions ranged in duration from little more than a few minutes to sometimes more than the suggested two hours.

Rather than adhere to the strict weekly schedule of the pilot, where missing a week due to illness, travel or pressing university deadlines may have precluded a participant from continued engagement with the study, participants here were allowed to make up for lost time by logging more than two hours in a single week. However, participants were asked to complete the battery of tests after logging the required time playing each game, regardless of the particular configuration of their play time. Thus, each game is treated as a milestone, rather than collecting data on a weekly schedule. Given the irregular, drop-in structure of the study this was deemed a more meaningful approach to data collection, as it may allow something to be said about the effect of individual games and cumulative time spent playing them. However, in practice, the game-by-game data is not especially meaningful or useful, precisely because of the drop-in structure: testing was not comparable between participants because there was nothing to stop individuals playing a little of two consecutive games in one day, then taking the next battery of tests. Furthermore, it was observed that participants occasionally forgot to complete tests after a game, and instead returned to them at a later date, perhaps even in the same sitting as another set of tests. The only meaningful comparisons are those made between week one and week eight, when all participants had logged comparable gameplay under lab conditions.

Figure 29: Lab environment used in the experimental study

The lab environment consisted of twelve very modestly specified PC workstations running Windows 7 with flat screen monitors, games controllers, and optional headphones. The lab's pre-existing network infrastructure was not initially connected to the internet but all of the machines were connected to a network hub, allowing for cooperative and competitive Local Area Network (LAN) play where supported by the games. Games and operating system updates were installed via USB drive and tethering to a mobile internet hotspot, which was relatively time-consuming. Some weeks into the study, a means of connecting the hub to the outside world via the university's existing high-speed internet connection was discovered, which made installation and maintenance of software somewhat more efficient. More pertinently, the network ports required to connect to the Steam platform were eventually opened by the university's network administration team, allowing for more straightforward purchase, download, and patching of the games software. These ports are typically blocked by Higher Education IT services for perhaps obvious reasons – games are not generally encouraged at university, and every open port increases the potential area of attack available to malicious parties outside of the institution.

Local user accounts were created for each registered participant on each computer. A batch file was written to write user logon and logoff events to a log file, with the intention that these logs could be consulted if there was some question over the veracity of a participant's manually logged play time. Ultimately, however, there was no cause to consult these logs. Having each participant log on as themselves on their arrival in the lab did, however, prove useful in terms of the manual time-keeping participants were asked to perform as a small stopwatch application was configured to start running on the desktop when a user logged in. Thus, if a participant came to the end of their available play time and had omitted to take a note of the time at which they had arrived, the stopwatch would provide an approximate measurement of their duration of play (approximate in that getting started with the prescribed game may take a minute or two, for example). To further encourage participants to log their play time, the log book was placed next to the door of the room and accompanied by signage to remind participants to log their visit. As the lab was always staffed, it was also possible to offer verbal reminders to participants if it appeared they were about to leave without updating the logbook.

A week into the study, at the suggestion of one of the participants, a private Facebook group was created. Participants could opt to join the group, with the idea that it might be used to help coordinate multiplayer sessions in the lab. It was used in this capacity on a few occasions but it was perhaps as useful as a means of informally communicating with participants about changes in lab opening times, details of the upcoming games, and other largely pragmatic issues.

5.1.4 Issues encountered

Certain challenges were encountered during the larger study, some of which were anticipated following the pilot study and others that were unique to the slightly modified approach taken to the subsequent work.

With the greater number of participants involved, it was not practical to use the small number of PlayStation consoles to support the larger study. As noted above, however, twelve

Windows-based PC workstations were obtained and all games were played on this platform. The predominant means of procuring games on PC is Valve's Steam service, which provides digital downloads (replete with a form of Digital Rights Management, or DRM) at competitive prices, especially during their regular sale events. Thus, this was the mechanism by which most games were obtained. It was known from the pilot project that the network ports required for Steam[67] were not open on the university firewall and a support call to have these ports opened was logged with the relevant IT service. Quite understandably, opening ports is a non-trivial undertaking for a large institution's networking team, which also happened to be engaged in rolling out the IT infrastructure for a recently expanded campus at the time. As a result, these ports were not open at the commencement of the study. For the most part, this issue caused little more than inconvenience – the researcher used a mobile internet hotspot and a USB Wi-Fi dongle to install Steam and the required games on each machine, which simply required time and patience. Potentially more problematic was the use of Valve's Steam service to facilitate matchmaking, mediating the connections between players that are required for multiplayer gaming. By default, Steam is used to facilitate the multiplayer component of *Portal 2* and *Team Fortress 2* – both titles produced by Valve. An unforeseen additional complication with Steam matchmaking related to the limitations placed on newly created Steam accounts. In order to purchase and install multiple copies of each game, a Steam account with an associated email address (e.g. phd1@matthewbarr.co.uk) was created for each machine in the lab and games bought – as gift purchases, via the researcher's own Steam account – for each. However, in order to "protect our users from spamming, phishing, and other abuse, Steam prevents some accounts from accessing certain community and social features"[68]. To this end, Steam limits the ability of accounts that have spent less than five US dollars to engage in multiplayer activity, such as sending friend invites. As all of the purchasing was done through a single account, this restriction remained in place for all of the accounts used in the lab[69].

However, solutions were found for both games. As noted above, a local dedicated server was created for *Team Fortress 2*, to which participants' games connected instead of looking to Steam for potential games. This was very straightforward to accomplish as LAN play of this nature is supported by default in the game. The solution for *Portal 2* was slightly less

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[67] *Required Ports for Steam*. Steam. https://support.steampowered.com/kb_article.php?ref=8571-GLVN-8711 (accessed 19 November, 2013)

[68] *Limited User Accounts*. Steam. https://support.steampowered.com/kb_article.php?ref=3330-IAGK-7663 (accessed 31 March, 2016)

[69] Furthermore, the creation of multiple shared Steam accounts may be in breach of the service's terms and conditions.

straightforward, as LAN co-op is not an option available to players when they launch the game and, while the functionality does exist in the game's code, it may only be accessed by entering command line instructions via a normally concealed console. A more user-friendly workaround was found on the Steam Users' Forum[70] that, through the modification of one of the game's configuration files, allowed the option to connect to games on specified lab computers to be added to the game's menu. Participants were then instructed to choose the relevant menu option, depending on whether they were to host or connect to a game. In the latter case, they were instructed to choose the option that would connect them to the machine hosting the game, as identified by its IP address, which was clearly displayed on each machine.

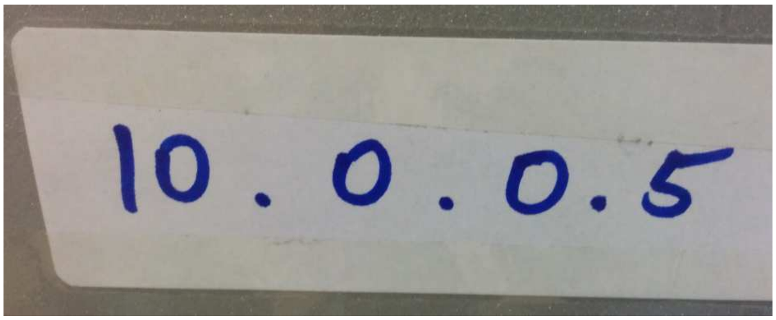

Figure 30: Each machine in the lab was clearly labelled with its IP address, which was used to facilitate certain multiplayer games such as *Portal 2*.

One game that was considered for inclusion in the study but could not be made to function without a persistent Steam connection was the multiplayer whodunit *The Ship,* which was, at the time, being redeveloped by Scottish development studio, Blazing Griffin[71]. MMORPGs *World of Warcraft* and *Star Wars: The Old Republic*[72] were also candidates for inclusion but these games both require still more network ports to be opened, so this was not a realistic aim. While technical issues precluded any experimentation with these latter titles, the learning curve and overall complexity of such MMORPGs was also considered. Certainly, in the two hours allocated to most of the other games, it seems unlikely that newcomers to the MMORPG genre would have progressed much beyond the most rudimentary stages of the game and thus would not experience the most relevant aspects of the genre, particularly the group-based questing. Further, if existing *WoW* players in the experimental cohort wished to use their own characters – an understandable desire if they have invested many hours into

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[70] *How To: LAN COOP*. Steam Users' Forum. http://forums.steampowered.com/forums/showthread.php?t=1855538 (accessed 19 October, 2015)
[71] http://www.blazinggriffin.com/games/the-ship-remasted/ (accessed 31 March, 2016)
[72] http://www.swtor.com/ (accessed 31 March, 2016)

their creation and development – this might also have been problematic, as high-level characters are generally prevented from grouping with new players in the first place.

More mundane were the issues relating to the available hardware. As noted above, the machines used in the lab were not especially well specified, and certainly not intended for gaming. They did, however, prove perfectly usable for most games, especially when graphical options were adjusted to reflect the limited capabilities of the machines' graphics cards. The exception to this was perhaps *Lara Croft and the Guardian of Light*, which, even on the lowest performance settings, was somewhat sluggish and occasionally unresponsive. *Lara Croft* was also one of the few games to rely on the supplied games controllers rather than the keyboard and mouse, and the build quality of the controllers – styled after the very popular Xbox 360 controller – was such that the effects of sluggish controls were amplified by the peripherals' shortcomings. These shortcomings, which mostly related to the left analogue stick typically used for movement, were not immediately obvious. On delivery, the controllers appeared to be of excellent quality and offered a more than acceptable recreation of the experience afforded by the rather more expensive Xbox-branded version of the peripheral. However, after a period of use, the analogue stick became unreliable, particularly in the diagonal directions – the very directions in which a player of an isometrically presented game is likely to wish to move.

Such issues were not critical, however. They might have been considered so if they had resulted in a significant number of participants abandoning the study in response to hardware or software problems but while several participants passed comment on the unsatisfactory nature of their experience with *Lara Croft,* none stated that it was unplayable or that they wished to abandon play. Participant attrition is discussed under Results below, but it is worth noting here that 20 participants completed the surveys associated with the preceding game (*Portal 2*) and 17 completed those associated with *Lara Croft*. This is not an especially significant loss when considered in relation to other stages of the study: of the 37 participants who completed the initial battery of tests (before playing any of the games), only 23 completed the subsequent batch of tests following the first game.

NVivo was used to analyse the qualitative interview data collected at the conclusion of the study. Due to an administrative error, a license for NVivo 11 Plus – rather than Pro – was allocated in the first instance. The Plus version of NVivo 11 includes built-in sentiment nodes for use with its advanced automatic sentiment coding features. In an effort to avoid duplication, these nodes were used to code the interview data, albeit manually. However, when the Plus license expired and a Pro license issued instead, these sentiment nodes became unavailable – data coded at the built-in nodes was still visible, but no new coding could be carried out using the built-in nodes. This occurred around the time that intra-rater reliability checks were begun (see Quantitative Results below), meaning that the researcher had to have access to these nodes in order to compare the first pass of coding with the second. Sentiment nodes were ultimately recreated, allowing comparisons to be made.

5.2 Quantitative Results

In total, 100 level one and two undergraduate students were recruited to the main experimental study. These participants were randomly assigned to either the control group or intervention group. 36 of the 50 potential participants assigned to the control group completed the first battery of online tests while 36 of the intervention group completed the same before playing any of the selected games. All subsequent analysis treats the completion of these tests as part of the entry criteria for the study. This approach differs from the 'intention to treat' of many medical studies (Hollis & Campbell, 1999) wherein all participants are included in the analysis regardless of whether they completed the study or received any treatment. However, as no relevant data pertaining to the absent participants was available prior to beginning the study (as might be the case in a medical trial, for example, where pre-existing medical records for those who did not complete any treatment might be used to establish a baseline), this approach was thought most appropriate here.

Data collected via the online battery of tests are considered below on an attribute-by-attribute basis, noting any findings that may support, disprove, or otherwise speak to the hypothesis that playing certain commercial video games is associated with gains in each.

The control and intervention groups were assessed for similarity at baseline (taken to mean the point at which the first battery of tests was completed, following randomisation) by comparing demographic factors and baseline test scores by attribute (Table 7). Correlations for all measures at baseline (week one) are for all participants: week one is when most data is available, and there is no issue with combining data because all participants are pre-intervention. All comparisons were by Fisher's exact test for categorical variables (for example, year of study), and by *t*-test measures (Welch's t-test) assuming unequal variance between groups for continuous variables such as those numerical values derived from attribute tests.

Table 7: Summary of week one test scores and demographic information by control/intervention. Includes only those participants who completed surveys at baseline (week one). Highlighted rows are those that refer to key attribute-measuring scores.

		Control	Intervention	*p*
N		36	36	
Measures				
Group (%)	Control	36 (100.0)	0 (0.0)	
	Intervention	0 (0.0)	36 (100.0)	
I-ADAPT-M (mean (SD))		202.69 (19.70)	200.36 (37.65)	0.743
Communicative Adaptability Scale (mean (SD))		100.14 (8.92)	99.06 (17.88)	0.746
Self-Perceived Communication Competence Scale (mean (SD))		885.44 (202.36)	873.69 (224.72)	0.816
Resourcefulness Scale (mean (SD))		82.75 (19.75)	81.44 (23.33)	0.798
Rosenberg Self-Esteem Scale (mean (SD))		22.56 (3.30)	23.25 (3.28)	0.374
General Self Efficacy Scale (mean (SD))		31.00 (3.57)	31.69 (6.23)	0.563
Agreeableness (mean (SD))		30.78 (4.07)	30.83 (5.16)	0.96
Conscientiousness (mean (SD))		33.22 (2.77)	33.22 (6.53)	1
Openness (mean (SD))		38.22 (4.91)	39.78 (9.60)	0.39
Neuroticism (mean (SD))		26.83 (3.57)	28.00 (6.03)	0.321
Extraversion (mean (SD))		27.28 (3.73)	27.64 (4.58)	0.715
Demographic information Note that one participant in both groups did not complete the demographic survey, so N = 35 for these data.				
Year (%)	Level 1	22 (62.9)	24 (68.6)	0.801
	Level 2	13 (37.1)	11 (31.4)	
Age (mean (SD))		19.80 (3.41)	21.09 (5.95)	0.271
Gender (%)	Female	18 (51.4)	20 (57.1)	0.346
	Male	14 (40.0)	15 (42.9)	
	Other	3 (8.6)	0 (0.0)	
Hours spent playing video games per week (%)	0	10 (28.6)	9 (25.7)	0.973
	1-4	12 (34.3)	14 (40.0)	
	4-8	6 (17.1)	6 (17.1)	
	>8	7 (20.0)	6 (17.1)	
Retention (%)	Completed	20 (55.6)	16 (44.4)	0.48
	Lost to follow-up	16 (44.4)	20 (55.6)	

Table 7 indicates that there were no significant differences between the randomly assigned control and intervention groups. The mean age of the intervention group (M = 21.09) was slightly higher than that of the control group (M = 19.8), with a larger standard deviation (SD = 5.95 versus SD = 3.41) but otherwise the groups were remarkably similar. Differences in key characteristics such as gender, year of study, and time typically spent playing video games per week were all well within acceptable bounds; for example, the percentage of participants who did not play video games at all was 25.7% for the intervention group and 28.6% for the control. Exposure to games outside of the study was an important variable that randomisation was intended to control – this was, perhaps, the factor most likely to skew the results of the intervention.

Due to concern about retention bias, baseline features were also compared between those with and without week eight (end of study) scores, i.e. those participants which completed the study and those that were lost to follow-up (Table 8). Total scores for each attribute were calculated, in accordance with the published scoring mechanisms, for each participant at each time point they completed testing.

To assess the primary research question, a summary measure of "score change" was calculated for each attribute by subtracting week one score from week eight score for each participant with available data. Thus, each participant has a score change for each attribute, which is negative if their score worsened, and positive if their score improved. The distribution of score changes was assessed in both groups (control and intervention) for each attribute:

- Score changes were assessed for normality by graphical means, using histograms (see Figure 31 below; distributions for each of the key attribute-testing measures are also visualized using violin plots under the relevant sections below);

- Each participant's week one score was plotted against their week eight score in a scatter plot, such that participants with positive score changes lay above the diagonal, and negative score changes below diagonal (providing a visualization of how score change differed across the range of week one scores);

- Differences in score change between the groups were formally assessed by calculating a Cohen's d for difference in the means for the groups and tested using t-test assuming unequal variance.

The parametric statistical tests used here rely on the assumption that data are distributed normally. The study's relatively small sample sizes were thought to prohibit assessing normalcy based on the changes in overall score change (as used in the analysis of the measures above). Therefore, normalcy was assessed by plotting histograms for each measure, showing the changes recorded for individual questions, as opposed to the overall score for each participant. This approach provided a great deal more data to plot and thus a more reliable assessment of normalcy. As shown in Figure 31 below, a classically normal distribution may be observed for all four of the attribute-measuring instruments, particularly where the CAS, I-ADAPT-M and Resourcefulness Scale data are concerned.

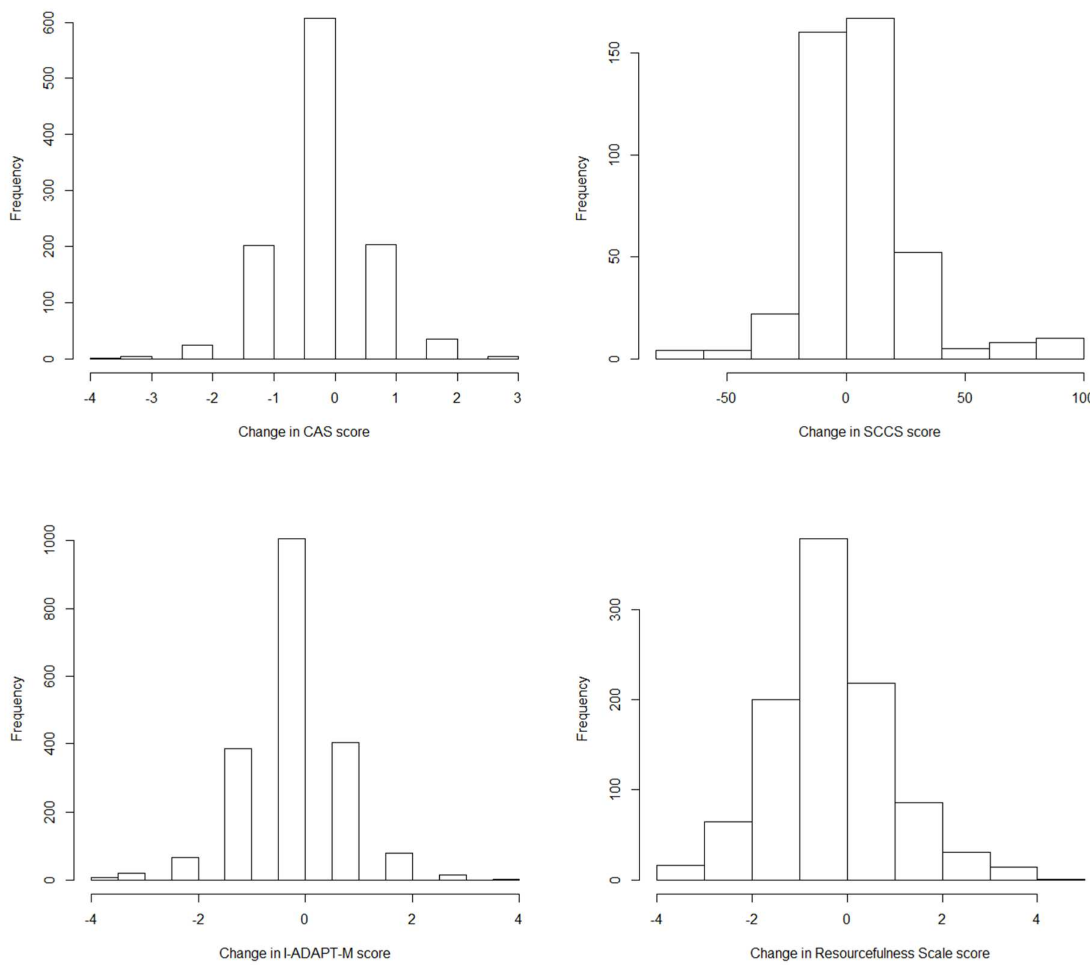


Figure 31: Histograms showing distributions of score change between week one and week eight for each measure (CAS, I-ADAPT-M and Resourcefulness Scale), for all participants.

In order to check that distributions for both groups (control and intervention) were similar, the same data were plotted again on a per group basis, as shown in Figure 32.

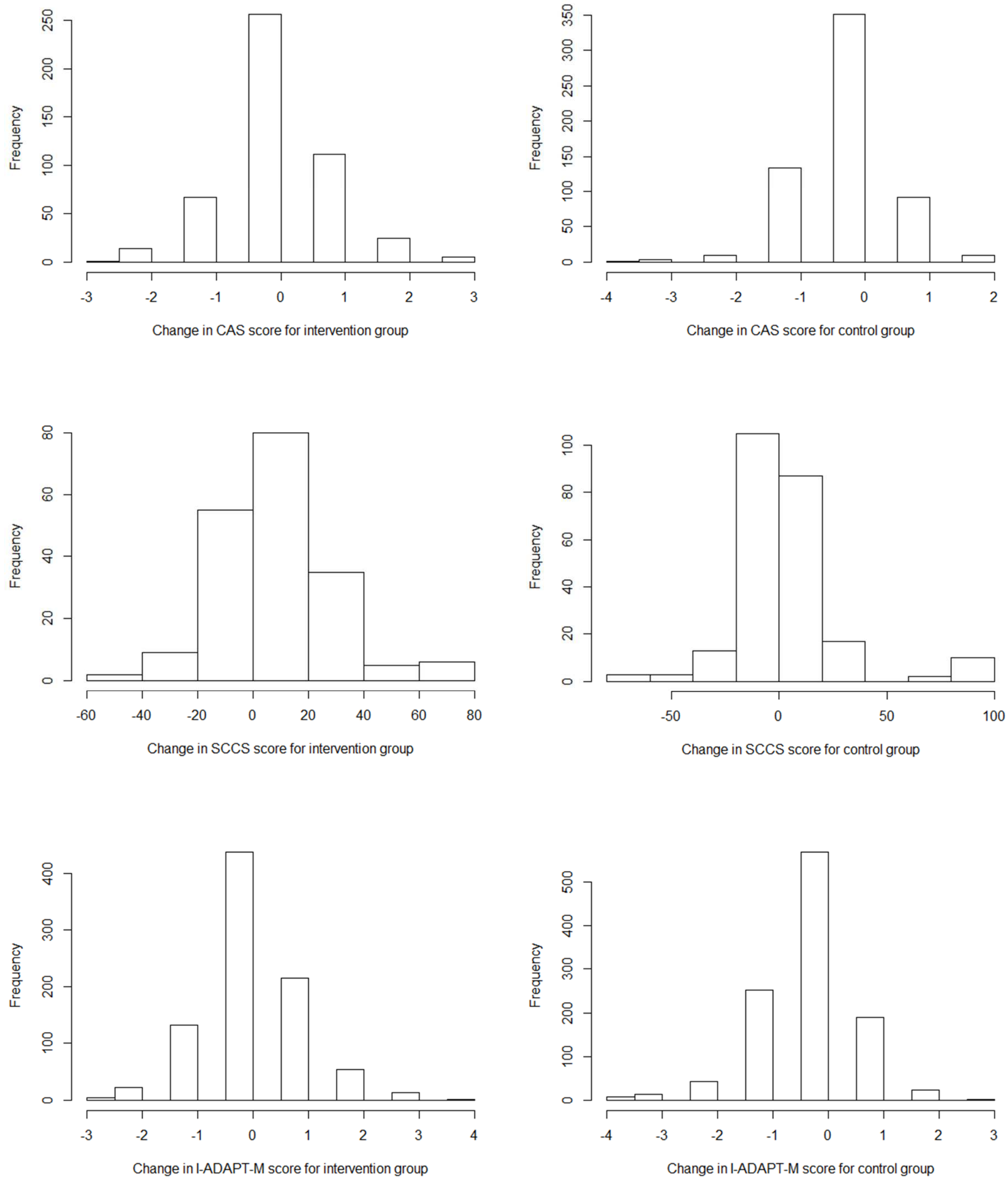


Figure 32: Histograms showing distributions of score change between week one and week eight for each measure (CAS, I-ADAPT-M and Resourcefulness Scale), for control and intervention groups.

Table 8: Summary of week one test scores and demographic information by completed/lost to follow-up. Highlighted rows are those that refer to key attribute-measuring scores.

		Completed	Lost to follow-up	*p*
N		36	36	
Group (%)	Control	20 (55.6)	16 (44.4)	0.48
	Intervention	16 (44.4)	20 (55.6)	
I-ADAPT-M (mean (SD))		200.22 (19.06)	202.83 (37.97)	0.713
Communicative Adaptability Scale (mean (SD))		97.72 (8.41)	101.47 (17.94)	0.26
Self-Perceived Communication Competence Scale (mean (SD))		824.50 (216.79)	934.64 (195.66)	0.027
Resourcefulness Scale (mean (SD))		80.94 (18.09)	83.25 (24.60)	0.652
Rosenberg Self-Esteem Scale (mean (SD))		22.67 (3.02)	23.14 (3.55)	0.546
General Self Efficacy Scale (mean (SD))		31.03 (3.65)	31.67 (6.18)	0.595
Agreeableness (mean (SD))		30.64 (4.02)	30.97 (5.19)	0.762
Conscientiousness (mean (SD))		32.97 (2.55)	33.47 (6.61)	0.673
Openness (mean (SD))		37.86 (5.29)	40.14 (9.32)	0.206
Neuroticism (mean (SD))		26.92 (3.22)	27.92 (6.24)	0.396
Extraversion (mean (SD))		27.06 (3.79)	27.86 (4.50)	0.414
Demographic information Note that one participant in both groups did not complete the demographic survey, so N = 35 for these data				
Year (%)	Level 1	19 (54.3)	27 (77.1)	0.078
	Level 2	16 (45.7)	8 (22.9)	
Age (mean (SD))		21.06 (4.28)	19.83 (5.36)	0.293
Gender (%)	Female	20 (57.1)	18 (51.4)	0.714
	Male	13 (37.1)	16 (45.7)	
	Other	2 (5.7)	1 (2.9)	
Hours spent playing video games per week (%)	0	7 (20.0)	12 (34.3)	0.32
	1-4	14 (40.0)	12 (34.3)	
	4-8	5 (14.3)	7 (20.0)	
	>8	9 (25.7)	4 (11.4)	

While there are no significant or otherwise troubling differences between those participants who completed the study and those who dropped out, a number of interesting features are revealed in this analysis. First, it may be noted that a slightly higher proportion of participants in the intervention group were lost to follow-up. This is almost certainly explained by the demands placed on the game-playing participants, which included not only finding around two hours per week to attend the lab but also, perhaps more arduously, being asked to complete a somewhat lengthy battery of online tests roughly once per week as well. On reflection, it is easy to imagine that falling behind on these tasks – even a little – may result in a participant disengaging with the study, particularly as other university-related demands increased. Related to this observation is the statistically insignificant but nonetheless interesting difference in conscientiousness scores, which were very slightly higher for those participants who dropped out. If these participants were truly more conscientious, it may be that they simply (and understandably) took greater care with their own studies than the game-playing experiment. One of the more significant differences between those participants who completed and those who dropped out was in year of study, where 27 of 46 (58.7%) level one students failed to complete compared with 8 of 24 (33.3%) level two students. This difference is not thought to have had any impact on the findings of the study and might be explained by considering that first year students may be less able to estimate their availability later in the semester. It is likely that first-time students may underestimate the demands placed on them as the semester progresses, and finding time for this study may not be a priority in the face of university exams, coursework, and extra-curricular responsibilities. Average baseline (week one) scores for each of the key attribute-testing measures were comparable between the two groups, with the possible exception of the Self-Perceived Communication Competence Scale, on which the participants lost to follow-up scored better than those who completed the study.

For each attribute measure, 95% confidence intervals and p-values for statistical significance in the difference between mean control and intervention group scores were calculated. These data are summarised in Table 9 below. By convention, p-values of ≤ 0.05 are considered significant, while 95% confidence intervals that do not cross zero suggest that the mean change in score may be expected to be either positive *or* negative in 95% of cases, should the experiment be repeated. Here, a negative difference in means indicates improved scores for the game-playing intervention group so, for example, in the case of the Communicative Adaptability Scale (CAS) scores, it may be expected that the mean difference between control and intervention groups would fall between -12.79 and -2.69. In other words, should the exercise be repeated under the same conditions, the game-playing intervention group would score between 2.69 and 12.79 points higher than the control. That the CI does not cross zero means that it does not contain the null hypothesis value: a difference of zero between the two groups would mean there was no difference between the two, thus supporting the null hypothesis. The absolute difference in mean for CAS scores was 7.74, meaning that, on average, the intervention group scores were 7.74 points higher on the Communicative Adaptability Scale. However, p-values and confidence intervals are concerned only with the probability of a difference occurring between the two groups; it is also necessary to determine if the size of the difference – the effect size – is significant. The scales associated with each measure used here are essentially arbitrary (is a difference of 7.74 points on the Communicative Adaptability Scale a significant difference?) and certainly not comparable to one another (the absolute difference in means for CAS is less than half that for I-ADAPT-M, so is it less significant?) In order to gauge effect size, then, Cohen's d (the 'Adjusted' column in Table 9) was calculated for each difference in mean. Cohen's d expresses the size of the difference in terms of standard deviations, otherwise known as the average deviation from the mean. Cohen (1988, pp. 25-27), while noting that the terms "small", "medium" and "large" are relative, suggested that d-values of between 0.2 and 0.5 represent small effect size, values between 0.5 and 0.8 represent medium effect, and values of greater than 0.8 represent large effect sizes.

Table 9: Summary of score changes from week one to week eight. Highlighted rows are those that refer to key attribute-measuring scores. Adjusted differences in mean are Cohen's d.

	Control		**Intervention**		**Difference in means**			***p***
Measure	**Mean**	**SD**	**Mean**	**SD**	**Absolute**	**95% CI**	**Adjusted**	
CAS	-2.80	5.65	4.94	8.41	7.74	-12.79 to -2.69	1.10	0.004
SPCCS	71.40	243.69	135.19	189.65	63.79	-210.58 to 83.01	0.29	0.383
I-ADAPT-M	-8.25	15.99	11.31	18.07	19.56	-31.32 to -7.80	1.15	0.002
Resourcefulness	0.25	9.71	9.69	11.42	9.44	-16.77 to -2.11	0.90	0.013
Self-efficacy	-1.55	6.29	0.75	3.53	2.30	-5.69 to 1.09	0.44	0.176
Self-esteem	-0.05	5.76	1.13	6.38	1.18	-5.36 to 3.01	0.19	0.571
Agreeableness	-0.90	4.15	0.38	2.66	1.28	-3.60 to 1.05	0.36	0.272
Conscientiousness	-0.55	4.15	-0.31	2.89	0.24	-2.63 to 2.15	0.07	0.841
Openness	-0.90	3.70	0.88	2.85	1.78	-3.99 to 0.44	0.53	0.113
Neuroticism	0.05	3.71	-0.31	3.22	0.36	-1.99 to 2.71	0.10	0.756
Extraversion	-0.55	4.29	1.19	1.87	1.74	-3.92 to 0.45	0.51	0.115

For each measure, box plots show pre/post differences in mean score for both control and intervention groups; these plots are thought to be particularly useful as they show the distribution of all data, with interquartile range and outliers clearly indicated. Violin (kernel density) plots provide an alternative means of visualising mean score distribution. Plots of test scores over time, for each participant each 'week' (after each game) are included in Appendix F, but for the reasons outlined above, these data are not considered useful and are not analysed here. The usefulness of this repeated testing is questioned in the discussion that follows but one of the limitations is quite evident here: it is very difficult to determine patterns or trends across these data when plotted on a single graph. There is little doubt that scores fluctuated over the course of the eight weeks, but the meaningfulness or significance of these fluctuations is not revealed by visualising the data in this manner.

Pre/post scatterplots show week one and week eight scores for each individual participant. The scatterplots for the Communicative Adaptability Scale, I-ADAPT-M and Resourcefulness Scale scores suggest that, generally, week one score predicts week eight score, for most participants: the upward slope observed on these plots indicates the trend is for higher week eight scores where week one scores are higher. Further, week eight scores are generally higher for participants in the intervention group than those in the control group, as indicated by the plotting of the line of best fit for the intervention group above that for the control group. It may also be observed that the higher week eight scores for intervention group participants appear to occur across the range of week one scores. This is suggested by the approximately parallel arrangement of the lines of best fit for both groups: had the effect of the intervention been greater for those participants with high baseline scores, for example, the lines of best fit would diverge towards the origin but converge at the higher end of the x-axis. While lines of best fit act merely as a guide, a brief visual inspection of the CAS, I-ADAPT-M, and Resourcefulness plots clearly supports these general observations, with, for example, a preponderance of intervention participants plotted above the scatterplots' diagonal (week one score = week eight score) and control participants below.

Plots for the Self-Perceived Communication Competence Scale scores do not generally conform to the patterns observed for other measures, as might be expected from the somewhat less convincing results for this measure, summarised in Table 9 (95% CI -210.58 to 83.01; Cohen's d = 0.29, p = 0.383). The results obtained from this measure are discussed in section 5.2.1.2 below.

Line graphs depicting each participant's trajectory (in terms of total score change between week one and week eight) are presented for each measure. These graphs complement the tables below which summarise changes in score for each measure for both groups. Both the line graphs and the tabular data provide a sense of the general (positive or negative) trend for the two groups. For example, Table 10 indicates that a majority (11 out of 16, 69%) of intervention participants saw a positive change in their CAS scores from week one to week eight while the corresponding line graph (Figure 36) provides a visual representation of this overall trend for individual participants.

Before examining the main attribute measures in detail, some observations may be made about the related measures. For example, the Openness trait, thought in very general terms to relate to the Ethically and Socially Aware attribute, showed a small positive change in the intervention group, and a small negative change in the control group, although the difference is neither terribly large, nor significant (Cohen's d = 0.53, p = 0.113). Traits are generally thought to be fixed, of course, so any gains observed here should be expected to be small, if taken seriously at all. However, as the qualitative data discussed below indicates, participants strongly agreed that playing selected games might help develop this attribute, regardless of the lack of a convincing quantitative measure.

Across all of these 'secondary measures', that is, those which do not relate directly to a specific graduate attribute, the intervention group generally fares better, in similarly small and statistically insignificant ways. In terms of both self-efficacy (Cohen's d = 0. 44, p = 0. 176) and self-esteem (Cohen's d = 0. 19, p = 0. 571), the intervention group saw a slight improvement in mean scores over the course of the semester, while the control group saw a small fall in mean scores. In very broad terms, the mean scores for the remainder of the Big Five personality traits either improved a little more or deteriorated a little less in the intervention group. However, given the absence of statistical significance or large effect sizes, and the fact that these measures do not relate directly to graduate attributes, they are not analysed in any further detail here.

5.2.1 Effective Communicators

Two measures of communication were administered, the Communicative Adaptability Scale (CAS) and the Self-Perceived Communication Competence Scale (SPCCS).

5.2.1.1 Communicative Adaptability Scale

The percentage of participants in the intervention group (69%, 11 of 16) with improved CAS scores was significantly greater than the percentage of participants in the control group (25%, 5 of 20) with improved CAS scores (p = 0.016, Fisher's exact test). Mean score change on the Communicative Adaptability Scale was -2.8 (SD = 5.65) in the control group and 4.94 (SD =

8.41) in the intervention group (absolute difference in means = 7.74, 95% CI 2.69 to 12.79, Cohen's d 1.1).

Table 10: Summary of changes in Communicative Adaptability Scale scores for Control and Intervention groups.

	Group		
Change	**Control**	**Intervention**	**Row Total**
negative (N)	15	5	20 (56%)
negative (N / row total)	0.75	0.25	
negative (N / column total)	0.75	0.31	
positive (N)	5	11	16 (44%)
positive (N / row total)	0.31	0.69	
positive (N / column total)	0.25	0.69	
Column Total	20 (56%)	16 (44%)	36 (100%)

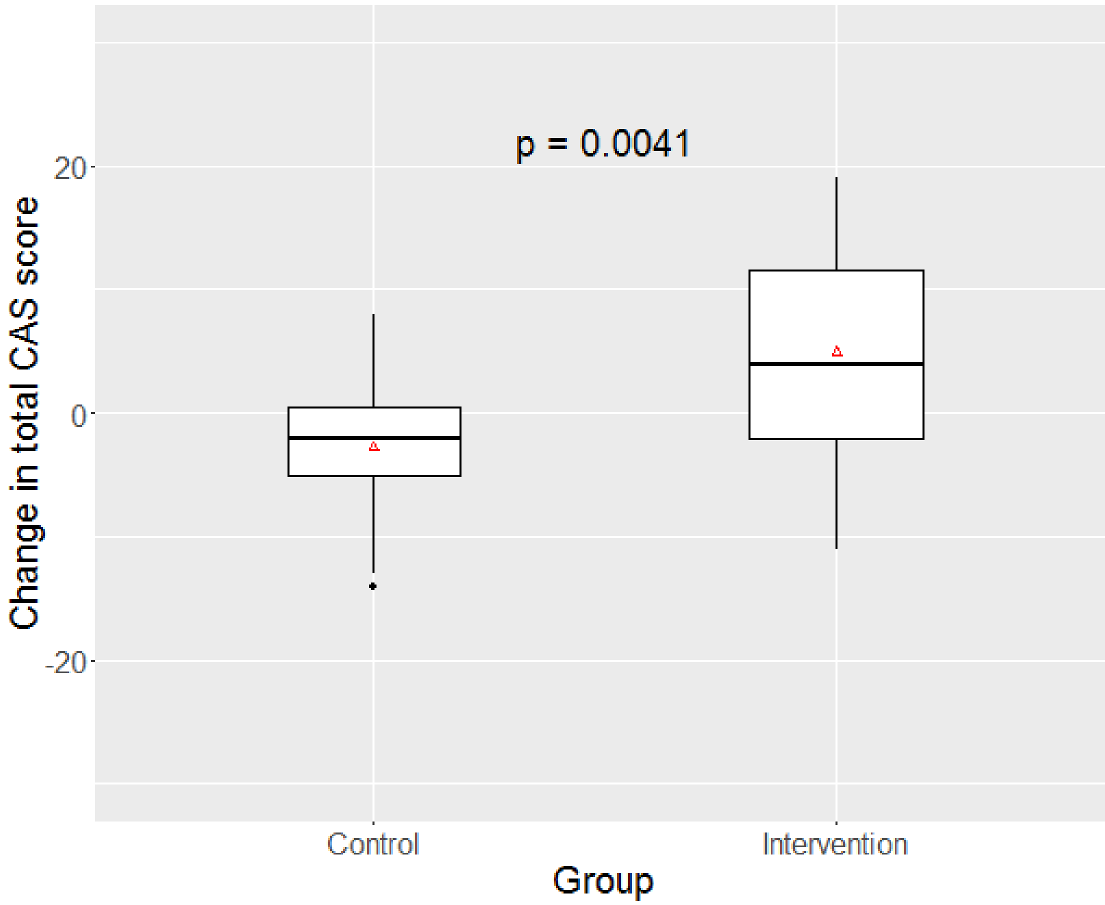


Figure 33: Box plot comparing distribution of total Communicative Adaptability Scale (CAS) score change from week one to week eight between Control and Intervention groups. The horizontal line is the median score change for the group, the triangles represent mean change, the box represents interquartile range, whiskers show the two standard deviation range used to define outliers, and outliers are plotted as dots.

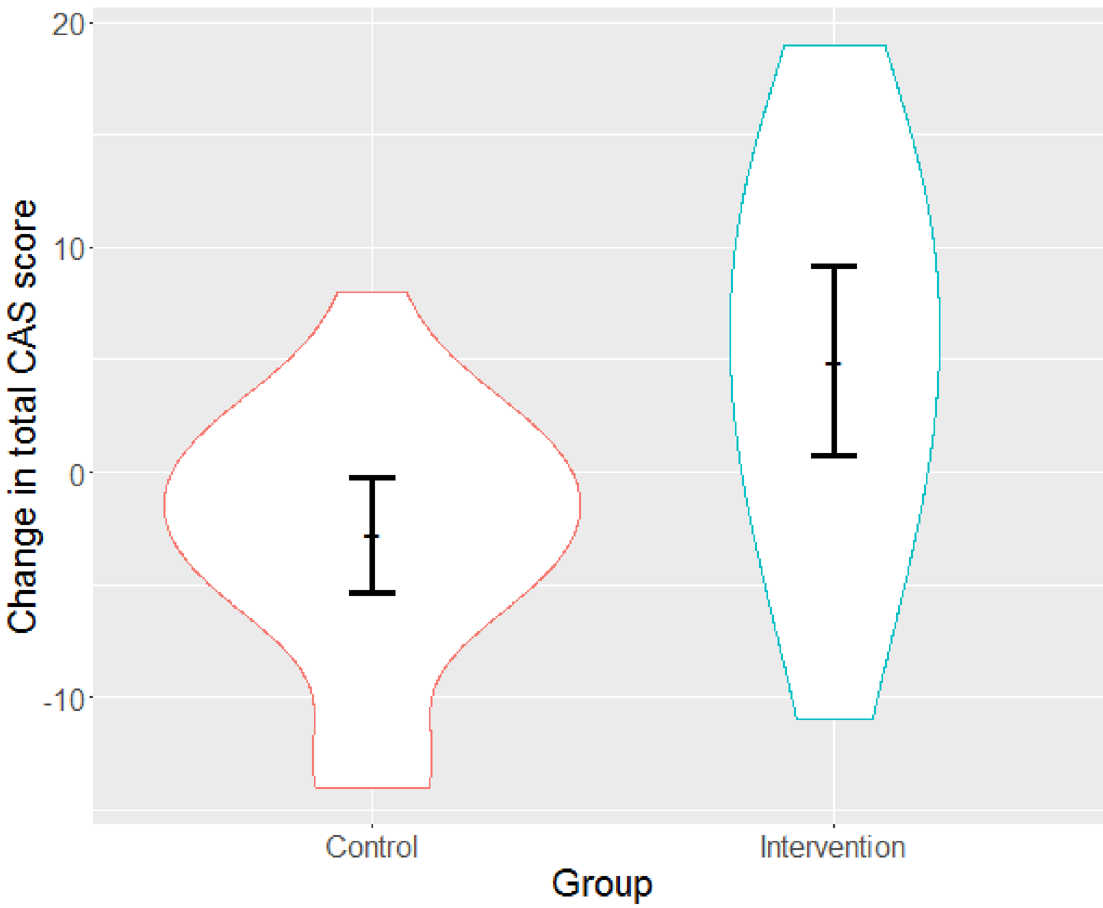


Figure 34: Violin (kernel density) plot showing distribution of total Communicative Adaptability Scale (CAS) score change from week one to week eight by Control and Intervention groups. Error bars are 2 standard errors of the mean.

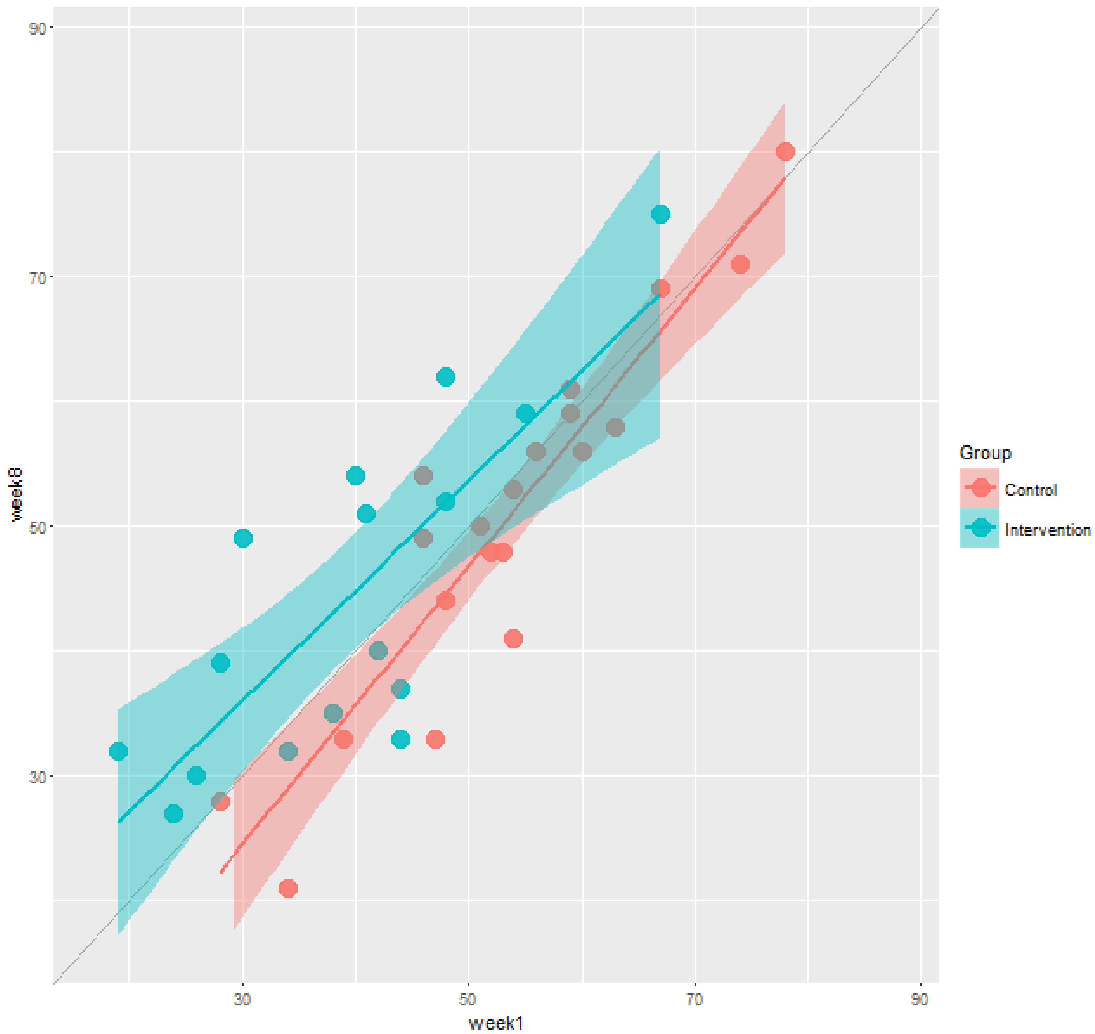


Figure 35: Scatterplot of Communicative Adaptability Scale scores for week one and week eight for both Control and Intervention groups. Line of equality for week one and week eight scores is shown (diagonal), and a line of best fit (least squares method) is plotted for each group.

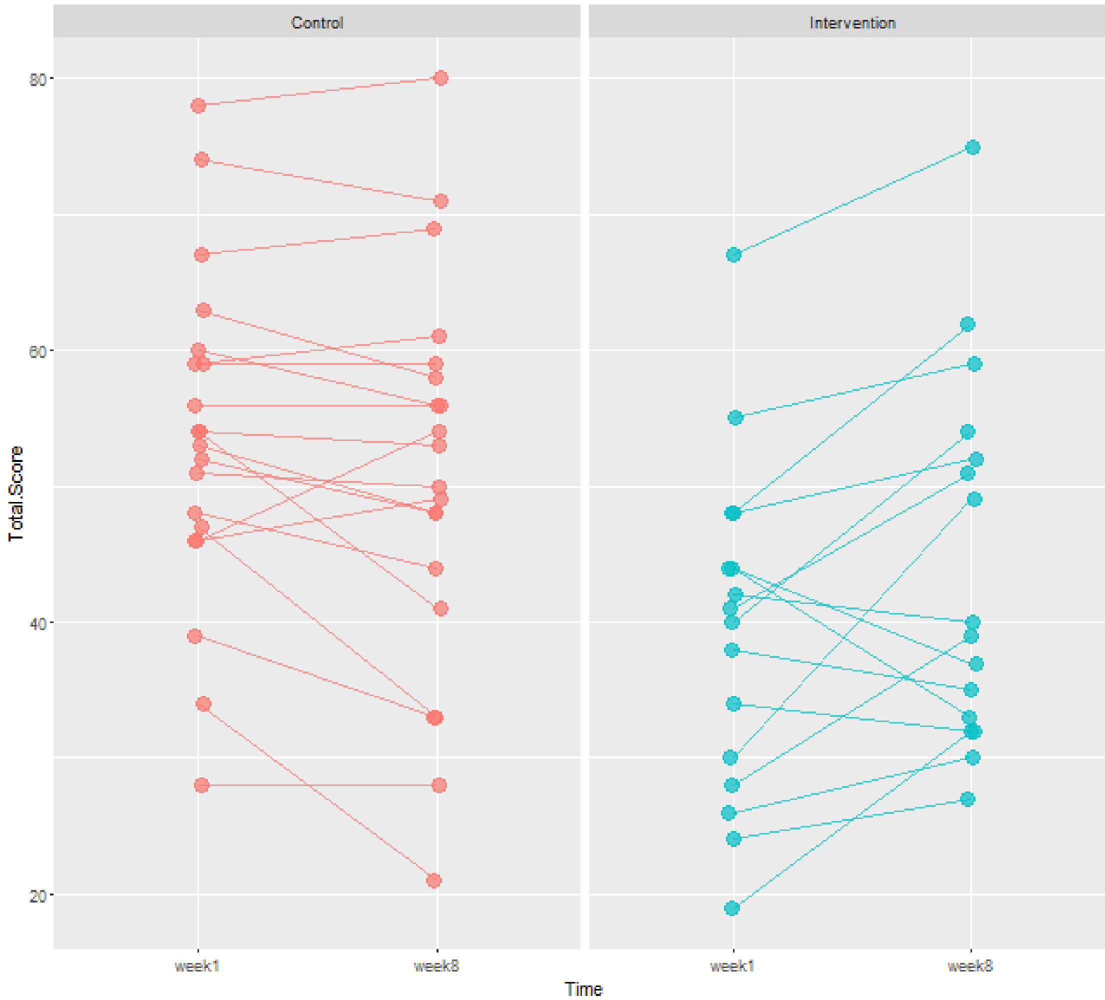


Figure 36: Repeated measures of Communicative Adaptability Scale scores for Control and Intervention groups. Each student who completed a survey at week one and week eight is shown, with a line connecting their score at the two time points.

5.2.1.2 Self-Perceived Communication Competence Scale

The percentage of participants in the intervention group (81%, 13 of 16) with improved SPCCS scores was greater than the percentage of participants in the control group (65%, 13 of 20) with improved SPCCS scores.

	Group		
Change	Control	Intervention	Row Total
negative (N)	7	3	10 (28%)
negative (N / row total)	0.7	0.3	
negative (N / column total)	0.35	0.19	
positive (N)	13	13	26 (72%)
positive (N / row total)	0.5	0.5	
positive (N / column total)	0.65	0.81	
Column Total	20 (56%)	16 (44%)	36 (100%)

Table 11: Summary of changes in Self-Perceived Communication Competence Scale scores for Control and Intervention groups.

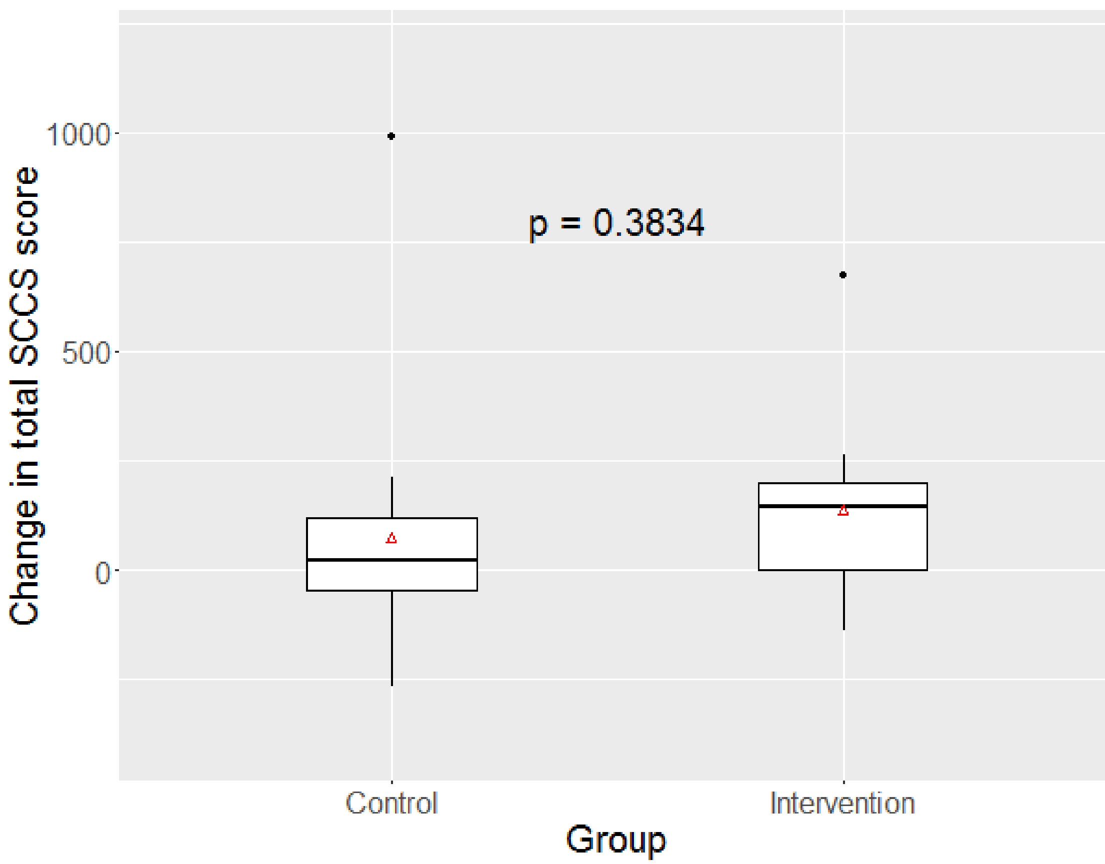


Figure 37: Box plot comparing distribution of total Self-Perceived Communication Competence Scale (SPCCS) score change from week one to week eight between Control and Intervention groups. The horizontal line is the median score change for the group, the triangles represent mean change, the box represents

interquartile range, whiskers show the two standard deviation range used to define outliers, and outliers are plotted as dots.

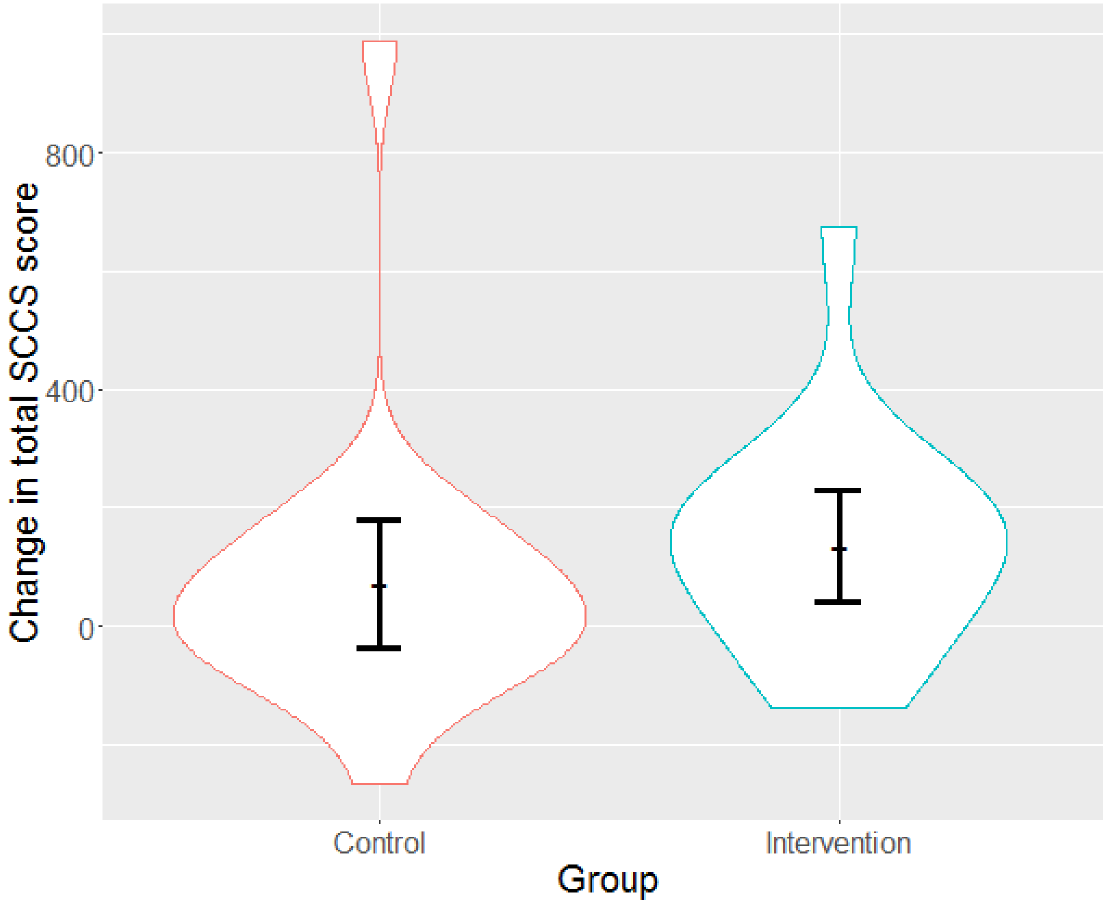


Figure 38: Violin (kernel density) plot showing distribution of total Self-Perceived Communication Competence Scale (SPCCS) score change from week one to week eight by Control and Intervention groups. Error bars are 2 standard errors of the mean.

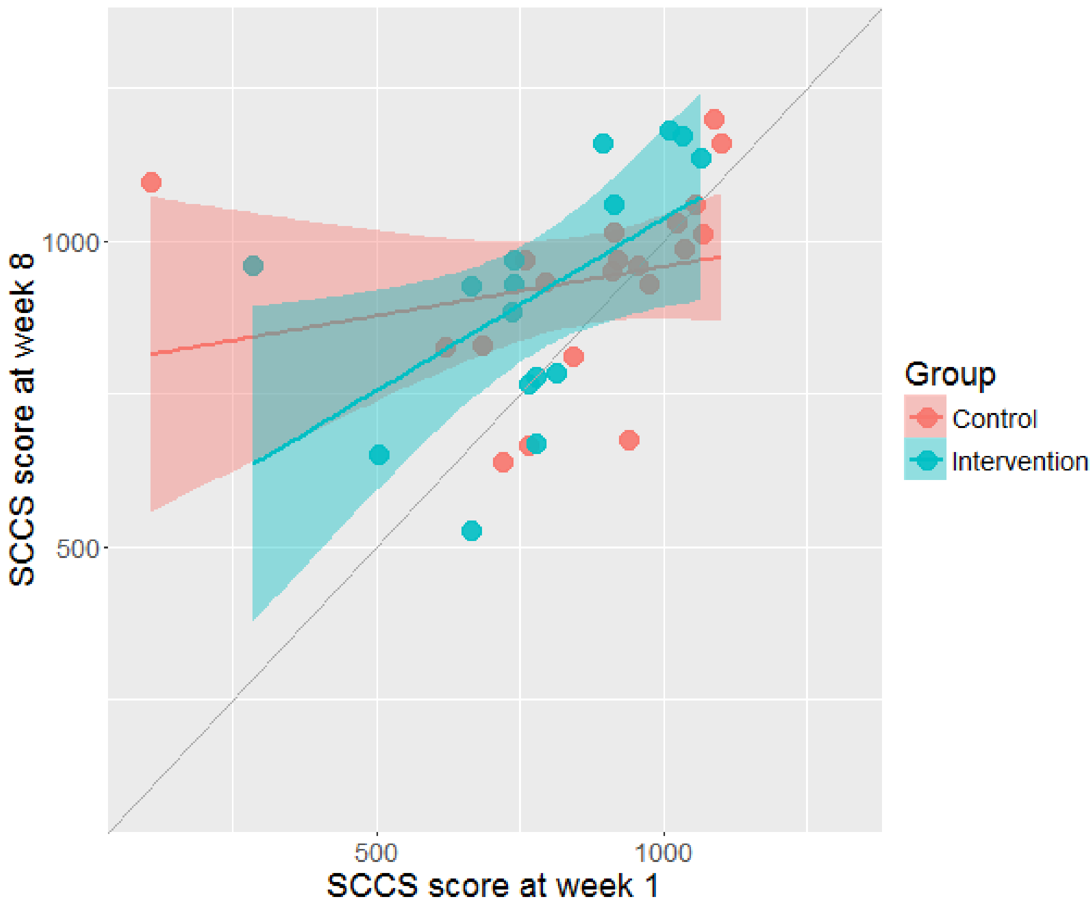


Figure 39: Scatterplot of Self-Perceived Communication Competence Scale scores for week one and week eight for both Control and Intervention groups. Line of equality for week one and week eight scores is shown (diagonal), and a line of best fit (least squares method) is plotted for each group.

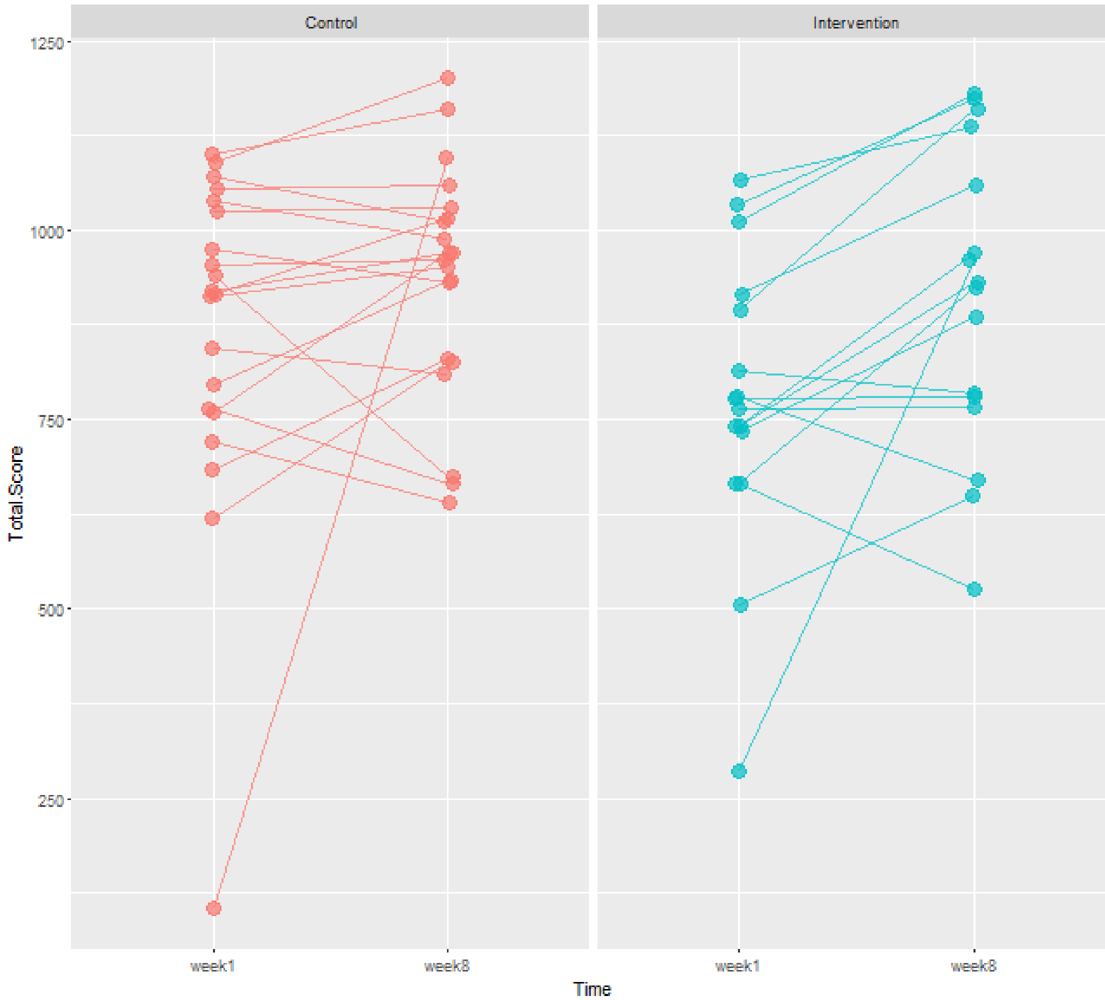


Figure 40: Repeated measures of Self-Perceived Communication Competence Scale scores for Control and Intervention groups. Each student who completed a survey at week one and week eight is shown, with a line connecting their score at the two time points.

5.2.2 Adaptable

Mean score change on the adaptability scale was -8.25 (SD = 15.99) in the control group and 11.31 (SD = 18.07) in the intervention group (absolute difference in means = 19.56, 95% CI 7.8 to 31.32, Cohen's d 1.15).

	Group		
Change	**Control**	**Intervention**	**Row Total**
negative (N)	12	4	16 (44%)
negative (N / row total)	0.75	0.25	
negative (N / column total)	0.60	0.25	
positive (N)	8	12	20 (56%)
positive (N / row total)	0.40	0.60	
positive (N / column total)	0.40	0.75	
Column Total	20 (56%)	16 (44%)	36 (100%)

Table 12: Summary of changes in I-ADAPT-M scores for Control and Intervention groups.

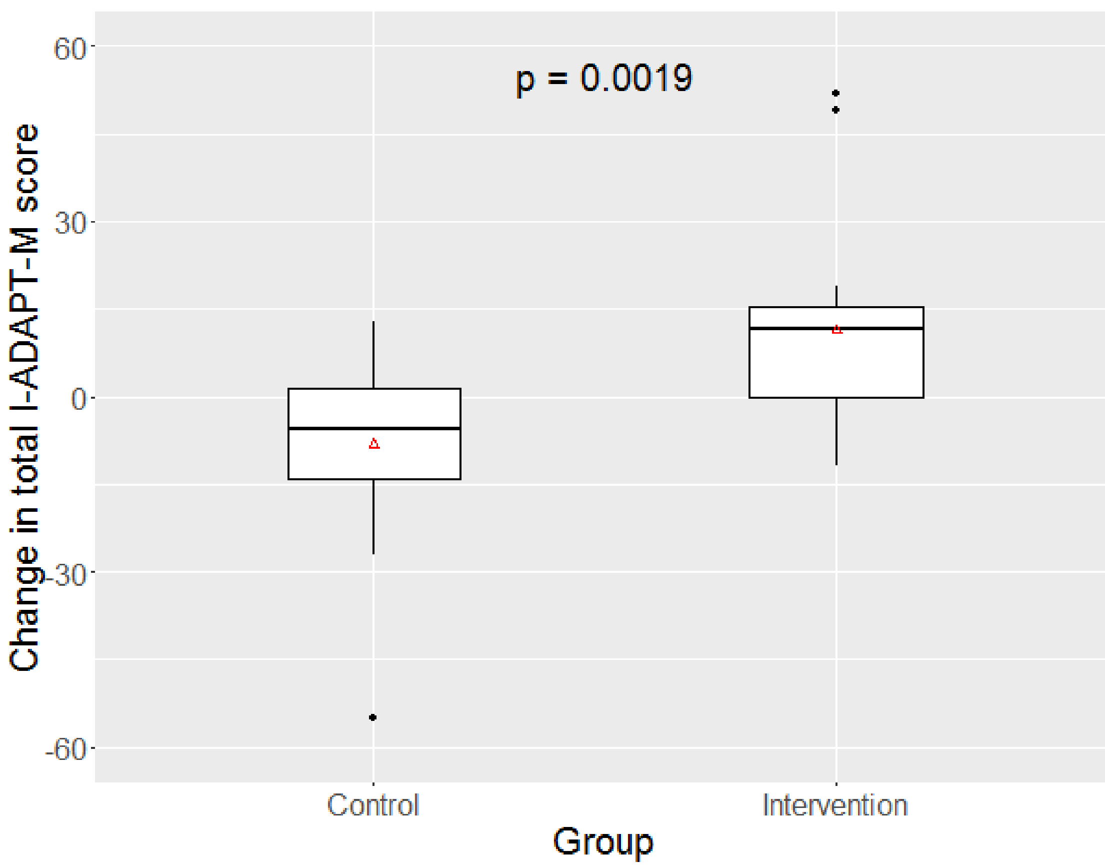


Figure 41: Box plots comparing distributions of total I-ADAPT-M score change from week one and week eight between Control and Intervention groups. Horizontal line is mean score change for group, box is IQR, whiskers are range, and outliers are plotted as dots.

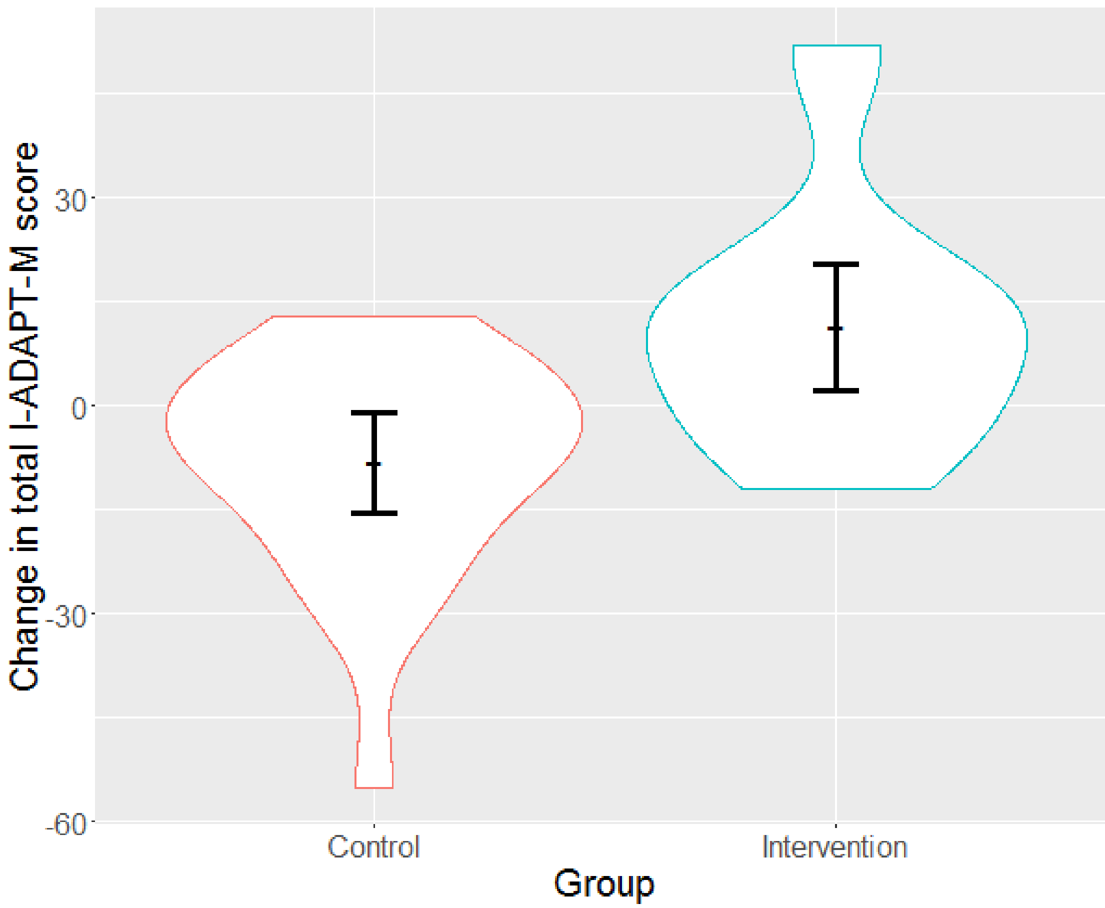


Figure 42: Violin (kernel density) plot showing distribution of total I-ADAPT-M score change from week one to week eight by Control and Intervention groups. Error bars are 2 standard errors of the mean.

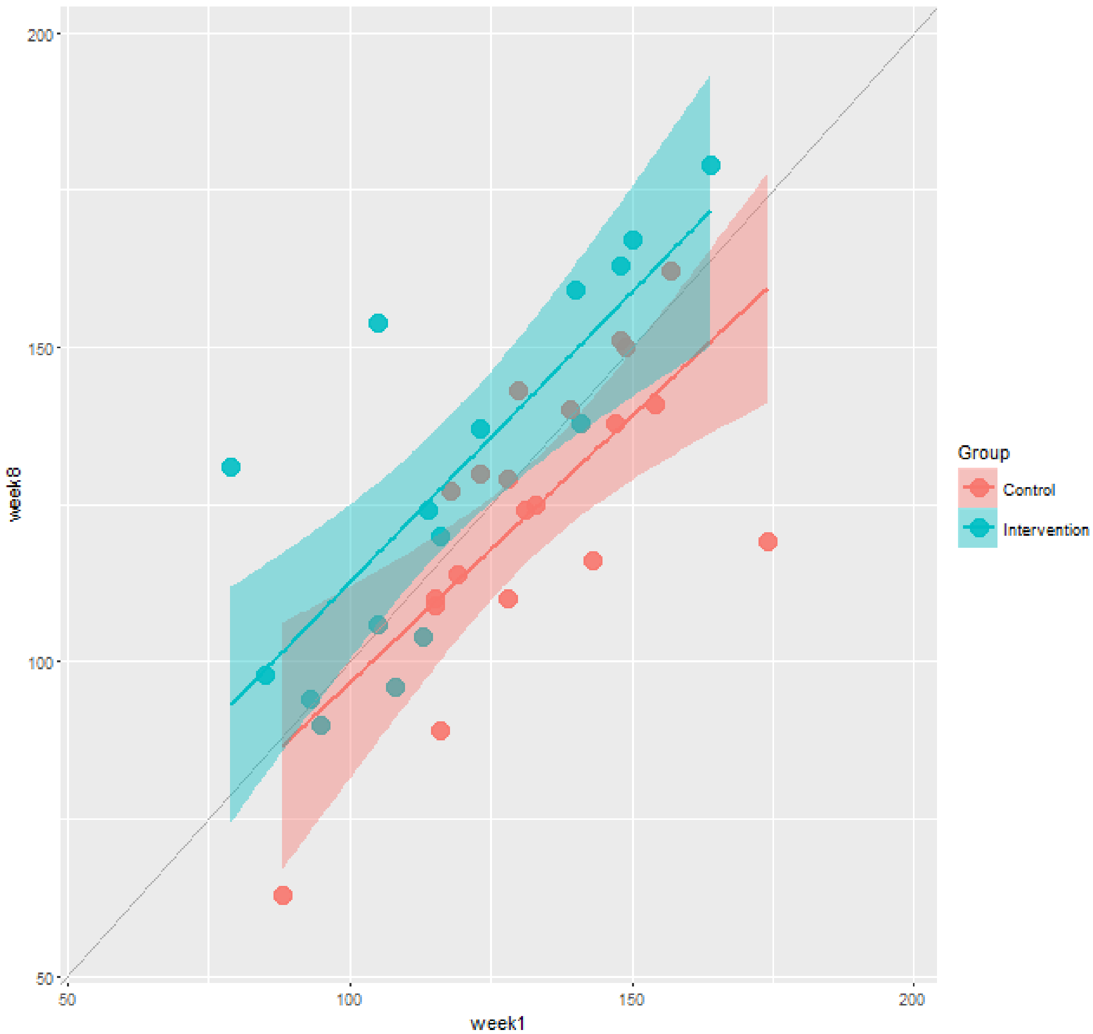


Figure 43: Scatterplot of I-ADAPT-M scores for week one and week eight for both Control and Intervention groups.

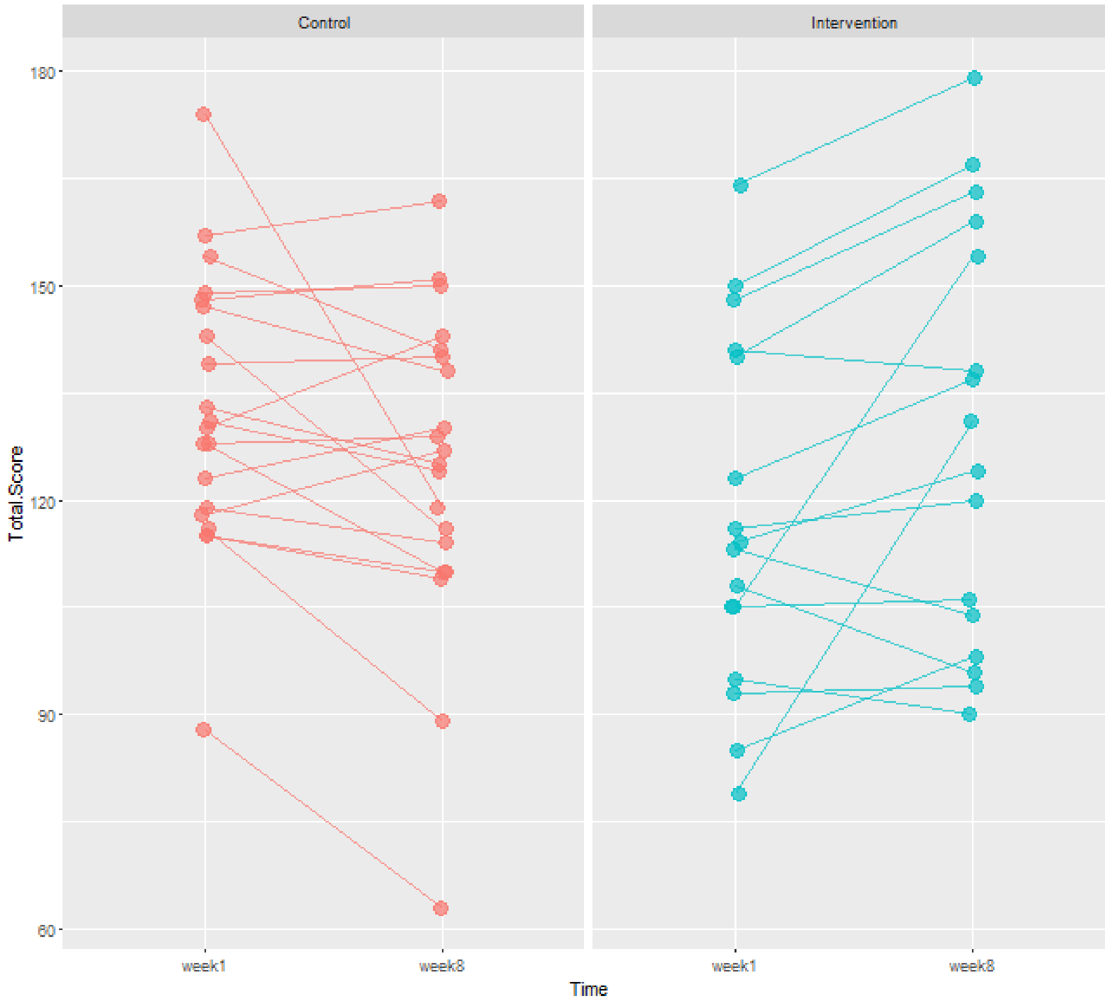


Figure 44: Repeated measures of I-ADAPT-M scores for Control and Intervention groups. Each student who completed a survey at week one and week eight is shown, with a line connecting their score at the two time points.

5.2.3 Resourceful and Responsible

No instrument for measuring responsibility was identified: only the resourcefulness aspect of this attribute is measured here. Mean score change on the Resourcefulness Scale was 0.25 (SD = 9.71) in the control group and 9.69 (SD = 11.42) in the intervention group (absolute difference in means = 9.44, 95% CI 2.11 to 16.77, Cohen's d 0.9).

	Group		
Change	**Control**	**Intervention**	**Row Total**
negative (N)	12	3	15 (42%)
negative (N / row total)	0.8	0.2	
negative (N / column total)	0.6	0.19	
positive (N)	8	13	21 (58%)
positive (N / row total)	0.38	0.62	
positive (N / column total)	0.4	0.81	
Column Total	20 (56%)	16 (44%)	36 (100%)

Table 13: Summary of changes in Resourcefulness Scale scores for Control and Intervention groups.

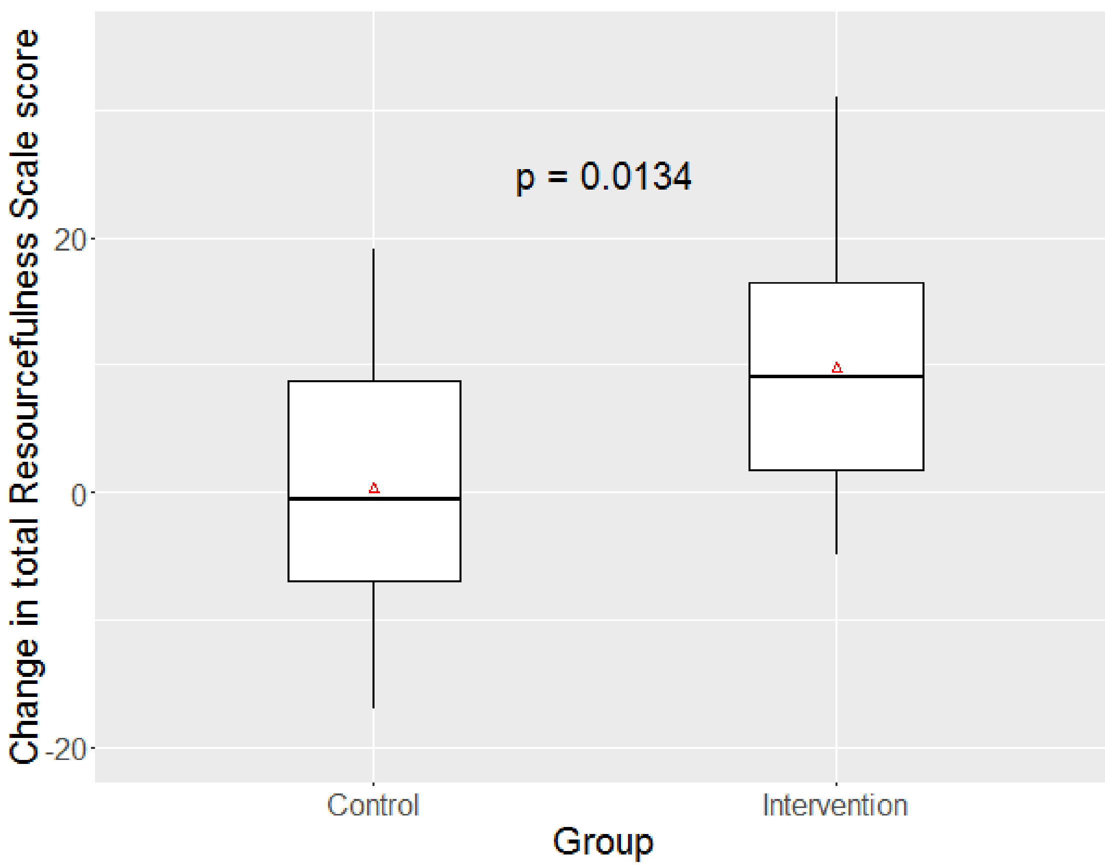


Figure 45: Box plots comparing distributions of total Resourcefulness Scale score change from week one and week eight between Control and Intervention groups. Horizontal line is mean score change for group, box is IQR, whiskers are range, and outliers are plotted as dots.

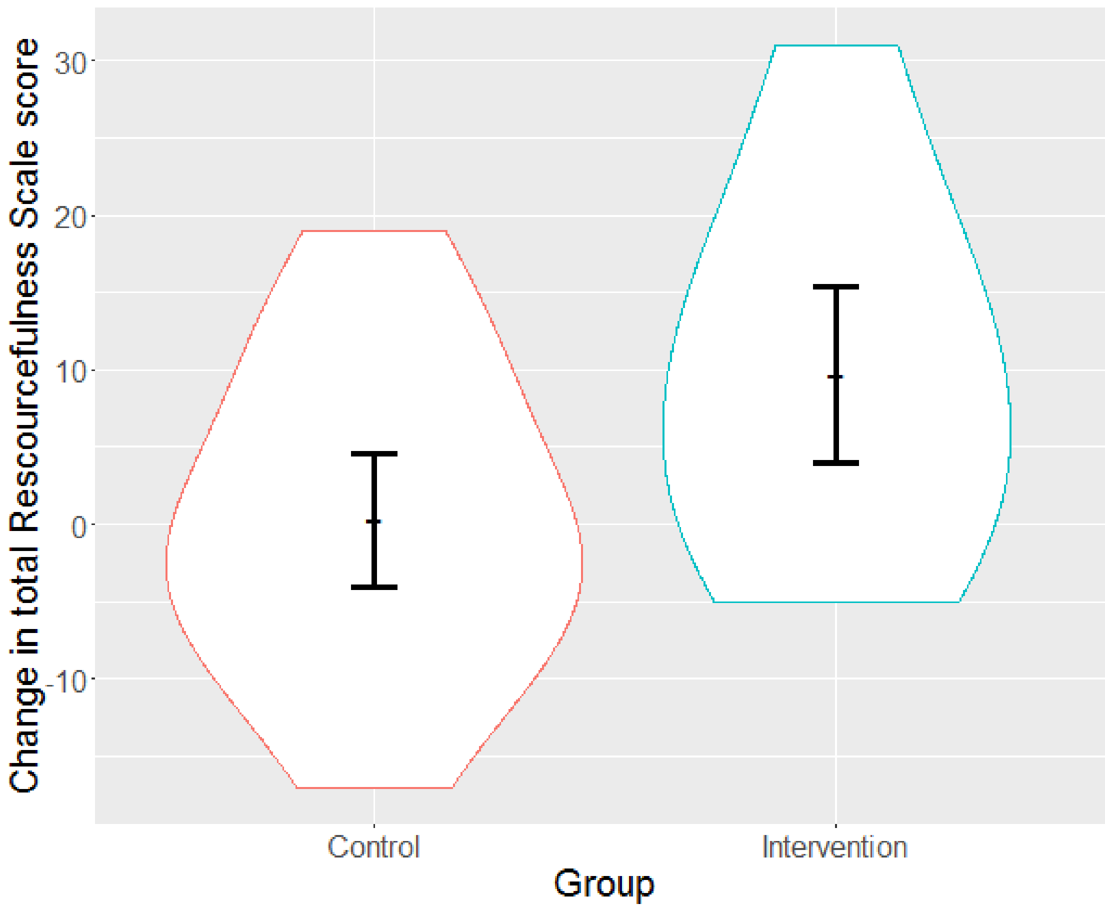


Figure 46: Violin (kernel density) plot showing distribution of total Resourcefulness Scale score change from week one to week eight by Control and Intervention groups. Error bars are 2 standard errors of the mean.

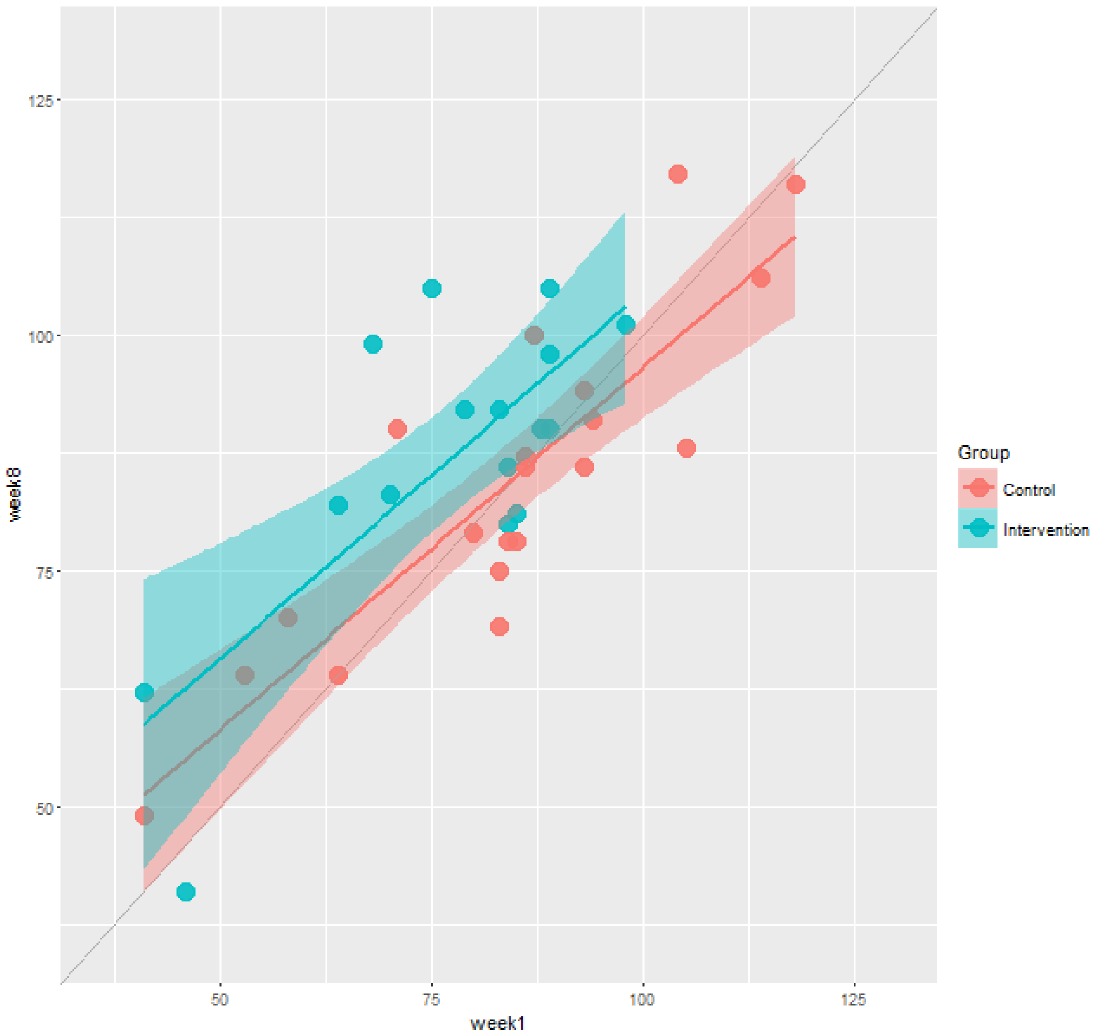


Figure 47: Scatterplot of Resourcefulness Scale scores for week one and week eight for both Control and Intervention groups.

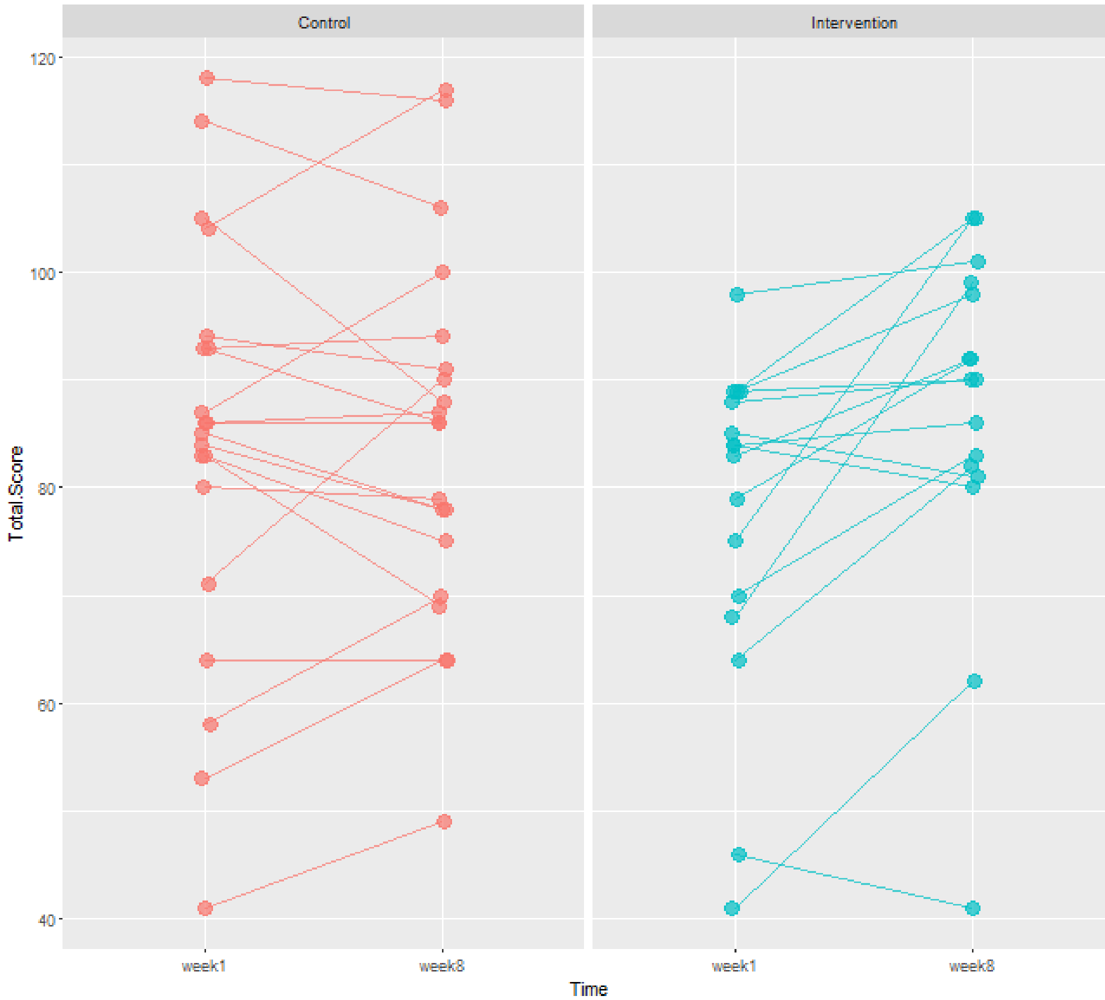


Figure 48: Repeated measures of Resourcefulness Scale scores for Control and Intervention groups. Each student who completed a survey at week one and week eight is shown, with a line connecting their score at the two time points.

5.2.4 Discussion

For three of the four graduate attribute measures, the data indicate a significant increase in mean scores for participants in the intervention group over those in the control group when week one scores are compared against week eight scores. The difference in mean scores for the second communication measure (Self-Perceived Communication Competence Scale) is not statistically significant, although the proportion of intervention participants with improved scores on this measure was greater than that in the control group with improved scores. The very low p-values for the remaining measures suggest that Type I errors (incorrect rejection of a true null hypothesis, or a false positive) are unlikely. The qualitative data, then, appear to support the hypothesis that playing selected video games can improve scores on certain self-report measures of communication, resourcefulness, and adaptability. However, the picture is more complicated than this, and a number of issues must be addressed. The cross-sectional study described below – in which a large cohort of students (N = 2145) at the same institution were surveyed and asked to complete each of the measures discussed here – may also provide some illumination.

A brief re-examination of the aspects of communication skill the two instruments are intended to measure may also be useful here, in order to understand the difference in correlations, and the difference in communication scores. In presenting the Communicative Adaptability Scale, Duran (1992) conceptualises communication in terms of "the cognitive and perceptual processes involved with the ability to adapt one's communicative behaviors across contexts", positioning communicative adaptability as an important component of communication competence. Duran also notes that to communicate effectively, individuals require the "confidence to approach a novel social setting and to engage in conversations with others who possibly are not previously known", an attribute to which he refers as social composure. Listening skills are also thought to be important, and the CAS instrument reflects this in items such as "I am a good listener". In the conceptualisation of communication competence that underpins the CAS instrument, then, there are clear echoes of the university-defined personal and transferable dimensions of effective communication, which cite both confidence and the ability to listen. It is interesting to note, too, that the academic dimension of the university definition actually refers explicitly to being able to "articulate complex ideas with respect to the needs and abilities of diverse audiences". This emphasis on diverse audiences is clearly reflected in Duran's idea that interlocutors must be able to adapt to different contexts.

As noted above, McCroskey & McCroskey's Self-Perceived Communication Competence Scale is based on the conceptualisation of communication competence as the "adequate ability to pass along or give information; the ability to make known by talking or writing" (1988). This brief definition is certainly in keeping with the dimensions of effective communication outlined by the university but, in their discussion of the instrument, the authors make it clear that their focus is entirely on self-perception. This, they argue, is all that self-report instruments can measure, by definition. This is a robust argument, particularly where the phenomenon being measured is evident to the respondent from the content of the questions, and the context in which they are asked. The argument also applies, as McCroskey & McCroskey note, to other communication measures, including the CAS instrument, but they also state that this does not invalidate such measures for the simple reason that much of our communication competence is based on how we ourselves perceive it.

Both measures are relevant to the work here, then, as suggested in the initial review of the literature, but they differ somewhat in their approach to measuring communication competence, which may explain the differences observed in the results of this study. CAS attempts to measure a dimension of actual communication competence (communicative adaptability) while SPCCS embraces the self-report nature of the instrument and aims solely to measure perceptions of communication competence.

Another issue that must be addressed is that of the loss of function observed in control group participants, particularly where CAS and I-ADAPT-M scores were concerned. On the CAS measure of communication, 75% of control group participants showed an apparent drop in communication skill, while 60% saw a drop in adaptability, as measured by the I-ADAPT-M instrument. It may also be noted that the standard deviation for score change in both the control and the intervention groups is greater in magnitude than the mean change in all four of the attribute scores (see Table 9 above). In addition, the mean score change for the intervention group, while positive, is less than one standard deviation greater than zero for all four measures, which is indicative of the loss of function observed in some participants in the game-playing group. Furthermore, the distribution of changes in score illustrated by the box plots above shows that for the CAS and I-ADAPT measures, the interquartile range for the control group's score change falls almost entirely below zero in both cases, reflecting the preponderance of control group scores that deteriorated over the course of the semester. Such negative score changes can only serve to exaggerate the positive gains made by the intervention group, and the apparent loss of function may be interpreted in a number of ways.

First, it may be argued that the observed deterioration in the control group's attribute scores calls into question the reliability of the measures used. Some deterioration in students' skills over time is not unprecedented. In their account of a skills development initiative carried out at Napier University, for example, Laybourn *et al.* (2013, p. 53) note that their control group (in this case, a group of students from another university, for whom no explicit skills development training was provided) saw a deterioration in four of the nine skills tested. The skills examined in this study did include communication skills, amongst others, although it is not clear in which of these skills they observed a deterioration in control group scores. There is also evidence to suggest that the very act of sitting exams – and most of the participants here would have been taking exams, or preparing to do so – can have a detrimental effect on students' intrinsic motivation (Remedios, Ritchie, & Lieberman, 2005). While motivation is not directly linked to any of the attributes measured here, it is interesting to note that such a mechanism, whereby the experience of taking examinations can result in negative psychological effects, has been shown to exist.

It is conceivable, then, that the stress associated with the end of semester – and the attendant assessment deadlines and examinations – is reflected in the reduced scores. At the point of taking the final battery of tests, the students involved are perhaps at something of a low ebb, mentally. It might be surmised that participants in the intervention group were either less susceptible to these stresses, or that the gains in function afforded by the game-playing experience offset the losses that are otherwise associated with the end of term. While the negative effects of stress on the control group's scores may only be supposed, interviews conducted with intervention group participants at the end of the study revealed a belief among the students involved that playing video games on campus or between classes helped alleviate stress. This aspect of the study is discussed, and qualitative data presented, in 5.3.10.3 below.

As the box plots above also show, outliers were observed in both groups, but the observed effect of the intervention was broadly similar across the range of baseline scores, as shown in the scatterplots above. As a sensitivity analysis, data were re-analysed with outliers (as defined by greater than two standard deviations from the mean) excluded; this made no substantive difference to the results of t-tests.

It may be argued that the mean positive and negative shifts in self-report scores for the intervention and control groups, respectively, might be due to changes in self-confidence. As noted in the discussion of measures above, confidence is certainly a component of communication, in particular, but may also be seen as a factor that influences adaptability and resourcefulness, in that a more confident person may be more willing to experiment with new methods. This may be a problematic argument, however. If confidence – or some aspect of confidence – really is an important part of what makes us more effective at communicating then it is quite appropriate that the communication measures employed here should detect an increase in this aspect. Confidence was not measured as part of the study *per se*, but self-esteem, which might be defined as confidence in one's own abilities, was measured, using the Rosenberg Self-Esteem Scale (Rosenberg, 1979).

As Figure 50 below shows, however, there is no significant difference in self-esteem between the control and intervention groups, with differences in scores at week one and week eight clustered around zero for both groups. Although, as the figures in Table 7 above indicate, the intervention group did see small, non-significant positive gains in mean self-esteem scores.

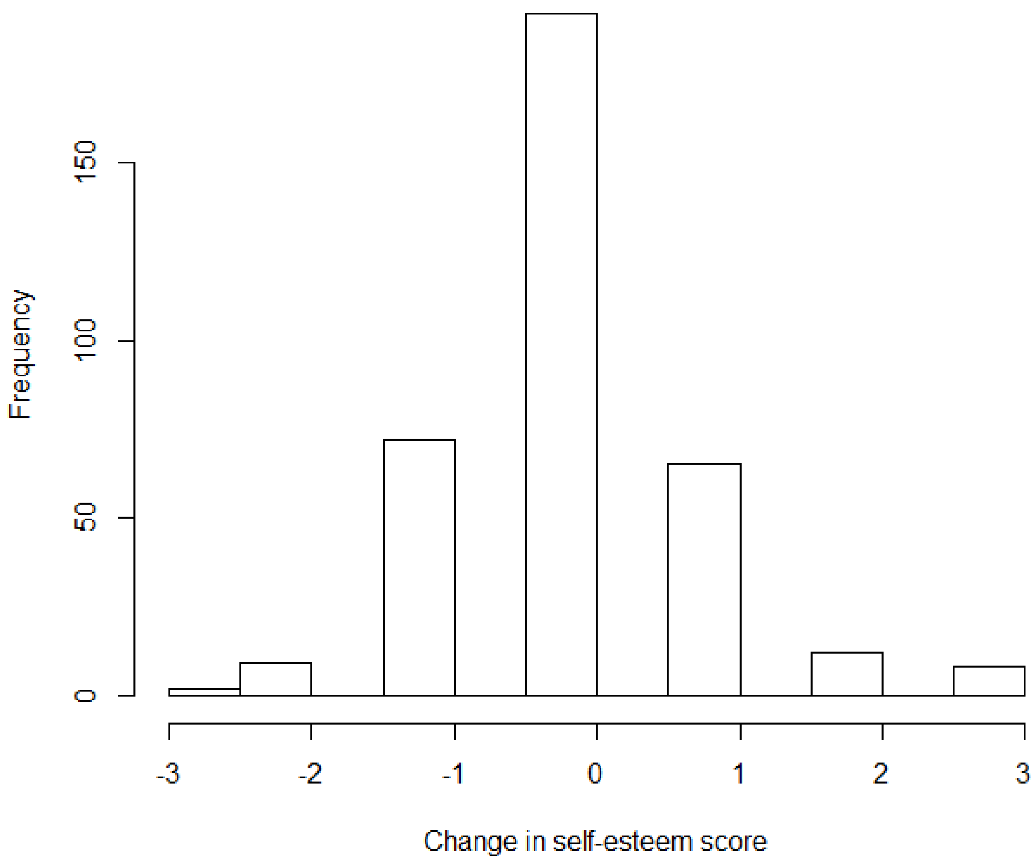


Figure 49: Histogram showing distribution of score change between week one and week eight for the self-esteem measure (Rosenberg Self-Esteem Scale), for control and intervention groups.

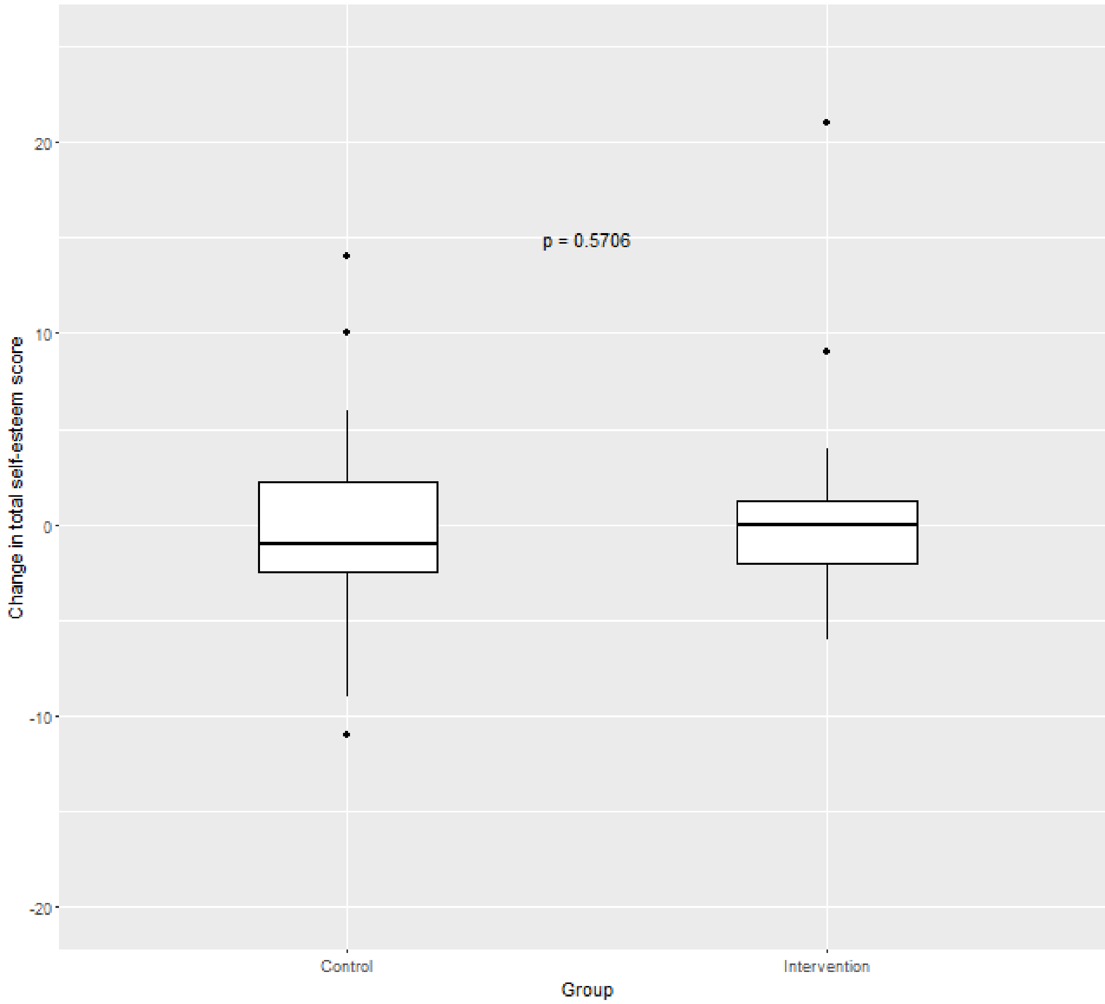


Figure 50: Box plot comparing distribution of total Rosenberg Self-Esteem Scale score change from week one and week eight between Control and Intervention groups. Horizontal line is mean score change for group, box is IQR, whiskers are range, and outliers are plotted as dots.

Self-efficacy – which might be thought of as one's belief that one can succeed, and therefore related to confidence – was also measured, using the General Self Efficacy Scale (Schwarzer and Jerusalem, 1995). These data showed remarkably little difference between the two groups, as Figure 52 illustrates, although, again, the intervention group saw small and non-significant positive gains in mean scores for self-efficacy.

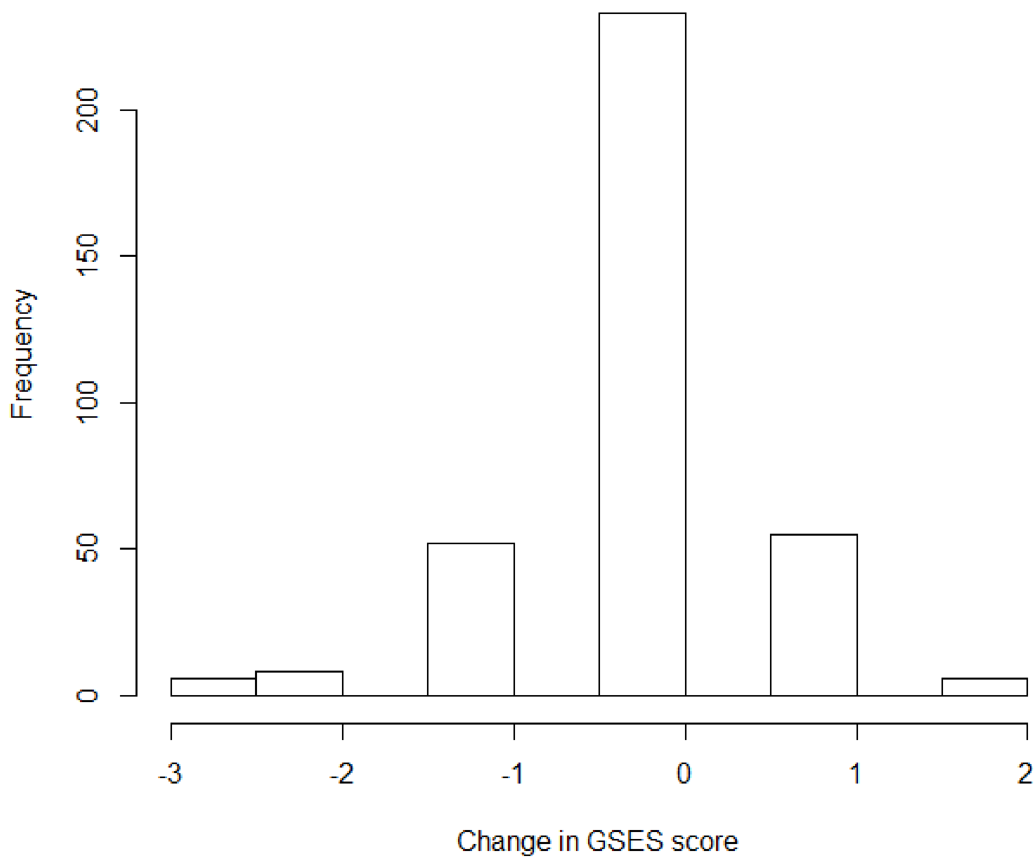


Figure 51: Histogram showing distribution of score change between week one and week eight for the self-efficacy measure (General Self Efficacy Scale), for control and intervention groups.

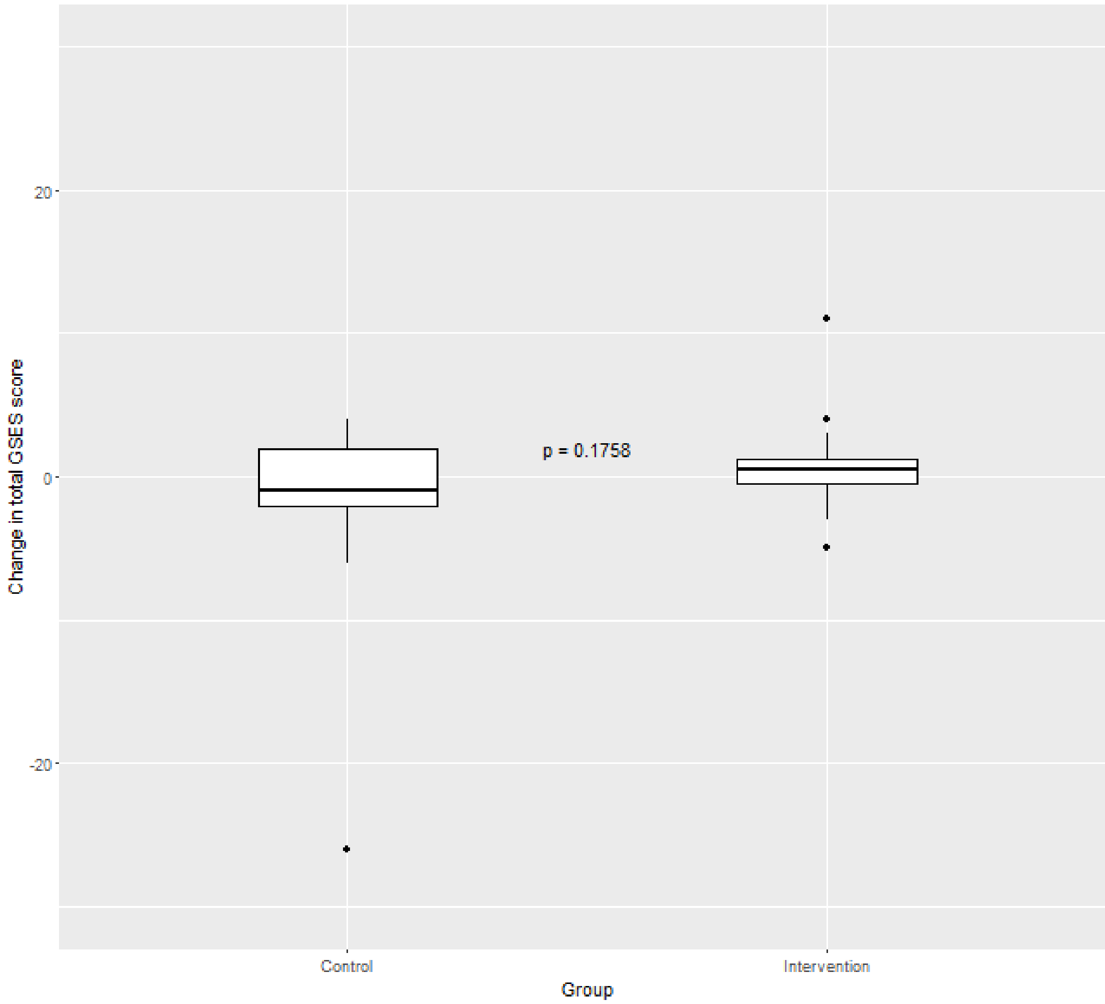


Figure 52: Box plot comparing distribution of total General Self Efficacy Scale score change from week one and week eight between Control and Intervention groups. Horizontal line is mean score change for group, box is IQR, whiskers are range, and outliers are plotted as dots.

In summary, then, the quantitative data show significant gains in mean score change for three of four measures directly related to certain attributes. While the supplementary data is largely insignificant, the intervention group fares better than the control and these data offer some small clues as to some of the underlying factors, such as confidence. Furthermore, it is likely that these factors – many of which are side effects of the work being conducted under certain conditions, for example, with a member of staff, with the same group of people, etc. – are part of what is driving the large relative improvement in mean intervention group scores.

5.3 Qualitative Results

Each of the participants in the intervention group who saw the study through to its conclusion was interviewed, an exercise which comprised 20 interviews in total. 18 of these interviews were conducted face-to-face in a room adjacent to the lab in which the games were played, while two interviews were completed by email, where participants had pre-existing end-of-semester travel arrangements. Audio recordings of face-to-face interviews were made and subsequently transcribed. It should be noted that the number of interviewees (N = 20) exceeds the number of participants who successfully completed the online tests (N = 16). However, collected interview data are treated as a whole, with no attempt made to filter out those interviewees for whom no corresponding survey data were supplied.

The interview script (reproduced in Appendix C) was structured primarily around the university's stated graduate attributes, with participants asked if they felt the games played in the lab had helped develop any of these. Some more open questions were asked about the participants' experience and each participant was asked to elaborate on a couple of the multiple choice style questions that appeared in the online survey instruments. A modest lunch was provided for participants taking part in the interviews, if they so wished.

Following transcription, interviews were read through quickly to begin familiarisation with the content, and to correct any outstanding typographical errors. Initial notes were taken during this process, with the intention of identifying key concepts for coding and recurring themes, whether expected (e.g. relating to a particular graduate attribute) or unexpected (e.g. a useful skill or experience that did not relate directly to a particular graduate attribute). Next, an attempt at coding the data was made by hand, using printed copies of the transcripts and a substantial supply of highlighter pens. This process served to further familiarise the researcher with the data and the coding of the transcripts could have been considered complete at this stage. However, since the transcripts already existed in digital form and a somewhat significant number of themes and questions were coded for, it was determined that qualitative data analysis software should be used to prepare the data for queries and extraction of quotations relating to particular questions. NVivo 11 Pro[73] was the software selected to carry out this task, as it is a well-established tool used across the social sciences and is available to purchase at a discounted rate from the university.

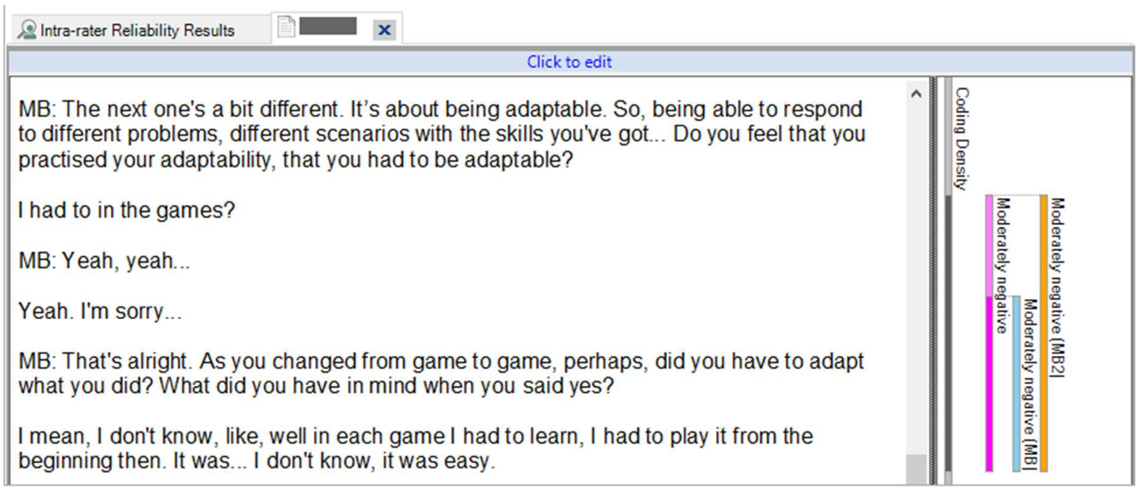
The themes (or 'nodes' to use the NVivo nomenclature) coded for were organised into four main groups: games, graduate attributes, general questions, and other skills and experience. The first of these, games, were the most straightforward to code, as a mention of a specific game is easily identified. To an extent, the graduate attributes were also straightforward to

[73] http://www.qsrinternational.com/nvivo-product/nvivo11-for-windows (accessed 28th July, 2016)

code, especially where they were discussed in response to the clearly delineated questions pertaining to each attribute. However, as is apparent in the discussion of each attribute that follows, there is often significant overlap between the definitions (as provided by the university or interpreted by participants) of certain attributes. In such cases, care had to be taken to ensure that comments that more closely related to other attributes were coded as such. Certain attributes were also touched upon at other points in the interviews, for example, in the initial open question about the skills and competencies games might help develop in players, and in that relating to the utility of games being played at university. More subjectively, an attempt was also made to code statements in terms of sentiment, indicating whether the opinion expressed by a participant in relation to a topic was positive or negative in nature. However, overall, there is relatively little margin for ambiguity in the sort of coding performed here.

The individual nature of the PhD arguably precludes the use of inter-rater reliability techniques to assess consistency of coding. However, given the structured nature of the interviews and an appropriately scoped approach to coding – intended to avoid the pitfalls of over-coding – it was felt that intra-rater reliability checks were sufficient. In order to carry out intra-rater checks, a copy of the NVivo project was made and a random selection of interview transcripts (N = 5, 25% of the total number of transcripts) was re-coded by the same researcher on the same installation of NVivo but using a second user account to represent the 'second coder'. Taking a copy of the NVivo data was an unnecessary step, perhaps, but this reassured the researcher that the unfamiliar process of coding the data a second time could not interfere with the original results.

As previously noted, the nature of the data is such that there is relatively little room for disagreement in how responses are coded. In contrast to, for example, a grounded theory approach (Glaser & Strauss, 1967) where the object of the exercise is to develop new hypotheses and themes, the coding here was carried out in order to organise the data and facilitate efficient extraction of responses that related to predetermined concepts (primarily the stated graduate attributes). The most subjective aspect of the coding lay in the analysis of sentiment. Where appropriate, responses were coded using NVivo's built-in sentiment nodes: 'Positive' (which includes the more granular 'Very positive' and 'Moderately positive' options) or 'Negative' (including 'Moderately negative' and 'Very negative). Some small disagreements were noted here, where, for example, a response might have been coded simply as 'Positive' in one instance and 'Very positive' in the other. The other form of disagreement (illustrated in the figure below) related to the quantity of text selected to represent the response being coded. In some cases, for example, only the most relevant portion of a participant's response might have been coded on the initial attempt while the subsequent attempt at coding might have included some of the preceding conversation.



Node	Source	Source Folder	Source Size	Kappa
Negative\Moderately negative	[redacted]	Internals	7026 chars	0.6621
Negative	[redacted]	Internals	7026 chars	0.7424

Figure 53: An example of one of the most significant disagreements between initial and subsequent coding wherein the 'second coder' (MB2) has coded a slightly longer piece of the same interview response as 'Moderately negative' than the 'original coder' (MB). The corresponding portion of the query results that highlight disagreements (including Kappa coefficients) is shown below.

A more significant, albeit isolated, instance of disagreement was found in the following exchange, relating to the Effective Communicators attribute:

> *I'm not very good at communicating...*
>
> Interviewer: *Well, did you have to communicate in any of the lab sessions?*
>
> *Maybe the first week in the first game, we were four, playing* Borderlands.

In this case, the response was first coded as 'Moderately negative', but on the second pass, this was deemed a 'Moderately positive' response. In the analysis below, the exchange is treated as one of the more negative responses for this attribute. However – while it certainly cannot be characterised as wholly positive – the fact that the interviewee concedes, after prompting, that communication took place on at least one occasion may be interpreted as not wholly negative. On reflection, the negative interpretation seems more reasonable and the infrequent occurrence of such apparently contradictory coding in these limited data is not thought to represent a major problem. However, this example is indicative of the sort of issues that might arise if such a qualitative approach were to be taken to a larger study that focused more specifically on participant attitudes. These issues would be addressed by taking a more robust inter-rater approach to checking for reliability.

NVivo offers measures of inter-rater reliability in terms of both Cohen's Kappa coefficient (Cohen, 1960) and percentage agreement figures[74], and the same facilities may be used to calculate equivalent values for the intra-rater data produced here. Table 14 below shows the results of these calculations for the five participant transcripts that were re-coded, for the nodes associated with sentiment analysis.

[74] http://help-nv10.qsrinternational.com/desktop/procedures/run_a_coding_comparison_query.htm (accessed 24th October, 2016)

Table 14: Results of intra-rater reliability analysis, including Kappa coefficients, as calculated by NVivo (sentiment analysis only)

Node	Source	Kappa	Agreement (%)	A and B (%)	Not A and Not B (%)	Disagreement (%)	A and Not B (%)	B and Not A (%)
Negative	Participant B	0.7424	96.71	5.19	91.52	3.29	2.62	0.67
Negative\Moderately negative	Participant B	0.6621	95.92	4.4	91.52	4.08	3.42	0.67
Negative\Very negative	Participant B	1	100	0	100	0	0	0
Positive	Participant B	0.9251	97.38	21.23	76.15	2.62	0	2.62
Positive\Moderately positive	Participant B	0.8752	96.73	13.88	82.85	3.27	0.65	2.62
Positive\Very positive	Participant B	1	100	0	100	0	0	0
Negative	Participant G	1	100	5.49	94.51	0	0	0
Negative\Moderately negative	Participant G	1	100	5.49	94.51	0	0	0
Negative\Very negative	Participant G	1	100	0	100	0	0	0
Positive	Participant G	0.9637	98.18	49.64	48.54	1.82	0	1.82
Positive\Moderately positive	Participant G	0.8859	95.21	27.37	67.85	4.79	0	4.79
Positive\Very positive	Participant G	1	100	0	100	0	0	0
Negative	Participant K	1	100	7.37	92.63	0	0	0
Negative\Moderately negative	Participant K	1	100	7.37	92.63	0	0	0
Negative\Very negative	Participant K	1	100	0	100	0	0	0
Positive	Participant K	0.9994	99.97	32.9	67.07	0.03	0	0.03
Positive\Moderately positive	Participant K	0.8801	96.93	13.49	83.44	3.07	0	3.07
Positive\Very positive	Participant K	1	100	0	100	0	0	0

Negative	Participant R	0	99.21	0	99.21	0.79	0.79	0
Negative\Moderately negative	Participant R	0	99.21	0	99.21	0.79	0.79	0
Negative\Very negative	Participant R	1	100	0	100	0	0	0
Positive	Participant R	1	100	51.78	48.22	0	0	0
Positive\Moderately positive	Participant R	0.7051	94.95	6.85	88.1	5.05	0	5.05
Positive\Very positive	Participant R	1	100	0.15	99.85	0	0	0
Negative	Participant L	1	100	0	100	0	0	0
Negative\Moderately negative	Participant L	1	100	0	100	0	0	0
Negative\Very negative	Participant L	1	100	0	100	0	0	0
Positive	Participant L	1	100	41.15	58.85	0	0	0
Positive\Moderately positive	Participant L	1	100	6.4	93.6	0	0	0
Positive\Very positive	Participant L	1	100	2.04	97.96	0	0	0

As might be expected of a relatively straightforward dataset such as this, coded on two occasions by the same person, both percentage agreement figures and Kappa coefficients indicate strong agreement. Kappa coefficients are considered useful because they take into account the degree to which the data may agree by chance alone, but there is no agreed standard for interpreting the strength of agreement indicated by the figure. The NVivo documentation, for example, suggests that coefficients of 0.75 or greater indicate “excellent” agreement, whereas Landis & Koch (1977) propose a gradation as follows: ≤0 = poor, 0.01–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial, and 0.81–1 = almost perfect. However, in medical research, the 0.41 lower bound of acceptability proposed by Landis & Koch and implied by Cohen is not considered acceptable (McHugh, 2012). By any standard, however, the Kappa values obtained here are reassuringly high. So, while the intra-rater reliability checks employed here were less robust than the inter-rater checks that would be expected of a larger project with a more ambiguous dataset, they nonetheless proved useful and the high degree of concordance between the sampled data suggests that coding of the interview data was sufficiently reliable.

For the purposes of the interviews, participants were provided with the current university definitions of each attribute. These definitions are reproduced at the beginning of each section below, where participant responses are discussed on an attribute-by-attribute basis. In order to preserve student anonymity, student numbers (used within NVivo to identify participants) have been systematically replaced with participant letters and accompanied by a short demographic description. Discussion of these qualitative results is presented in conjunction with the data for each individual attribute.

5.3.1 Effective Communicators

- *Articulate complex ideas with respect to the needs and abilities of diverse audiences.*
- *Present their ideas clearly and concisely in high quality written and spoken English.*
- *Communicate clearly and confidently, and listen and negotiate effectively with others.*

Communication skill was mentioned by two participants in response to the open question that asked if any of the games played might have helped develop useful skills or competencies. For example:

> *I think definitely kind of communication* [...] *And especially stuff like* Minecraft *and* Warcraft *and things like that where you did actually have to properly communicate with people and ask, like, "are you going to go and get this, or should I do it?" Like, that was really, really good.* (Participant M, female, age 17)

Another participant, a self-confessed lone player ("...I don't talk to people, I'm not in any guilds, I don't join any groups, I don't raid or dungeon or anything, I'm just questing all by myself. It's the best way to be!"), found herself enjoying the social aspect of playing together in the same room. Again, before the Effective Communicators attribute had been discussed specifically, this participant noted the pleasurable and practical advantages of being able to communicate with other players:

> *It was kind of nice obviously because you're sitting in the same room because it's easier to communicate, and say, you know, 'go to your left', because I can see on their screen where they are in a slightly easier way than just in-game stuff would allow you to do. So that was, you know, a good way to cooperate for the co-op stuff.* [...] *It was nice just to communicate with other people in the same room which was a bit different than normal* [online] *multiplayer stuff.* (Participant J, female, age 29)

Similarly, another student noted that the study participants had formed something of a community, which was, perhaps, more fun than expected:

> *Yeah, I think it would be more fun to play games with people you know than those you don't but certain times I felt like a little community is building up, for example,* Minecraft. (Participant I, female, age 21)

Responses to the specific question of whether the games played could have helped develop the Effective Communicators attribute were positive. Participants agreed that communication played a significant part in the games played, with many going on to state that this experience helped develop their communication skills:

> *Definitely, yeah, because they all have like a multiplayer aspect to them, and you're having to work with other people and talk to each other. So it'd definitely help with that.* (Participant L, female, age 18)

> *Yeah, definitely. Especially, like, negotiating with people, trying to figure out where you were going to go, and stuff like that.* (Participant M, female, age 17)

One of the more cautious comments came from a mature student:

> *But yeah, I don't know if I communicate very clearly or confidently. I communicated effectively because we got through it but, yeah, I don't know if I was very clear.* (Participant A, male, age 32)

Participant A was one of several to connect communication with leadership ("Yeah, the girl that I was playing with, she'd already been through it but she'd forgotten how to do [the puzzles], so I ended up taking the lead on that…"), an aspect that is discussed under Experienced Collaborators below.

Participant C agreed that effective communication was necessary when playing the games provided but was also unable to say for certain that the experience helped improve his skills:

> *Definitely, it did require communication. I don't know if it helped improve it necessarily but for sure, you notice how you communicate with others. You notice using very much shorter words, more direct, and not necessarily nice as in written and spoken English. But I think definitely there was a lot of communication needed. Not necessarily developed, but then we played only two hours per week.* (Participant C, male, age 19)

Participant C was one of the more dedicated game players taking part in the study, however, estimating that he played more than eight hours per week outside of the lab. Considering these playing habits, it is perhaps unsurprising that this participant was unsure if the relatively insignificant time he spent playing games in the lab could have had an effect on his own communication abilities.

Another participant was very positive about the relationship between the games played and certain aspects of the supplied Effective Communicators definition:

> *I think communicating confidently, definitely, because you don't want to lose the game. So you have to be able to tell people, even if you've just met them, "excuse me, sir, don't be such a fool, defend this base" and such. And negotiating, for sure, is another one because, again, the game itself becomes priority, so you do have to communicate quite well.* (Participant T, male, age 19)

However, while the games might have required confident communication and deft negotiation, Participant T was less certain that his in-game communication possessed clarity:

> *...in "high quality spoken English" I'm seeing here, and "communicating clearly", that's different, because you are just shouting at people, often. You know, you'd like to be a calm and collected individual who can clearly articulate in a calm manner what you'd like to happen but instead you go, you know, you just scream at each other – by name – you're hoping that if, by me just* shouting [another participant's name]*, she'll understand what I'm trying to get her to do.* (Participant T, male, age 19)

The idea that communicating with fellow players in a pressurised gaming scenario might result in a successful outcome despite a lack of clarity was echoed by another participant:

> *...it kind of depended on the game because some of them where, you know, if there's people coming at you, it's kind of hard to communicate clearly and confidently. It ends up being "ahh, someone's over there to your left, kind of, sort of... oh, is that where you are? Oh God, oh God..." Um, so that's maybe not as clear and confident as one would normally like in a standard job situation but at least communication was there. So, I think that was helpful.* (Participant G, female, age 22)

Another participant suggested that necessity was the mother of effective communication when faced with time-sensitive in-game challenges:

> *A lot of the games, especially like* Portal*,* Team Fortress*,* Warcraft*, they had that element of needing to communicate with someone. So, when you* *<u>have</u>* *to communicate with someone, you'll learn how* *<u>best</u>* *to communicate with someone because you know when you have to do it… in those sort of team-based games where you have to be able to say "you do this and I'll do this".* (Participant R, female, age 18)

Some participants offered ideas about what aspects of the experience were most valuable in terms of improving communication skill. For example, Participant H pointed to the disparity in her fellow participants' game-playing ability actually enriching the experience:

> *I definitely think that especially the game sessions we played in the lab helped with communication because we did co-op.* […] *Because we get to do it with people that have different levels of experience. Because we get to do it with people that are experts at the game, or people who are completely new to it, people who have played it sometimes, so they have a general grasp, and you get to compare yourself to them but also learn from them or help others. So I definitely think that the game sessions here do a whole lot to develop communication skills.* (Participant H, female, age 23)

While she did not necessarily enjoy playing with less experienced players, another participant alluded to the need to adapt the nature of their communication in order to progress, which might be thought of as useful experience:

> *Yeah, I suppose like, you know, you kind of have to communicate if you're doing a team game but it just depends on who I'm playing with. Like, I think it was* Borderlands *I was playing, at first we were playing with a few girls who were pretty decent at it, you know, it was the first time they'd played it but they knew what to do. Whereas someone else came in and they obviously hadn't played anything before and I was just like, "ah, ffff…"* [sound of frustration] *Like, just, "that's how you walk forward."* (Participant G, female, age 22)

For another participant, the fact that many of the games involved "communication with others in the room, many of whom [are] complete strangers who you are now relying on for the success of your goal" (Participant F, male, age 19) was part of what made the experience interesting. He pointed to the procedurally generated world of *Minecraft* in particular:

> Minecraft *especially surprised me with the amount of communication involved. I was willingly taking advice from a person I'd never met, allowing him to guide me and give me tips for success. Whilst at other times I was placed in his position, giving others advice on how to play.* [...] *When random strangers are dropped together in an unknown and sometimes dangerous world, they bond together and have to have clear communication in order to get their points across and survive together. It was great!* (Participant F, male, age 19)

One less enthusiastic opinion was expressed by Participant B (female, age 21) who responded by first stating that "I'm not very good at communicating..." before conceding, following a prompt from the interviewer, that some communication had taken place: "Maybe the first week in the first game, we were four, playing *Borderlands*." It is perhaps worth noting that English was not this participant's first language, and it may be that her experience at an English-speaking university (the interview was conducted during her second year at the institution) had influenced how she perceived her communication ability[75]. On reflection, it might have been interesting to explore with the participant how her experience of *Borderlands 2* differed from, say, *Team Fortress 2*, which features similar team-based game play.

Only one participant entirely rejected the notion that the game-related communication was useful:

> *Not really, the communication was more about sharing feedback with each other ("Dammit! I thought I killed you!") than trying to communicate effectively in order to solve problems.* (Participant Q, male, age 18)

Overall, then, participants felt that the experience of playing the selected games – most of which featured some form of multiplayer component – was likely to have had a positive effect on their ability to communicate. This outcome is supported by the quantitative data obtained via the instruments described above, and so these interview data help shed some light on what aspects of the experience the participants felt were most relevant to improving communication skill. Chief among these factors, based on participant interviews, is the simple fact that multiplayer video games require players to communicate in order to succeed. This is

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[75] It is notable that Participant B's baseline scores on the CAS and SPCCS communication measures were 102 and 665, respectively, which places her slightly above the mean score for CAS (99.6 across control and intervention groups) but well below the mean score for SPCCS (879.57). As the name of the instrument implies, SPCCS is intended to determine *self-perceived* communication competence.

hardly a revelation, but what is interesting to note here is that the players' intuition about such games' utility for developing communication ability is apparently well founded. Another relevant factor identified by participants is the time-sensitive, high-pressure nature of the scenarios presented by video games that require players to communicate efficiently in order to progress. Again, this seems entirely plausible on paper, and very much the kind of experience an employer might seek in a potential employee: the issue is that the experience is gained by means of playing a video game, a means that may not be recognised by employers as legitimate. A final factor that is revealed in the participants' responses is that of being required to communicate with players of differing ability and experience. This necessitates more experienced players to adapt their approach to communicating with their teammates. Furthermore, in this case, the experienced players' teammates are students with whom they often have no existing rapport or comparable experience on which to draw, as might be the case when playing with their own friends. Less experienced players, too, must learn to listen to their more knowledgeable peers if the team is to achieve its in-game goals, and be ready to ask questions in a clear and efficient manner, as well as make sense of the answers received.

Van Lier (2010), in his discussion of the "ecology of language learning", frames Bruner's concept of pedagogical scaffolding (discussed under 'Theories of Learning' above) as occurring on three time scales: macro, meso and micro. The last of these timescales refers to the "interactional unfolding of learning activities" rather than the premeditated, structured approach to scaffolding that a teacher or tutor may take. It is defined as comprising the "contingent interactional processes of appropriation, stimulation, give-and-take in conversation, collaborative dialogue and so on" to which several of the interviewees here appear to allude. Van Lier also suggests that the learning of language "crucially relies on how the learner, as an active participant in meaningful activity, learns to perceive activity" and is a process that takes place within a semiotic context. There are clear links here to Gee's broader theories of learning in games, wherein the game is the semiotic context (or domain) and the learners/players are active participants in constructing meaning, here understood to be a shared language or means of communicating. Players learn through activity that is not limited to the spoken word, but encompasses the deixes or contextual knowledge that players of the same game share, as well as gestures and utterances that, in a different context, might be meaningless. Van Lier also presents three interlocutor configurations, based on their inter-relationships. *Primary intersubjectivity* relates to face-to-face communication and is characterised by communication between infant and caregiver. *Secondary intersubjectivity* refers to shared observation of an object, a triadic interaction between two interlocutors and an object; it is characterised by an older infant and their caregiver referring the object in question, initially by means of pointing. *Tertiary intersubjectivity* is characterised by the ability to refer to phenomena that are temporally or spatially distal, and begins to occur in children from around age three. This final form of communication is essential to most forms of multiplayer video games, as the interview data here illustrate: tertiary intersubjectivity is required for relaying players' relative positions in *Team Fortress*, sharing the location of certain resources in *Warcraft*, or describing an off-screen clue in *Gone Home*. In fact, the complexity of these communications – exacerbated by the different perspectives on the game world offered by individual players' screens – suggests a *quaternary intersubjectivity* configuration. Here, the interlocutors are discussing objects of which there are multiple copies, and which are virtually distal – that is, they exist only in a virtual world – in addition to being temporally and spatially distal. This subtle increase in complexity, which is manifest in a first-time player's bewilderment, may be part of what makes video games suitable for developing communication skill. Furthermore, in a world where business is increasingly conducted online, the ability to exercise this quaternary intersubjectivity may be all the more valuable.

Participant T appears sceptical that merely shouting his co-player's name is effective, but given the context in which he is doing so – and the shared nature of their experience – this, in fact, may be a sufficiently clear and efficient means of communicating with his partner. This is not the form of communication this participant or, indeed, most of us have been taught to value but it is true that brevity is key to successful communication in many real-world domains (for example, the military, or air traffic control). There are echoes here of Grice's (1969) distinction between what is uttered and what is intended to be understood by the utterer. This idea of communicative intention that has been taken up by relevance theorists (see Stojanović-Prelević, 2011) and described in terms of explicature and implicature. Here, explicature consists of causal and temporal conclusions about what is said, e.g. the shouting of a fellow player's name, a description of an enemy or obstacle that makes sense only within the context of the game, at that moment. Implicature consists of implicated premises and conclusions about what is meant, e.g. the identity of the person best placed to help, and the nature of the problem at hand. So, while the participant's chosen mode of communication is far from sophisticated, there may a useful lesson to be learned here if players were to reflect on the efficacy of their in-game communication, and to consider if the message they intended is being communicated.

Of course, many activities may provide a context in which communication may be developed. Video games, however, offer a means of creating shared and dynamic contexts that are not readily matched – in terms of fluidity, complexity, and authenticity – by conventional classroom experiences.

Observations about the influence of gender on communication were also made, primarily in relation to collaboration, and this influence is discussed under Experienced Collaborators below.

5.3.2 Experienced Collaborators

- *Engage with the scholarly community and respect others' views and perspectives.*
- *Are experienced in working in groups and teams of varying sizes and in a variety of roles.*
- *Conduct themselves professionally and contribute positively when working in a team.*

The collaborative nature of the game play sessions was frequently cited in response to the initial open question, with six of the twenty interviewees suggesting that useful experience of collaborating – more commonly referred to here as teamwork – was gained. For coding purposes in NVivo, a 'team work' node was created as a child of the Experienced Collaborators node, an arrangement that was thought to accurately reflect the university definition given above ("working in groups and teams"). Thus, any mention of teamwork was coded as being related to the Experienced Collaborators attribute.

Responses to the initial open question ranged from the non-committal ("Em, maybe teamwork?" – Participant D, female, age 18) to the somewhat more definite ("Maybe team work. I think team work is one." – Participant N, male, age 18). The overtly cooperative nature of certain games was also highlighted in responses to the open question, and typically associated with the idea of teamwork. For example:

> *Probably team work. Especially the likes of* [Team Fortress 2]. *Learning how to work with new people as well.* (Participant L, female, age 18)

Also in response to the open question, one participant noted that the experience was beneficial because she was not normally fond of teamwork:

> *Working in a group when you have to rely on people and make sure that everyone does their part, that's quite useful. And, I'm not really a team player, so that helps me gain patience and stuff.* (Participant E, female, age 20)

When asked specifically if the games played had helped provide experience of collaborating, the response from participants was overwhelmingly positive: "Yeah. Yeah, definitely." (Participant D, female, age 18); "Yeah, for sure, yeah." (Participant R, female, age 18). Given that students have been found to value team work and collaborative learning experience (Crebert, Bates, Bell, Patrick, & Cragnolini, 2004), this is an encouraging response.

Participant F (male, age 19) was quite confident that the games spoke to the definition of Experienced Collaborators given here, and that this experience was relevant beyond the games:

> *In many of the games you are simply forced to work with others, and change positions as well. There is often no single leader, the roles switch as different people's strengths come into play, or depending on your prior knowledge of the game. Almost every game on the study required teamwork, you are doing just as you would if you were working together to solve a problem* [...] *in the workplace – just it's in a virtual environment. To say one demonstrates and advances skills of working in a team whilst another doesn't hardly makes any sense.*

There was agreement from Participant L (female, age 18) that the collaborative experience ("especially when you're working with different people all the time") had benefits beyond the lab:

> *Yeah, I think definitely a lot of the skills learnt you could apply outside of video games, things like the confidence and team work. Yeah, I think you could apply* [them] *to uni, work, just everyday life.*

Participant K (male, age 18), however, was not convinced that the collaboration – which he did agree had occurred – was relevant outside the games:

> *Yes, yeah.*

Interviewer: *Useful experience?*

Em… useful within games.

Interestingly, another participant saw strategizing and multitasking as part of what made the collaborative experience useful, although these ideas were not echoed by any other participants:

> *In* Team Fortress*, good cooperation and strategizing in groups by choosing complementary classes became a habit after about 30 minutes of gameplay. That,* Warcraft*, and* Lara Croft *globally enhanced my ability to watch what others were doing while playing on my side at the same time.* (Participant Q, male, age 18)

Another interesting idea touched on by only one participant was that of trust being an important aspect of collaboration:

> *…like especially in* Portal*, you couldn't just do everything by yourself, you had to trust the other person, just let them do what they need to do.* (Participant O, female, age 18)

Participant C (male, age 19) is a practised player who believed the collaborative experience was, for him, enhanced by the need to play with less knowledgeable players ("I gained experience of working in a group of people that were not my same skill level"). He also noted the potential for collaboration in the single-player games, played in the same room as others:

> *…mainly* Gone Home*, when there is a person there, we're almost at the same level but maybe we went different routes. We can speak to each other and we're enquiring, what happens on your side, how can I get there? And, 'oh you should try that' so it's a common investigation of the same issue but from different perspective and getting a different understanding of what's going on* […] *I've never been in that kind of experience where we are both unskilled or both unknowing about differences, so we worked together.*

Another participant agreed that being asked to collaborate with players of differing abilities was also a useful, more challenging experience:

> *Yes, definitely* […] *Outside* [the lab] *I didn't* [play multiplayer] *as much, or I may do it with just one person that I play with very often, so I know that we're pretty much at the same level of expertise. It's actually harder to collaborate with others if they have a different level of experience.* (Participant H, female, age 23)

Other participants noted that the games provided opportunities for players to take on different roles, as specified in the university definition of this attribute, even if, as in the case of Participant I (female, age 21), that role was not necessarily a useful one:

> *Yeah, I was always the distractor, I think* [laughs] *Because of the lack of my experience with those who played it before were distracted.*
>
> Interviewer: *But you felt you got some experience of collaborating, even if you were the "distractor"?*
>
> *Yes.*

Participant A (male, age 32) also noted how he fell into a supporting – albeit important – role:

> *...I did find myself taking, or kind of seeking, a secondary role in co-op games, and just being happy. On* Team Fortress *I ended up being the person who pushed the bomb along.*

While leadership is considered under the Confident attribute below, one participant was enthusiastic about the possibility of taking on a leading role, but also assuming a secondary role, as required:

> *Depending on the game, depending on what other people were good at* [...] *Like for* Minecraft *I was kind of helping a couple of other people with the ropes and you kind of know to take a slightly more leader-y 'OK, I know what I'm doing'* [role]. *And then, equally, there were games where I knew absolutely nothing, like* Warcraft*, and so I'd take a back seat and people would say 'do this' and I would do that, go fight that person.* (Participant T, male, age 19)

Participant T was also able to generalise what he had learned from his experience of playing multiplayer games, such that it might prove useful beyond the games:

> *So, yeah, I suppose it helps in regards to knowing when to take a little bit of control and when to sit back and let the people who know what they're doing, do it.*

In contrast to these positive remarks, Participant B (female, age 21) was perhaps least enthusiastic, with a somewhat positive response only drawn out when the interviewer suggested that *Borderlands 2* was a game in which collaboration might have occurred:

> [Long pause]

> Interviewer: *Just* Borderlands *again, maybe?*
>
> *Yeah. It was very fun to play together.*
>
> Interviewer: *But not so much experience of working as a team, as a group?*
>
> *Well, we didn't know each other, so, I don't know...*
>
> Interviewer: *So because you didn't know each other, did that make it more difficult?*
>
> *Yes, at the beginning, but then we started to talk about what to do...*

In this case, the response prompted by the interviewer's mention of *Borderlands* suggests that collaboration (or perhaps communication) was actually required to succeed at the game, but the players concerned had to overcome the fact that they had not previously worked together. The other response that stands out as less positive than most came from a mature student (Participant A, male, age 32) with extensive work experience:

> *Possibly... I mean... it's kind of an environment that I'm comfortable in, being part of the team, because I'm a mature student so I've been a chef for about ten years. That's very... I mean, if you're not part of the team, you're out the door. I play in bands and things as well. I play drums and I like collaborating with people in that way. So, I think, I guess... I probably wouldn't have noticed, because I'm so used to being* [collaborative]. *So it probably didn't jump out.*
>
> *Interviewer: But may still have been there, to some degree?*
>
> *Yeah, yeah, I could recognise it, yeah. It didn't take me by surprise* [...] *getting something out of being in that sort of group dynamic.*

This response indicates that the participant didn't feel he personally gained useful experience of collaborating – over and above that obtained already through other activities – but that the experience was there to be had.

Finally, one participant had an interesting perspective on gender differences in the collaborative approach taken to playing *Borderlands 2:*

> *There was a lot of collaborative effort, because I think especially with the three girls that were playing, like, well, me and two other girls that were playing, it was like 'I'm going to come over an heal you!', 'I'll come over and do all this stuff'. Whereas with, I*

> *don't know if this is like a sexism thing, whereas with the two guys, they were like 'I'm just going to go and kill things' and I was like 'Where ARE you? I can't even help you when you're over there'. So, that was quite interesting. Just as a side note, I think the girls were better at like tacit, implied, 'I'm going to come over and help you if you're in trouble' whereas with the guys you had to clearly state 'could you, like, not do that?* (Participant J, female, age 29)

This idea is interesting because violent first-person shooter games – which would include *Borderlands 2* – are often considered masculine spaces (Assunção, 2016). If female players' collaborative and communicative abilities were, in fact, superior to those of their male counterparts, this might suggest they possessed some advantage in a game that apparently relies upon collaboration and communication. Certainly, the results of the larger cross-sectional survey conducted following the main experiment suggest that female students are slightly better communicators than their male peers.

There is evidence in the literature to suggest that women are better at collaborating or, at least, more disposed towards collaboration, than men. For example, in a study that used co-authorship of scientific papers as a proxy for research collaboration, Abramo *et al.* (2013) demonstrated that female researchers show greater propensity towards collaboration than male researchers at "general level, intramural level and domestic extramural level", while noting that "a gap remains in the propensity to collaborate at the international level". The authors speculate that this gap may be indicative of the reduced opportunity for mobility that women can encounter in the workplace, rather than a disinclination towards international collaboration, however. Gender differences in attitudes to collaboration and competition have also been observed in the workplace. Kuhn & Villeval (2014), for example, cite a range of previous work showing that women shy away from competitive work environments while presenting data that suggests women are more likely to opt to collaborate with colleagues than men, driven by a more positive view of colleagues' abilities.

Differences between how men and women communicate – and the capacity for such differences to result in miscommunication – are described by Maltz & Borker (1982). The differences they identify include how women and men perceive questions, with the former viewing them as "part of conversational maintenance" and the latter as "requests for information". They also note that men are more likely to assume the verbal sharing of a problem is an explicit request for a solution, which may be dispensed regardless of the (male) interlocutor's understanding of the topic at hand[76], and that men and women perceive the role of verbal aggressiveness differently (p. 213). Coates (1993) draws attention to Maltz & Borker's characterisation of girls' talk as "collaboration-oriented" and boys' as "competition-oriented", suggesting that while men are more inclined to talk loudly, swear, and ignore other men's utterances, women, when talking to other women, use so-called "powerless" language to express mutual support and solidarity (pp. 139-140). It is not difficult to imagine how the latter, female approach might offer some advantages when playing cooperative video games.

However, as Canary & Hause (1993) note, a reliance on stereotypes, and the polarization of the sexes can muddy the waters where research into gender differences in communication is concerned, and these issues undoubtedly persist where research pertains to the related area of collaboration. Reeder (1996) also notes that research into gender differences in communication is often hampered by studies that conflate gender with biological sex, and those that treat gender as a predictor variable. This implicitly ignores the reverse relationship between communication and gender, wherein aspects of what define a person's gender are created by the way in which they communicate.

The implications of this idea are not entirely clear. It might be suggested that male players could stand to gain from being asked to play with female players, from whom they may learn to collaborate more effectively. If female players are generally better at collaborating, then, it might also follow that they have less to gain from taking part in such game-based activities, although experience of working with less able male players may prove, in itself, useful.

These gender differences are largely speculative: there is little qualitative evidence here to suggest any significant disparity between male and female players, although the quantitative data obtained by means of the larger cross-sectional study (discussed below) suggest that gender differences do exist. Perhaps the differences are so slight as to render them unobservable in situations such as these or, as Participant J alludes to, perhaps concerns about appearing sexist discourage comment on any observed differences. However, if this work were to be carried out on a larger scale, potential gender differences should be examined in more detail. With a more detailed knowledge of the differences and interactions between genders,

[76] Wherein may lie the origins of mansplaining – see http://www.dictionary.com/browse/mansplain (accessed 5 September, 2016)

future interventions could be modified to address any potential issues and capitalise upon any potential advantages, for example, in the gender balance of game-playing groups.

Collaboration and communication are skills that clearly require active participation to develop, as the above discussion of Van Lier's and Gee's ideas indicates. As suggested in the initial literature review, there is a potential link between the active nature of game-based learning and deep learning, and the higher levels of Bloom's taxonomy of learning. This, in turn, is why games may offer an opportunity to develop these skills, and, indeed, many of the other attributes considered here. It may be further argued that for learned skills to be transferable the learning must be deep in nature – the simple memorisation of facts is largely irrelevant when it comes to learning about how to communicate and collaborate: the ability to abstract meaning and a deeper understanding of reality are required, to use Marton & Säljö's terminology. Therefore, it is interesting to note Participant J's scepticism about the applicability of their game-based experience of collaboration beyond games. This is in contrast to Participant Q's assertion that playing games "globally enhanced" such skills, and a general agreement among participants that aspects of their game-playing experiences were relevant in 'real life'. It also contrasts with the findings of Toups *et al.* (2011), who showed that even a "zero fidelity" simulation game – one that does not attempt to accurately portray a real-world scenario, but rather, an abstraction thereof – was effective in improving team coordination amongst first-response emergency workers. The fact that the experience was gained within a game that bears no resemblance to an external reality was, in this case, irrelevant to the transferability of the skills.

5.3.3 Adaptable

- *Experience multi-disciplinary and/or inter-disciplinary learning in an internationally renowned institution.*
- *Respond flexibly and adapt their skills and knowledge to excel in unfamiliar situations.*
- *Demonstrate resilience, perseverance and positivity in multi-tasking, dealing with change and meeting new challenges.*

The response to this attribute was also broadly positive, with several participants highlighting that the variety of games played in the study required some adaptability on the part of the player.

> *I think it's when we're playing a different game every week and most of them I hadn't played before either, I tend to pick up new things very quickly.* […] *You do have to adapt slightly depending on what you're playing.* (Participant L, female, age 18)

> *Yeah, I think so. Although I'd never played any of those games before, so… for me it's all about being in a foreign environment and also those games, just not so familiar also in language for me. So, I definitely had to be adaptable.* (Participant S, female, age 18)

Participant K (male, age 18) also felt that the variety of games played was the important factor here, answering as follows: "To an extent, I imagine the games did, but probably getting a variety of games probably helped more than the individual games themselves". Another participant described the feeling of being "dropped into it" with each successive game, a term that seems to speak to the university definition of adaptability rather succinctly:

> *I mean, most of the games were kind of like, especially* Borderlands *again, were we were just kind of dropped into it, 'I don't know what this does' and, you know, you kind of figure it out relatively quickly. So I think that kind of shows adaptability in a way that, you know, you have to learn how to navigate the game…* (Participant J, female, age 29)

Another participant agreed that the variety of games was important but, in contrast to Participant K, also noted diversity within the games, too:

> *Yeah, I do think that the game sessions helped because we not only played a variety of different games like shooters or adventures but in the same game you can have lots of different tasks that require different skills.* (Participant H, female, age 23)

Participant E (female, age 20) agreed that different missions (or levels) within the same game each required a different response: "Yeah, I think if you do different missions every time you need to find a new approach to solve the mission […] so I think that that helps as well". She cited *Portal 2* as an example of a game that required this form of serial adaptability. Participant O (female, age 18) suggested that the dynamic scenarios presented by *Team Fortress 2* were also relevant: "when things would go really bad, you just had to get through it, adapt to the changing situations". Another participant referred to need to adapt the approach taken to the successive scenarios presented by *Team Fortress* 2, by varying her choice of character class, which would dictate the skills available to her (see section 5.1.2.6 above):

> *...if you'd chosen maybe a class or a character that isn't particularly helpful in that scenario if you then die and have to respawn you can make another choice which I thought was quite helpful because there were some times when I had made the wrong decision. And then being able to choose a different approach I thought was quite helpful. So in that case it was a little bit reflective, a bit more on-the-go, I suppose. So... that's just about applying different skills in different situations and again that sort of goes into adaptability as well.* (Participant J, female, age 29)

Continuing the theme of dealing with ever-changing scenarios, Participant F (male, age 19) highlighted the procedurally generated worlds of *Minecraft*, "again for the unfamiliarity of the vast world with new explorations and findings causing change in goals and priorities". Smith, Ford, & Kozlowski (1997) note that the modern workplace requires less in the way of what may be termed "routine" expertise (required to solve familiar problems), and more adaptive expertise. Adaptive experts can recognise when to try alternative approaches when faced with novel problems, exactly as Participant J describes above, and closely related to the common observation that the variety of games played was important here.

In much the same way as Participant E above recognised that being asked to play along with a group of strangers – in conflict with her preference for solo play – was beneficial in terms of improving her collaborative skills, another participant suggested that playing the games challenged her lack of adaptability when it came to making plans:

> *I think that [adaptability was improved] definitely as well. I'm just kind of one of these people when they have a plan, I really hate things being changed. So,* [...] *where I've got a plan already fixed in my head, if someone changes it, I'll just freak out about it and be like "no, I can't do that". But I think it's different with video games because obviously you have to... it's all about reaction times, about the really quick decision making.* (Participant M, female, age 17)

Participant B (female, age 21), however, was less certain that the games required adaptability on her part, as she took each new challenge in her stride: "I mean, I don't know, like, well in each game I had to learn, I had to play it from the beginning, then. It was... I don't know, it was easy". Participant B's confidence, however, was not shared by all participants, as one might expect. The following exchange with Participant I (female, age 21) demonstrates the importance of providing the necessary guidance and support – the scaffolding – to ensure that less experienced players are not overwhelmed:

> *Yes, a little, but I feel if you didn't explain* [to] *me the games before it would be worse.*
>
> Interviewer: *So it needed that little introduction?*
>
> *Yes, and like the paper with the controls and everything.*

The point made by Participant S – that participants were required to adapt to a "foreign" environment, including the lab and the other participants – was echoed by a number of other interviewees. For example, one participant noted the need to adapt to unfamiliar cultural norms:

> *Well, I think it does with another person, because of how they are used to do things is not the same. Probably because they are from here, or England, or from other countries and I'm from Spain, it's very different from every culture.* (Participant P, male, age 27)

Another participant highlighted the need to adapt to the differing levels of gaming experience in the room:

> *To be honest, it was probably more other people responding to my lack of experience with games but, yeah, I think just like working with other people with different abilities probably helps.* (Participant D, female, age 18)

Another, more experienced player also noted that a disparity in game play ability required her to adopt a certain role – that of a teacher – while playing, supporting Participant D's idea that more able players had to adapt to working with novices:

> *Yeah, yeah. But I think there was a lot of people weren't as, as you say, 'gaming literate' as me. And so it was sort of being able to pull them along because* [...] *it sort of became obvious that most people hadn't played the games before and didn't really know what they were doing. And when you know what you're doing you sort of take that to... teach other people how to do it. So I guess it's a kind of... teaching other people, the experience of... from my point of view, anyway, it was sort of telling other*

> *people the best way to do... this collaborative sort of thing.* (Participant R, female, age 18)

Some participants, however, were uncertain about the transferable value of the experience, indicating that while they were required to adapt their game-based skills from game-to-game, this was not relevant beyond gaming. Participant G (female, age 22), for example, had this to say:

> *I mean, obviously again it depends what sort of job or thing I'd be doing, like, outside of gaming but I suppose it could help with some things, like systems and I think there were a couple of games that were quite strategic, so, I guess it makes you think.*

Other participants referred to adaptability only in terms of video game play ("I think so, the more games I played the least [*sic*] time it took me to learn new gameplay mechanics" – Participant Q, male, age 18), although this kind of response does not preclude the notion that the experience was more generally useful. One participant made a connection between skills acquired in the real world and applying them within a game, a reversal of the idea being explored here:

> Papers, Please *was a good example of using previously acquired information and time management skills to complete a virtual and unknown task. Every single game in some way required you to take things you have learnt elsewhere and enforce them in new situations, therefore allowing the brain to understand new ways of applying those skills.* (Participant F, male, age 19)

Experienced players expressed some scepticism, suggesting that their knowledge of a wide variety of games resulted in few "unfamiliar situations" to which they had to adapt ("Em, well the thing is I've played most of the games before, so it was all kind of all familiar to me" – Participant N, male, age 18). Another experienced player elaborated:

> *That's interesting because they were not necessarily unfamiliar situations, so, I mean, I don't feel I adapted much, because that's what I do a lot of the time anyway... I play quite a bit. The only game I didn't play was... well, I didn't play* Warcraft III *but I played plenty of* Starcraft *and the same with* Lara Croft. *Mainly* Lara Croft *was about using the controller so it was a bit, for me, clunky. So there was possibly that,*

> *but even then, it was more remembering the skills and knowledge I have already ready and using it, continue using it.* (Participant C, male, age 19)

Participant A (male, age 32) was the only interviewee who was certain that the games did not require adaptability on his part, responding to the question of whether they did so as follows: "Hmm... [long pause] No, no."

On the issue of the transferability of the experience, it could reasonably be argued that this is not the point of the Adaptable attribute. It is the act of adapting to unfamiliar situations that is of importance here, not the ability to adapt an understanding of a particular game mechanic to a non-game context. The transferable dimension of the university's attribute definition states that graduates should "demonstrate resilience, perseverance, and positivity in multi-tasking, dealing with change and meeting new challenges" and there is evidence in the responses of several participants to suggest that many, if not all, of these criteria have been touched upon in their experience of playing these games in the lab. Resilience in the face of the unfamiliar is what is transferable here, not the ability to understand a specific game or gaming convention.

The contention of the experienced players that they were not faced with unfamiliar situations may also be challenged: as indicated by one participant above, the games and their mechanics might be familiar, but the circumstances under which they were played – and, perhaps most obviously, the people with whom they were played – did, in fact, require adaptation on even the experienced players' part. Furthermore, adapting to playing with – or working with – a diverse range of unfamiliar individuals, as touched upon by several participants, is arguably an increasingly important form of adaptability, due to the effects of globalisation on the job market (Lord & Smith, 1999). It might also be argued that Participant B (a moderate game player, engaging in 1-4 hours of game play per week), who described the games' various challenges as "easy", is simply displaying adaptability[77].

It is worth noting, perhaps, that certain of the examples cited by participants in relation to the Adaptable attribute have clear connections with other attributes. For example, the need to adapt to playing with people of differing gaming ability – raised here by Participant R – is also mentioned in relation to the Experienced Collaborators attribute above. The experience of

[77] In fact, participant B's baseline score for adaptability (197) was slightly below the mean I-ADAPT-M score (201.53).

adapting to playing with people from different cultural backgrounds is also raised under the Ethically and Socially Aware attribute below, which suggests graduates should “welcome exposure to the richness of multi-cultural and international experiences, opportunities and ways of thinking”.

Confidence was also mentioned in relation to adaptability, for example:

> *...you become more confident in your ability to be able to do that kind of thing in other situations. So it's not a case of, like, actually, literally applying what you've done but it does give you that, the self-confidence to sort of be flexible in like... 'Oh, I know I can do this because I, you know, I've played games like this before and it involved the same kind of thing' so it gives you the sort 'I know I know that I can do this'.* (Participant R, female, age 18)

And again, in a somewhat oblique reference to an employment scenario:

> *Ah, I think that I would be more confident. I mean, the more regularly I play, the more confident I get and since these were weekly labs I think I would be moderately confident, possibly more for an employer, but just because of the money factor* [laughs].
>
> Interviewer: *And is that because you're doing something different every week in the lab?*
>
> *Yes, definitely, and you have to adapt.* (Participant T, male, age 19)

Pulakos *et al.* (2000) developed an eight-dimension taxonomy of adaptive job performance by analysing over 1,000 “critical incidents” in workplace environments. Many of these eight dimensions – which are cited by Ployhart & Bliese (2006) in their development of the I-ADAPT measure used in this study – are evident in the interview data. For example, several participants referred to the need to cooperate with a variety of unfamiliar people, which is encapsulated in the “demonstrating interpersonal adaptability” component. The discussion of participants adapting to the cultural norms of their fellow players clearly relates to the “demonstrating cultural adaptability” component. The unpredictability of *Minecraft’s* procedurally generated worlds, and the unfamiliar scenarios presented by games that participants had never played before, have clear parallels to the “dealing with uncertain and unpredictable work situations” component of adaptability identified by Pulakos *et al.*

White, Mueller-Hanson, Dorsey, Pulakos, Wisecarver, Deagle, and Mendini (2005) suggest that "behavior change is at the core of the definition" of adaptability. Based on this definition, and the various components of adaptability described above, the qualitative evidence strongly supports the notion that video games – particularly when played under the circumstances described here – can exercise a player's adaptability.

However, after considering just a few of the institution's stated graduate attributes, it is clear that there is overlap between these attributes, or, at least, there are relationships between them. This overlap may be related to how the language of the attribute definitions is understood by different participants. However, there is also the possibility that these attributes – as illuminated by these discussions of video game play – may be facets of a single, if somewhat amorphous, attribute or phenomenon, along the lines of Coetzee's (2014) 'graduateness'.

5.3.4 Resourceful and Responsible

- *Are experienced in self-directed learning and authentic research-led enquiry.*
- *Are motivated, conscientious and self-sufficient individuals capable of substantial independent work.*
- *Manage their personal performance to meet expectations and demonstrate drive, determination, and accountability.*

While the associated quantitative instrument measured only resourcefulness, interviews provided an opportunity for participants to comment on the 'responsible' aspect of the attribute, and several interviewees did so. On reflection, and with the hindsight afforded by the transcription process, however, it might be observed that the interviewer occasionally over-emphasised the resourcefulness aspect of the attribute at the expense of that relating to responsibility. This is most likely a result of the interviewer being conscious of what the equivalent instrument was measuring, and a desire to obtain qualitative data to support and illuminate these measurements. Of course, the opposite is the case: qualitative interviews offer a means of collecting data on an aspect of the attribute that was not readily measured by quantitative means. Fortunately, the manner in which the attributes were presented in the interviews – with printouts of the complete university definitions accessible to interviewees – was such that both aspects of the attribute were highlighted to participants, and the opportunity for comment was not lost, even on those few occasions when the interviewer focused on resourcefulness.

Another feature of this particular question worth noting before describing the data was the participants' understanding of the word 'resourcefulness'. In most cases, the meaning of the word was adequately understood, and the presented university definition helped ensure some mutual understanding, but a few participants were clearly uncertain about the true meaning (for example: "I don't know what resourceful, whether it means what I think it means…", or "…in what I think resourcefulness means…"). In a small number of cases, the term was taken to have a more literal meaning than perhaps intended by the university definition, as participants associated the word with collecting resources (such as gold or lumber in *Warcraft III*) rather than with making independent decisions. For example: "Well, when you said resourcefulness, I just thought of *Warcraft* [laughs], because of all the resources, yeah" (Participant N, male, age 18) or, more subtly, "In some games you're put in situations in which you don't have much to use and you had to just make use of what you had to continue" (Participant K, male, age 18).

Resourcefulness, as understood by the participants, was frequently described as being related to how they responded to the often unfamiliar games.

> *…a lot of them I had absolutely no clue what I was doing, so I would have to make things up as I went along. And just sort of work with the little knowledge of games I had and just try and patch something together with that. It worked most of the time.* (Participant L, female, age 18)

> *Yeah, I suppose there was a bit of that, like, you know when you get dropped into* Minecraft *or* Portal *or something you've got to kind of figure out what on earth you're doing and, like, whoever you're playing with, you kind of help each other out and stuff like that.* […] *So I suppose in that sense you were kind of resourceful in that, like, you're kind of looking for what on earth you do and how the game works and sort of tricks to get you through the next puzzle, and stuff like that.* (Participant G, female, age 22)

Specifically, the constraints imposed by the limited amount of time spent on each game in the study, and relative lack of instruction were cited as factors which required resourcefulness (while echoing some of the sentiments expressed in relation to adaptability above):

> *Probably. Just because... you don't* [get] *much in the instructions, so if you haven't done it before, you kind of have to figure it out for yourself.* (Participant D, female, age 18)

> *I think resourcefulness* [...] *normally when you get a game you spend the first three hours walking around the tutorial map but learning how to shoot the gun. But because we only had two hours, you really wanted to make something of the game in the two hours, so you kind of hit the ground running. And that meant you had to be resourceful* [...] *in that you kind of have to be good, you have to do what you can do to be good, and try and get other people to also be good so you can make something of it.* (Participant T, male, age 19)

Participant T also related resourcefulness with teamwork and effective collaboration:

> *I mean, with* Borderlands 2*, we sat down and we were like, 'we've got two hours, let's try to make it to Sanctuary* [ostensibly the first geographic goal in the game] *in this two hours'. And so we were totally in the zone, right, OK, let's properly work with each other, let's do this. What are you good at? What am I good at? OK, you go to the front and shoot this guy and I'll stay at the back and shoot this guy. Let's see what we can do. So that was like the epitomy of communicating with each other and trying to be good. I say 'trying to be good', although we did make it to Sanctuary.*

So, while some of the discussion around this aspect of the attribute was at the edges of what might constitute resourcefulness, ideas relating to meeting fellow players' expectations and demonstrating drive and determination in the face of the unfamiliar are clearly articulated. In addition, some participants were able to provide individual examples that align exceptionally well with the university definition of this attribute. For example, one participant spoke directly to the motivation required of players:

> *I think mainly the fact that a lot of games have very clear objectives, and it's impossible to go further if you don't complete those tasks. So, you definitely have to be motivated, you cannot just be like 'oh, I'm not really in the mood to do this' because if you want to complete the game you actually need to have the motivation to just go further, even if it's a difficult task, even if it implies having a good sense of direction that you don't have, you just develop it along the way because you have to do it.* (Participant H, female, age 23)

Still another participant made the connection between carrying out independent work and the single-player nature of the final two games played (*Gone Home* and *Papers, Please*):

> *When it says "independent work", like, I can manage to do everything I have to do by myself? Well, in the last two games - because those were the only two where we played by ourselves - yes, it does.* (Participant P, male, age 27)

Responsibility was discussed in two senses: the in-game responsibilities associated with assuming a particular role; and the real world responsibility associated with seeing this study through to its conclusion and committing to the requisite two hours per week. Participant A (male, age 32), while dismissive of the possibility that the games might develop resourcefulness, described the former form of responsibility as follows:

> *Em, maybe not resourceful. A sense of responsibility, yeah.*
>
> Interviewer: *OK, in what way?*
>
> *Just knowing your… knowing your place. Going back to* Team Fortress*, even though I was just pushing the bomb…*
>
> Interviewer: *That was your responsibility?*
>
> *Yeah, I kind of knew, it was kind of clear… I mean, there has to be, in games like that, there has to be a clear divide, I think. Someone has to do one thing and the other person takes care of another aspect.*

The idea that players were responsible for contributing to the progress of their in-game team was echoed by Participant H (female, age 23): "especially if you are playing in co-op, if you slack off, that's not really gonna help the team". Another participant framed their team responsibilities in terms of what he perceived as his inadequacies as a game player, drawing on some of the language of the university definition:

> *…the least I am influencing, and you know, ruining that experience for other people, so I'm trying to do less of myself and more of the others.* […] *So maybe that's part of it, managing your own performance to meet expectations. Not necessarily improving it, but more managing it.* (Participant C, male, age 19)

A couple of participants suggested that they felt they should manage in-game resources in a responsible manner, an idea which falls somewhere between a literal interpretation of what it means to be resourceful and a perfectly reasonable conception of responsibility. Participant S (female, age 18), for example, suggested that "in *Minecraft*, you have to like think about what's… which things you are going to use and which you are going to save [for others]". *Minecraft* was also cited by another participant, who similarly linked responsibility with sharing resources with others:

> *Like going around and having to find resources and having to kind of like collaborate with people to make sure you've got enough stuff to make weapons and armour and things like that, but that would be the only one I can think of.* (Participant M, female, age 17)

And, while her response was framed in terms of resourcefulness, the pooling of resources Participant J (female, age 29) described was similarly responsible (and collaborative) in nature:

> *Oh, well I think* Minecraft *is good for like resourcefulness, especially, at least when I was playing, I kind of was looking around like 'what can I make, what do we need?' I say 'we' as in the collective group of whoever is going to be playing after me as well – what might they need? – and we came up with that idea of having a chest of stuff.*

Extending the collaborative theme, while perhaps departing somewhat from the accepted meaning of resourcefulness, the same participant elsewhere noted that one's teammates might be considered a resource to be managed, collectively:

> *…for example, in* Lara Croft *you kind of have to, you know, almost use each other's skills to navigate certain puzzles and issues so I think kind of demonstrates resourcefulness.* (Participant J, female, age 29)

The other form of responsibility cited by participants – responsibility for completing this study – was not anticipated. In an email-based interview carried out contemporaneously with the face-to-face interviews that provide most of these data, one participant had this to say:

> *Well, we all played the relevant hours I guess! There's an element of completing the entire PhD (or indeed for general purposes, goals of gaming in general) without any forceful prompting from an external source – displaying we've take*[n] *the responsibility upon ourselves to complete the tasks provided for us. This is particularly true if other sources of independent tasks outside the study are considered.* (Participant F, male, age 19)

So, contributing to the researcher's PhD was important to this participant, although he does suggest that game-based goals may also be seen as a responsibility, competing with other "independent tasks" for attention. Another participant who referred to their responsibility for completing the study used the term "meta-responsibility" to describe it:

> *Also, in terms of responsibility, the actual set-up itself, you do commit to saying I'm going to play two hours a week and then doing the surveys and stuff, I think that, as an aside is a sort of a meta-responsibility.* (Participant J, female, age 29)

While most participants had something positive to say about one or other aspect of this attribute, there were those who – possibly as a result of not fully understanding the meaning of the word 'resourcefulness' – could not make any connection between the games played and being resourceful or responsible ("Mmm… I don't know"). Others, however, were more confident in their dismissal of the idea: "Yeah, I'm not sure that this one would be helpful, like from the games" (Participant E, female, age 20); "Yeah, I think there is room for it but I don't think I experienced it" (Participant R, female, age 18).

Finally, a wry comment from one participant, which certainly appears to speak to the university definition of 'resourcefulness':

> *Well at some point I played co-op* Lara Croft *with two controllers on my own which I had never done before, and developed strategies to do well anyway. I think that demonstrates a good amount of self-sufficiency and motivation…?* (Participant Q, male, age 18)

As described above, *Lara Croft and the Guardian of Light* is a cooperative game that requires two players. Also described elsewhere, however, are the challenges associated with running a drop-in gaming lab with multiplayer games: it is not always possible to guarantee the availability of the required number of players. In this case, the participant has undoubtedly displayed a form of resourcefulness in progressing through the cooperative game on his own, by alternating his control of the two on-screen characters. That this opportunity for resourcefulness arose not by design of the game or the experiment is interesting in itself and arguably represents a particularly authentic example of this attribute being exercised.

Recalling the conceptualisation of resourcefulness on which Zauszniewski *et al.* (2006) based their Resourcefulness Scale, this attribute comprises two dimensions: personal resourcefulness (maintaining independence in the face of challenging circumstances) and social resourcefulness (knowing when to seek help from others). Broadly speaking, the former of these dimensions is more evident in interview responses. When participants refer to being able to advance despite a lack of instruction or a limited amount of time, they are demonstrating independence in the face of challenging circumstances. Evidence of participants seeking help from other players – of social resourcefulness – was lacking. However, it should be noted that interview questions were based on the university definitions of the relevant graduate attribute, not the definition of resourcefulness offered by Zauszniewski *et al.* Social resourcefulness naturally underpins much of Zauszniewski *et al.*'s Resourcefulness Scale, and, given that the intervention group demonstrated a significant increase on resourcefulness as measured by this scale, it is logical to assume that many of the interviewees were socially resourceful. Indeed, there is qualitative evidence to support this supposition, although it is not presented in relation to game play: it is revealed in participants' answers to the question about how they might cope with being asked by an employer to carry out an unfamiliar or ill-defined task (which, in turn, was based on items present in the quantitative Resourcefulness Scale). For example, Participant M (female, age 17) replied "I'd probably try it first and if I still couldn't quite figure out what was going on, I'd ask someone and ask them if they could help me out". Similarly, Participant N (male, age 18) responded, "Well, I'd kind of ask them for help when doing it first [...] just to, like, help me understand it properly."

So, while participants are certainly capable of exercising social resourcefulness, it is not reported in relation to game play. However, this is not unexpected, given that the university definition for this attribute – to which respondents were asked to refer during interviews – does not make reference to seeking help when required. Indeed, the phrase "self-sufficient individuals capable of substantial independent work" seems to preclude this aspect of resourcefulness. An interesting side-effect of the university attribute definition combining resourcefulness with responsibility, however, is that there is evidence here of help being *given*, if not sought – for example in participants' collaborative *Minecraft* efforts. Elsewhere, experienced players describe the help they bestowed upon less experienced participants and, unless all of this help was unsolicited, it seems likely that some participants did actually seek help when required.

While it was not expected that participants would mention responsibility for completing this study in relation to the Resourceful and Responsible attribute, perhaps it should have been. Clearly, there are factors beyond the games themselves at work here, not least the social and interpersonal interactions that take place in a lab environment, with the researcher as well as the other participants. Whether out of a sense of duty one or other of these parties, it is clear that responsibilities are being roused here that have nothing to do with the games played.

As with all of the attributes under consideration here, there is a distinction to be made between experiencing something and internalising that experience such that it influences or informs subsequent behaviour. So, while the quantitative measure for resourcefulness provides some tangible evidence that this attribute was improved in a majority of the intervention group participants, it is more difficult to say that simply because the participants could provide examples of responsibility from their experience of the study, this experience made them any more responsible. The wording of the university definitions does, in places, acknowledge this distinction: it is suggested that graduates be 'experienced collaborators' rather than 'skilled collaborators', for example. However, as the discussion of this attribute demonstrates, there are still questions about what exactly the university experience – or interventions such as this – can impart to a student. The issue of whether these desirable skills and competencies may be taught or even practised is discussed below.

5.3.5 Investigative

- *Are intellectually curious and engage in the pursuit of new knowledge and understanding.*
- *Are able to locate, analyse and synthesise information from a variety of sources and media.*
- *Are able to investigate problems and provide effective solutions.*

In a manner consistent with how the concept of team work was coded as a child node of the larger Experienced Collaborators attribute, and in line with the university definition provided above, mentions of problem solving were coded as a child of the Investigative node. Indeed, investigating and solving problems (or puzzles) was the most commonly cited facet of this attribute, while Valve's *Portal 2* dominated the discussion when participants sought to provide examples of their problem solving ("Yeah, definitely. Especially in *Portal*." – Participant S, female, age 18; "*Portal*. Just *Portal*." – Participant M, female, age 17). The following comments are illustrative of the support for the idea that the games exercised problem-solving skills, beginning with those that mentioned *Portal* specifically:

> *Mainly the games that rely a lot on logic, like when we played* Portal *that was, I think, the hardest one but it was also, I think, the most stimulating one as well, so it's one of the games that we played that I actually enjoyed the most because I had to think. It sounds stupid but I actually had to think deeply to complete tasks that after completion seemed really, really simple and obvious.* (Participant H, female, age 23)

> *This is what* Portal *is all about, providing a solution to a problem, then finding out why it doesn't work until it finally does. So I guess so, yes.* (Participant Q, male, age 18)

> *In the games? Yeah, many games.*
> Interviewer: *In many games?*
> *In* Portal *again, for example.* (Participant B, female, age 21)

> *Yeah, I mean, all of the games sort of like...* [...] Portal *definitely seems to fit into that. There was a lot of times in a lot of the games that we played where you were presented with a puzzle that... I mean, I think I'm just going to* Portal *here now* [...] *it's like a problem solving kind of thing. It makes you think on your feet quicker.* (Participant R, female, age 18)

As has been observed already, there is clear overlap between the attributes, as illustrated by Participant I's (female, age 21) response to the 'investigative' question, which makes a connection to team work (the Effective Collaborators attribute):

> *Yeah, yeah. I think especially in the one when you had to work in a team, the team works to solve the problem.*
> Interviewer: *Portal?*
> *Yes, Portal 2.*

Participant C (male, age 19) also described the "common investigation of the same issue but from a different perspective" that occurred in the lab as a group of participants played a single-player title simultaneously, again alluding to collaboration. Heller, Keith, & Anderson (1992) describe an experiment in which problem solving is taught to college physics students through cooperative group learning. Their finding that better solutions were produced by students working collaboratively to solve problems, compared to those working independently, is reflected in the collaborative approach to problem solving participants chose to take here. Heller *et al.* also noted that collaborative problem solving exercises improved problem solving skill across the range of abilities in the class, which may suggest that the collaborative approach taken to solving game-based problems here is beneficial to all concerned. One significant difference between Heller *et al.*'s experiment and the study described here is that the physics students were instructed in a problem solving strategy prior to commencing collaborative work. However, while this study did not involve any such intervention, it is striking that Heller *et al.* also observed the significant influence of peer interaction and support within their groups, recalling the kind of peer tutoring observed in mixed ability pairs in this study:

> *In well-functioning cooperative groups, students can share conceptual and procedural knowledge and argument roles, and request clarification, justification, and elaboration from one another* […] *The results of this study suggest that this type of collaboration did occur.* (Heller *et al.*, 1992)

Indeed, pairs – or dyads – may be the optimal configuration of collaborative game-based learning. Students who played the water quality game in Barab *et al.*'s (2009) study in pairs out-performed not only those students who learned from a textbook, but also those who played the game alone. Schwabe, Goth, & Frohberg (2005) also found that teams of two were optimal, at least in terms of fun and immersion, while teams of four or more, or single players, were less motivated to learn. Related to the Experienced Collaborators attribute above, Schwabe *et al.* also found that dyads were the optimal configuration for team building. However, the effects on learning were less clear.

The frequency with which *Portal 2* was associated with investigating and solving problems is also of note, particularly if the study were to be repeated or rolled out in any more formal sense – Valve's 'physics-based puzzler' is clearly a candidate for inclusion, based on these data. However, other titles, such as *Lara Croft and the Guardian of Light*, were cited as requiring investigative and problem solving skills:

> *Yeah, I think that's quite a lot to do with* Lara Croft*, it was very puzzle-based. Yeah, I think the kind of special tombs where you didn't have to do them but each one had a puzzle solve, they were quite... thought provoking.* (Participant K, male, age 18)

> *Yeah. For, like, puzzles and stuff and* Lara Croft *and stuff like that. I think they were good for investigating problems.*
> Interviewer: *Puzzle games in particular, then?*
> *Yeah.* (Participant N, male, age 18)

One participant was particularly enthusiastic about this attribute, and cited no less than three of the games played in the study:

> *This is an interesting one, because I would say every game developed this skill but did it through different aspects of investigation. For example location, between the vast and seemingly endless world of* Minecraft *to the restricted yet intricate house in* Gone Home *or purpose, like finding out information about all the necessary states in* Papers, Please. [...] *These experiences which we likely wouldn't get to have in real life, allow us to apply the investigation skills we've learnt so far and attribute it to new experiences which could allow them to develop.* (Participant F, male, age 19)

The idea that players may accumulate individual "investigation skills" of subsequent utility seems to echo Anderson's (1993) conceptualisation of human problem solving as the acquisition of "production rules". Anderson also highlights the importance of the "strength" of the example from which a production rule is learned: the participants here are suggesting that the examples afforded by the games are strong enough to support the development of such rules, and thus enhance players' problem solving ability.

The single-player games mentioned by Participant F, *Gone Home* and *Papers, Please*, were cited by several other participants:

> *Yeah, I think that games are really useful for this.*
> Interviewer: *And the games that we played, there was some of that there?*
> *In* Papers, Please*, you had to like, go through everything, and investigate everything.*
> (Participant E, female, age 20)

> *...everything else was basically problem solving. So, yeah, a lot of that going on, especially with the likes of* Papers, Please *and* Gone Home*, that was very investigative. But yeah, you were kind of left to your own devices with a lot of the games to just come up the solutions yourself, so there was a lot of that involved.* (Participant T, male, age 19)

Participant A (male, age 32), however, while citing *Portal 2's* "limited kind of move set" as providing an ideal environment for experimentation and investigation, was left disappointed by the *lack* of investigation required by *Gone Home*:

> *I thought it was good, interesting, but I didn't feel really compelled to solve anything. I don't know why. It felt like I was kind of on a rail, to be honest, even though it was kind of free movement. I felt I was being directed.*

And, when the interviewer remarked that the interviewee had mentioned *Gone Home* in relation to the Investigative attribute, without being prompted, the interviewee elaborated:

> *I just feel after about half an hour, I felt like I'm going to discover what the developer wants me to, regardless, rather than using my nous or something like that.*

However, as a whole, the response to this attribute was almost universally positive. The participants here are in little doubt about the fact the games played – particularly those with a puzzle element – required them to be investigative. However, the interview data also suggest a small note of caution:

> *Yeah, I think especially in the likes of* Portal*, there's a lot of problem solving in that. Although I did get* [another participant] *to do most of the problem solving in that one. I just sort of went into the mazes and did what he told me.* (Participant L, female, age 18)

Similarly, Participant M's earlier comment about *Portal 2* was quickly followed by this, potentially more problematic, reference to the effect of playing along with the researcher:

> *Although I think that was mainly you doing that because that one of the ones we ended up playing together and you kind of led me through everything. Like, 'yeah, I think you should go over there, and maybe that will work, maybe that will help'* [laughs].

As the participant's laughter suggests, this comment was light-hearted in nature – and the researcher was at pains to ensure that he did not undermine student players' own attempts at problem solving through undue direction – but it does raise an issue. Taking on particular roles – even secondary ones – and tackling in-game challenges as a team are ideas that have pervaded these interview data and that resonate with other attributes, especially Experienced Collaborators. However, if one player was to dominate in a game such as *Portal 2*, it is difficult to say that the other player is really exercising their investigative skills, or many of the other skills and competencies being considered here. Certainly, there is a subtle distinction to be made between recognising that a fellow team member's abilities exceed one's own in a certain area, and exploiting this, versus taking a back seat entirely, and failing to engage with any of the game's intellectual challenges.

With these caveats in mind, it may be concluded from the qualitative data that participants saw opportunities to exercise their problem solving abilities using the games played. The problems presented by video games may be complex and varied, reflecting the nature of problems encountered in real life, and in many workplaces. As Simon & Newell, (1971) noted in their review of human problem solving theory, much of this is tested using "highly structured symbolic tasks", implying that traditional tests of problem solving lack the authenticity of real-life complexity. Perhaps carefully selected video games may offer a more authentic test of problem solving ability, one of the central tenets of the university definition of the Investigative attribute.

5.3.6 Independent and Critical Thinkers

- *Identity, define and assess complex issues and ideas in a researchable form.*
- *Exercise critical judgement in evaluating sources of information and constructing meaning.*
- *Apply creative, imaginative and innovative thinking and ideas to problem solving.*

This attribute – which might be reduced to 'critical thinking' – also touches upon problem solving, albeit from the point of view of using critical and independent thinking to solve the problems. As such, there is overlap with the previously discussed Investigative attribute, the university definition of which also makes direct reference to problem solving. *Portal 2*, *Gone*

Home and *Papers, Please* were again amongst the most frequently cited games, which perhaps reflects the overlap between these two attributes. For example:

> *Yeah, sure* [laughs]. *I mean, you almost always use critical thinking, so… or maybe should. For example, in the last games, like* Gone Home*, but also in* Portal*, it was demanding. And… all games you have to think, usually critically, about what you are doing.* (Participant S, female, age 18)

> *Well, I think, for example, in* Papers, Please*, you're given this information from this authority figure, like 'you have to do this' but, for example, you get this bureaucrat coming in and saying 'this is my friend, she's coming in, don't give her any problems' but she doesn't have the right papers. So really, you should, you know* [not let her through]. *But then you have to maybe think critically and be like, 'Hmm, how will this affect my future in this fascist regime?'* (Participant J, female, age 29)

Therefore, there was some agreement on the particular games that exercised this attribute. However, an interesting source of disagreement was the team-based shooter *Team Fortress 2*. One participant, who stated that *Portal 2* "kind of demanded" critical thinking of the player, was somewhat less positive about *Team Fortress*:

> *I mean, stuff like* Team Fortress*, I didn't really think at all!* […] *I just got lost in my own base which was really bad. And then I started putting some more thought into where I was and alternative routes, and things like that. But yeah, I just thought of* Team Fortress *as a first-person shooter, which is 'walk into a room and blindly blast everything and hope for the best'.* (Participant A, male, age 32)

Comments of this nature – about becoming lost or confused in a game – provide an example of when assumptions implicit in game-based learning concepts such as Gee's 'Amplification of Input Principle' may fall down, at least initially. A confused player is unlikely to feel that they are getting a lot out of the game, in relation to the effort they are required to put into it.

Another participant agreed that *Team Fortress* was not one of the games that demanded critical thinking, citing the apparent lack of strategy involved:

> *I think it probably comes down to again the sort of* Portal*,* Warcraft*, the strategy games over the sort of* Team Fortress *types where you actually have a sort of, a*

> *puzzle that you need to solve and you're given information and you have to figure out what to do with it.* (Participant R, female, age 18)

However, more than one participant cited *Team Fortress* as an example of a game that did require critical thinking, even if this is not immediately apparent:

> *...it's all about judgement, it's all about, 'OK, what does this do, what does this do? What's the best way of organising everything in order to win this game?' And I think a lot of the games are like that as well, even* Team Fortress*, you have to know 'OK, the enemy are three guys with guns, am I going to do that as well, am I going to fight fire with fire here, or am I going to be sneaky guy and come up behind and attack?'* (Participant T, male, age 19)

And, for another participant, *Team Fortress* was actually the exceptional game that required such thinking:

> *Not much, but if it did, I think it would be through* Team Fortress*. When the same approach gets you killed every time, you are forced to find another way to attack, another angle that gets you less exposed, on your own.* (Participant Q, male, age 18)

Participant R was not alone in equating this attribute with strategic thinking, and several participants also made a connection with puzzle games, echoing comments made in relation to the Investigative attribute. For example:

> *Yeah, especially, following on from the puzzle game thing, you're supposed to think critically through how would you solve this problem, what would be the answer to this problem? Also stuff like* Warcraft *as well, you have to think strategically, so you have to think what would work in this scenario.* (Participant N, male, age 18)

> *...again I think probably like* Portal *and* Lara Croft *are the two different kind of puzzle games and having to, you know, see what you've been given, see how you can figure it out and then, even if you think it's not going to work...* (Participant M, female, age 17)

> Papers Please *was for sure the most obvious example of a game requiring critical thinking, as the entire game is one massive puzzle to solve and closely examine.*

> Portal 2 *follows closely behind, especially when you get to the advanced stages, with the puzzles involving a major sense of 'thinking outside the box' in order to complete the puzzle.* (Participant F, male, age 19)

A theme that runs through many of the participants' responses to this attribute is that of judgement, picking up on the "critical judgement in evaluating sources of information" that the university definition mentions. As Participant T asserted above, playing video games is "all about judgement". Another participant agreed:

> *Yeah,* Papers, Please *was... a lot of judgement required if you were able to survive in* Papers, Please*, to do with the story in that. Didn't have to be too creative in* Papers, Please*. But I think in other games, perhaps.* (Participant K, male, age 18)

Sources of information could include other players in the room, and the advice they provide critically evaluated:

> *...I never played* Minecraft *before, so I was like 'what do I need to do?' and I was asking a lot of people. And I was like 'OK I'm gonna try that, it sounds interesting, let me try that'. But in other games, like in* Warcraft*, I just plain ignored people telling me, like, 'yes, yes, of course, that's definitely what I need to do'. And maybe that's part of evaluating sources, trusting your own knowledge to limit what other people tell you to do and trust more yourself, in a way.* (Participant C, male, age 19)

Participant I (female, age 21) seemed to associate this attribute with *Gone Home*, but, perhaps because she did not particularly enjoy the game, had to be coaxed into admitted that critical judgement might be involved:

> *Well, it makes me think of* Gone Home*, but I didn't enjoy it.*
> Interviewer: *You didn't enjoy it at all?*
> *It's hard to define what is really, like, important when you have loads of information coming at you.*
> Interviewer: *That's a good example, you're presented with tonnes of notes... And did you feel that you were exercising critical thinking? You were saying 'well, that source of information is more useful than the other'?*
> *Yeah. Well, I had to decide which I should use and which not.*

In most cases, it should be noted that participants were discussing this attribute in terms of critical judgement and problem solving. Where they were touched upon, the more creative or imaginative aspects of this attribute were not considered to be present, as suggested by Participant K above. As Participant C went on to explain:

> *Yes, yes, the independent thinking. Because again, I feel, you know it says here "Apply creative, imaginative and innovative thinking and ideas to problem solving". I don't... maybe. I didn't feel like I did much of creative stuff, creative thinking in my gaming. I was much more critical judging what people were telling me, and how to use that information.*

Participant T (male, age 19) agreed, saying "...yeah, there is a lot of that. And then, I don't know about the creative thinking. I mean, I guess, problem solving, yeah." The same participant went on to describe how he had experimented with adopting tactics that were the opposite of his fellow players' but that this somewhat crude attempt at 'creative' thinking rarely paid off.

Participant G (female, age 22) laughed off the idea that her solutions to the problems presented by the games were novel, but was confident that critical thinking was involved:

> *I don't know about "novel"* [laughs]
> Interviewer: *You're too modest.*
> *Yeah, I think, it's quite good because a couple of the ones we did were quite problem solving and, you know, you just kind of think out different ways to win, or not lose so badly. So, it was quite good. Again, like* Warcraft *was like that, you were trying to figure out what am I going to build first and how quickly and how much can I afford to build before the invading force arrives. So, a bit of critical thinking there.*

Aside from Participant A's derisory comments about *Team Fortress*, there was little resistance to the idea that the games played might have exercised critical – if not imaginative – thinking. However, Participant E (female, age 20) was sceptical that any of the games required critical thinking, as the following exchange demonstrates:

> *I don't really think that this is linked to the games, at least not the ones that we played, there might be some that develop this but...*

> Interviewer: *You mentioned* Papers, Please*. I'm wondering if that would fall into the critical judgement, about evaluating the different sources, or not.*
> *Maybe...*
> Interviewer: *Not convinced?*
> *No, I don't know.*

Finally, there was another brief mention of the potentially problematic imbalance in mental effort devoted to the games within a pair of players:

> *Yeah, probably* Portal 2 *was probably critical thinking because you had to figure it out. I think* [another participant] *probably did most of the work on that one.*
> (Participant D, female, age 18)

Robert H. Ennis, one of the authors of the Ennis-Weir Critical Thinking Essay Test used in the pilot, defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do" (Ennis, 2015) and there is a clear emphasis on deciding what to do in the interview responses. Participant C, for example, frames his experience of *Minecraft* in terms of the question "'what do I need to do?", while Participant T noted that playing video games was "all about judgement", which is, perhaps, another way of interpreting Ennis's definition. However, while this is a neat and very credible definition of critical thinking, Ennis and others have identified numerous facets to the concept of critical thinking, each of which may be considered individually. For example, Norris and Ennis (1989, p. 12) identify a list of critical thinking dispositions that includes trying to be well informed and seeking a statement of the thesis or question at hand. Exploring each of the dispositions and abilities that comprise critical thinking was beyond the scope of these interviews, which were focused on the university definitions of the graduate attributes in question. However, there is sufficient evidence here to warrant further work that explores video games' relationship with the more detailed conceptions of critical thinking that exist in the literature. Furthermore, other work has suggested that problem-based learning (PBL) is effective in improving critical thinking skills (see Williams, 2001, for an overview of the literature on the use of PBL to develop nursing students' critical thinking). As Connolly *et al.* (2004) have noted, game-based learning draws on concepts related to PBL, so it is quite plausible that games can exercise players' critical thinking. Further exploration of the relationship between video games and critical thinking, however, will require an alternative means of measuring any gains associated with playing, as the pilot described above illustrated the problems associated with using the Ennis-Weir test in a pre-/post-test experiment.

As the sixth attribute to be considered by interviewees, the critical thinking responses highlighted more than any previous discussion the extent to which these attributes inter-relate: “I don't know, yeah, all the games had a bit of each thing” (Participant B, female, age 21); “Well, in every game you have always in the beginning [the question of] what to do, right?” (Participant C, male, age 19). And, regardless of the attribute to which problem solving is thought to most closely relate, for Participant J (female, age 29) this aspect of the critical thinking attribute definition is common to all: “Some of these things, they just all sound like problem solving to me! Just different aspects of problem solving, I guess.”

It may be argued, however, that the critical thinking attribute appeared to overlap with so many others not simply because it was discussed later in the interview, but because critical thinking actually underpins many of these other attributes. This idea is discussed in the Research Context chapter above, where Nicol’s (2010), assertion that “critical evaluative experience” may foster the development of a range of different attributes is considered. The limited qualitative data presented here may be seen as supporting this assertion, bearing in mind that critical thinking was discussed following consideration of several other attributes.

5.3.7 Confident

- *Defend their ideas in dialogue with peers and challenge disciplinary assumptions.*
- *Possess excellent interpersonal and social skills fostered within an internationalised community.*
- *Demonstrate enthusiasm, leadership and the ability to positively influence others.*

Again, based on the university definition, a number of themes were coded as being related to the Confident attribute, including leadership and social skill. When these aspects of the definition are taken into account, participants had a substantial amount to say about games and confidence, the majority of it positive (“Yes, definitely in my case, I was beginning to gain more confidence over time” – Participant S, female, age 18). One participant, responding by email, was effusive about the confidence-enhancing properties of video games, especially where playing with other people was involved:

> *Definitely in the times in which there were others in the video game lab and we had to work together, confidence was really tested as these could be people I'd never met before.* (Participant F, male, age 19)

The participant went on to relate his previous game-playing experience to his real world confidence, echoing the ideas of Bandura & Wood (1989):

> *Personally I know for a fact that a lot of the confidence I have today has been built by talking and working together in chat rooms when teaming in online games such as* League of Legends *etc. Mainly because you don't just have to be a nice person but you need to prove to the group that you are competent, sharp and good at what you do. Training yourself to output this attitude so that the others in your team respect you is a whole load of work and came, for me, from the whole gaming aspect of my life – long before I attempted to find a job.* (Participant F, male, age 19)

Participant L (female, age 18), as noted, connected "things like the confidence and team work" with collaboration, while, for Participant H (female, age 23), confidence was gained from the sense of achievement that video games can produce in the player:

> *I think I feel like after I play I feel more confident.*
> Interviewer: *Really?*
> *Yes, I don't know, maybe it's because they give you achievements to complete. So definitely that. I think they do a lot to build your logic skill as well, especially puzzle games or those games where sense of direction is important. I personally have a very, very impaired sense of direction but video games actually help a lot.*

As noted under Adaptability, Participant K (male, age 18) suggested that confidence may be gained somewhat indirectly through playing games. He conceded that many of the skills acquired through playing games are not directly applicable outside of the games, but suggests that knowing that one possesses the flexibility to adapt one's skills from game-to-game is confidence-enhancing ("it gives you the sort 'I know I know that I can do this'").

Relating confidence to the aspect of the university's Experienced Collaborators attribute which states that graduates should "contribute positively when working in a team", Participant H continued:

> *Mainly, at least for me, the confidence comes from being able to see that I was able to complete a task on my own but also to know that I wasn't a burden to the people I was in co-op with. I actually had the drive to do my best, so I was really satisfied after I complete a game and I see that I haven't done a bad job. It makes me feel a lot better. I'm a lot more convinced about what I can do.*

Social skills and the confidence to talk to others were mentioned by many participants. The idea that video games may be used as an effective 'ice breaker' – for example, at the beginning of the university term, or beginning a new job – is discussed below, but this clearly relates to the notion that playing video games with others can create an environment in which social skills may be exercised.

Providing some useful reflections on the limitations of self-report measures, such as those used for quantitative data collection here, one participant also described how the game playing sessions improved confidence in her social skills:

> *I think you kind of under-mark yourself, maybe, and then you go to the session and you're like, actually, this isn't as hard as I thought it was to speak to people. Especially when you're focusing on something else, like you're just kind of tapping away at the keys and the someone comes in and you're just sort of like 'hello' and then kind of chat as it's going on, so that was quite good. And then you kind of think again about how good you are at speaking to people you don't know, and you kind of put yourself up in the survey a bit.* (Participant G, female, age 22)

Another participant referred directly to the self-report measures (actually drawing on the language of the Self-Perceived Communication Competence Scale) in their discussion of confidence, and was similarly positive about the effects of playing games in the lab:

> *…it may seem strange but I think the confidence that playing games gives me actually would make it easier to present the talk to strangers.* […] *So, yeah, I mean, before… I have to say, before starting this lab, I think one of the first times that I answered that poll* [the self-report measures] *the score for presenting and talking to strangers was very, very low. But I think it increased significantly in the last session, so, yes!* (Participant H, female, age 23)

Interpersonal and social skills improving over the course of the lab sessions was a feature of several other participants' responses, for example:

> *...definitely as I went along I got a lot more confident. A lot more comfortable just going in and playing a game with a few people.*
> Interviewer: *OK, so confident not just in being better at games but more confident going into the room and playing with other people.*
> *Yeah, before playing a lot of the games I probably couldn't have came* [sic] *in without having* [another participant] *there, because I wouldn't want to go into a room full of people I didn't know, whereas now I'd be fine coming to the lab and just playing with new people.* (Participant L, female, age 18)

> *Yeah, I think... obviously it kind of ties in because* [I'm] *a first year student coming to uni, I've just - and with the video game study as well - I've become much more confident, just talking to people, and not being afraid to just start conversations and just ask people stuff.* (Participant M, female, age 17)

> *I guess it was good practice for, like, being in a social area, talking to people, like 'oh, can you help me with this?* [...] *In the multiplayer games* or *something, if I needed help, I'd just be like 'I don't know what I'm doing' and somebody would help me.* (Participant O, female, age 18)

The following exchange with Participant P (male, age 27) illustrates how social and interpersonal skills are related to the "leadership and the ability to positively influence others" aspect of the university's Confident definition, citing the negotiations that occur in cooperative games:

> *Yeah. Yeah, I think, games have always been like that, like you have to follow someone or someone follows you. You have to be comfortable with another person to...*
> Interviewer: *You have to be comfortable working with other people?*
> *Yeah, because sometimes when you, for example, it happened to me when I used to play some games with my brother and he do something I don't like, or he want to go... in the* Lara Croft*, for example, maybe someone wants to go one way and the*

> *other wants to go another way, you cannot move. So you have to make a point between or try to say 'OK, we are going this way, and then we'll go this way'.*

Another participant, who stated “when I play video games I tend to just play with my friends”, connected developing the confidence to speak to others with the ability to lead, noting that the labs required him to play with those outside his existing circle of friends:

> *So when you open it up to people you don't know very well at all, it sort of gives you that nudge* [...] *to go for it, to be the first person to speak, to be the first person to take leadership of the team and devise a strategy, devise a plan.* [...] *It give that sort of... it gave me the confidence to be the first person to speak anyway.* (Participant K, male, age 18)

Leadership was mentioned more specifically by a number of participants. One participant provided a lengthy example of how the role of leader moved from one player to another during a *Borderlands 2* session:

> *...ones where leadership is going to be an issue, for example, coming back to* Borderlands *again... there was one moment where one of the other players, she had been in that situation before and she was kind saying 'well this is what's going to happen, so if you do this then that's probably a good idea'. I thought that was really helpful because, you know, she was sharing her knowledge* [...] *but later on when she had left suddenly I was the only person playing who had actually been in that part before and suddenly I had to take up the mantle, as it were, and be like 'well, I think it's over there because we've done that and X, Y, Z and that's where the map is pointing. So, you kind of have to step up and say well, this is the knowledge I have and be willing to share so that we as a team can not die.* (Participant J, female, age 29)

This need for somebody to be confident enough to assume the role of leader was identified by other participants, too:

> *The confidence to sort of... be the first person to say something and be the person to say 'oh, you do this'. Like, the leadership, throwing yourself into it, especially when everyone else was not speaking, to be the first person to go 'OK, so, maybe we should have a plan, have a strategy?' I sort of found that a lot easier as the weeks went on, to*

> *be the first person to say 'look guys, this is what we need to do, this is where we need to be headed'.* (Participant R, female, age 18)

> *And also the confidence with like the leadership* [...] *Games like* Warcraft*... everyone was working together but someone tended to take control and someone tended to lead the group, like 'we're going to attack them now' or 'we're gonna make sure you get lots of wood' and stuff like that...* (Participant M, female, age 17)

Another participant identified the need for leadership and describes 'stepping up' to assume this role, albeit, perhaps, somewhat unexpectedly:

> *I didn't seek it out, and I don't think I would ever deliberately take the lead. Especially if someone else was comfortable doing that, I wouldn't try and supersede them. But, yeah, because we were a bit stuck on* Portal*, we were going round in circles, it was level two and there was clearly a long way to go, I thought it best to sort of step up.* (Participant A, male, age 32)

Another participant describes how the unexpected opportunity to lead was a boost to her confidence:

> *When you figure out the bits, like when you can actually do something and you can, like, tell other people what to do, that's quite good because you feel like you can lead a bit. But, I mean, that was very rare for me [laughs].* (Participant D, female, age 18)

There were few instances of participants rejecting the idea of a link between confidence and game play altogether, but there was some scepticism about the usefulness of any such link. While Participant Q (male, age 18) offered only a flat "No" when asked if such a link existed, Participant B (female, age 21) was noncommittal ("Yeah, maybe", followed by a long pause). Participant I (female, age 21), meanwhile, was unconvinced of the transferable benefits: "Well, I'm more confident talking about games! [laughs] I don't really think that it impacted on my confidence as a person." Participant E (female, age 20) noted that they felt their confidence improved as they played the game, but suggested that this was true of any activity that may be practiced:

> *Hmm, I don't think it's the game itself that helps you gain confidence but the more you play it, the more confident you feel* [...], *it's just like you improving when you play it more and more and more, so that's just like it comes from you.*
> Interviewer: *So it could be anything, where you just practise it and get better?*
> *Yes, exactly, so it's just practice.*

The Confident attribute is one of several graduate attributes that may well be influenced by playing video games but, based on the quantitative and qualitative data collected here, it is not possible to isolate this influence from the combined effects of playing the selected games under lab conditions. That is to say, the effects – measured or perceived – may be attributed to the overall experience of the participants playing the games together in the lab over a period of weeks. It is not possible to say, for example, that playing the equivalent number of hours of the selected games alone at home (or even online) would have the same effect on confidence as participants perceived here. As Participant K notes above, under normal conditions, he would play games with his friends, which would not require him to engage in potentially confidence-building conservations with strangers. Furthermore, the quantitative Rosenberg measure of self-esteem, included in the main experiment as a proxy for confidence, revealed only a small, statistically insignificant difference between the control and intervention groups. The popular notion – espoused by John Seely Brown (2006; 2012) – that multiplayer video games can develop leadership skills was not quantitatively measured, but the interview data suggest that participants were aware of the need for leadership. The limitations and implications of the study are discussed in a subsequent chapter but it is worth noting here the frequency with which participants made reference to their lab experience in relation to both confidence and leadership. It is also worth noting that there is some precedent for the idea that playing video games may help develop leadership skills: Xanthopoulou & Papagiannidis, (2012) describe a one-month longitudinal study wherein the results “supported the direct spillover of transformational leadership, as well as the boosting effect of high game performance in this spillover effect”. The authors also note that games may be relevant to the development of new organisational training techniques.

5.3.8 Ethically and Socially Aware

- *Consider and act upon the ethical, social and global responsibilities of their actions.*
- *Welcome exposure to the richness of multi-cultural and international experiences, opportunities and ways of thinking.*
- *Have a practical and contemporary knowledge of relevant professional, ethical and legal frameworks.*

Participants' comments on this attribute may be categorised into two broad groups: those that relate to relevant in-game experiences, and those that relate to in-room interactions between players in the lab. The final, single-player games included in the study – *Gone Home* and *Papers, Please* – were intended to speak to this attribute and it is therefore not surprising that these were the titles most often associated with the former group. As detailed above, these games cast the player in the role of a young woman exploring the story of her sister's coming out, and in the role of an immigration official on the border of a fictional country, respectively. The ethical dilemmas presented by *Papers, Please* were referred to by many participants in relation to this attribute ("you actually had to think on an ethical basis" – Participant H, female, age 23), although there were variations in how seriously these dilemmas were taken. For example:

> *This one became most relevant in* Papers, Please*, when you were forced to make quick decisions between doing your job correctly and getting paid or facing the possibility of ruining someone else's life. You were made to consider, within seconds, whether you would doom a husband and wife to the terrors of war or have enough money for your family to eat – heavy stuff for a rather brief game.* (Participant F, male, age 19)

> *I think the game that was mostly related to this particular section was* Papers, Please *because to go further in the game, I mean, to perform better and to get more money, you actually had to ignore, completely disregard a lot of ethical issues. So [...] you didn't really know whether to do that, to just progress in your own game and completely disregard the ethical issues that arise. Or, address those issues but perform really, really badly at the game. I mean, I killed all my family because I was just too compassionate. I mean, I did ignore some ethical issues, but I mostly tended*

> *to address them because I felt badly about it but that actually led me to not have enough money to progress in the game.* (Participant H, female, age 23)

> *I was aware of what* Papers, Please *asked you to do, and the kind of moral aspect to it but I totally just did my job* [laughs] (Participant A, male, age 32)

> *Yeah, definitely.* Papers, Please *is a very sort of… especially when, yeah, I can think of a lot of times when there's been people in Papers, Please where you've had to make a sort of ethical judgement or like a moral judgment on something. You kind of grow numb to it after a while. That's really bad!* [laughs] (Participant R, female, age 18)

Another participant referred to *Papers, Please* in relation to critical thinking, but her response was coded as being more relevant here, given the moral dimension of this attribute: "Well, you had to decide if you wanted to go with your morals, if you wanted to not get thrown in jail" (Participant O, female, age 18).

According to Participant A (male, age 32), *Gone Home* opened up possibilities about "what a game can be", featuring a female lead character and themes of sexuality. Another participant agreed:

> *Oh, in* Gone Home*! It was the only game about lesbians! I loved it! That was good. Because all the rest of the games we played* […] *it was just mainly, like you play a stereotypical game person.* (Participant O, female, age 18)

For Participant N (male, age 18), *Gone Home* provided an opportunity for him to explore some unfamiliar territory:

> *Em, yeah, I suppose, because, well, there's like a lot of like…* Gone Home *was obviously about a lesbian story, so. Yeah, kind of like different kind of culture, well, not different kind of culture but you know what I mean…*
> Interviewer: *Like a different perspective?*
> *Yeah, I mean, I'm not a lesbian, so…*

Video games are not synonymous with diversity in terms of their content: the continued prevalence of the straight, white, male protagonist in mainstream titles has attracted criticism and formed the basis of many Internet memes. However, as recent work by Adrienne Shaw has revealed, LGBTQ content in games exists in games various forms:

> *It is not only characters who are implicitly or explicitly LGBTQ but also locations players can visit, actions they can engage in, and artifacts encountered in games. Non-normative gender and sexuality can be also referenced through mentions, often in passing, and traits that PCs can acquire. Some games have LGBTQ narratives at their cores, exploring lives and experiences of LGBTQ individuals. Others feature homophobia and transphobia.* (Shaw & Friesem, 2016)

Shaw's nascent LGBTQ Video Game Archive[78] already includes hundreds of examples of "non-normative" content in video games and work such as this may help reveal potential for games to help educate and inform players about LGBTQ culture. As discussed below, LGBTQ – or even female – characters are rarely featured as the playable protagonist in mainstream games, but Shaw's work suggests that greater diversity may lie below the surface. The widespread occurrence of homophobia and transphobia (not to mention racism) is worrying but, if presented in suitable terms, such content might aid discussion and ultimately understanding of these problematic points of view – not least because, given the right game, players may experience the negative consequences of regressive attitudes for themselves.

The other category of responses – referring to the potential for personal interactions in the game lab to expose participants to new cultures and new ways of thinking – is exemplified by the following comment:

> *Yeah, I think the games helped with that because there was so many different people, different types of people that you were playing with. People from different countries and things as well.* (Participant L, female, age 18)

Several of the participants were aware that they were playing along with students from other countries with whom they might not otherwise interact, as Participant P (male, age 27) indicated when discussing adaptability: "Probably because they are from here, or England, or from other countries and I'm from Spain, it's very different from every culture".

[78] https://lgbtqgamearchive.com/ (accessed 28 January, 2016)

One participant noted that communicating with players from different backgrounds (those who do not “who live down the road in Glasgow or in Edinburgh or wherever”) required some experimentation, given the active, collaborative nature of the games:

> *So, if you're sitting next to a Spaniard or an Italian, you don’t know if you're going to get the same response from somebody who is from a very different cultural background by being very blunt with them and saying, you know, 'you're doing terribly at this game, please stop.'* [...] *You have to try it out, you have to see what people are going to be like and you tend to find that we are all the same.* (Participant T, male, age 19)

Speaking from the perspective of one such overseas student, for whom English is not their first language, one participant noted the benefits of engaging in the sort of natural conversation that a shared gaming experience can elicit:

> *... foreign people will be better to learn the language because in games people are always talking and you will listen to what they say. Not only the, not common, the good English, but also the slang, how they use it in games, for example the 'LOL' and that kind of thing that people use a lot on video games and that kind of things.* (Participant P, male, age 27)

Games, in fact, have been used to teach English to non-native speakers. As Zheng, Young, Wagner, & Brewer (2009) report, the virtual game world of *Quest Atlantis* was used to facilitate intercultural collaboration between native and non-native English speakers, the latter improving their language skills by working with native speakers to solve problems.

Participant P’s comment about how players from different countries do things differently is reflected in a number of other comments that treat gaming as an aspect of our culture, and one that varies from country to country and person to person:

> *I ended up interacting with a lot of people through the video games study that I wouldn't normally talk to* [...] *meeting up with people who are from the Canary Islands, and Italy and kind talking about that and seeing the different types of games that they play and seeing how their skills translate into that, seeing their different experiences and how that plays out in a video game context.* (Participant M, female, age 17)

> *...it's more 'have you played games before or have you not played games before?' That's part of your culture, in a way, and it's more specific but definitely there was the need of being very aware. Because I never had experience of playing with people who never played games before.* (Participant C, male, age 19)

For at least one participant (Participant B, female, age 21), however, the labs were only one facet of her university experience, and it was not possible to isolate the lab-based interactions as the single-most important:

> *In the games?*
> Interviewer: *Or in the whole experience.*
> *Yeah, like, but not only from the games, I guess.*
> Interviewer: *That's fine. How do you mean?*
> *I don't know, taking into account all the experiences I had in the last semester, for example.*
> Interviewer: *So experiences outside of the lab, you mean the whole thing?*
> *Mmm.*

And, not all participants agreed that sharing the room with players from different backgrounds was significant, as this exchange with Participant I (female, age 21) illustrates:

> *Yeah. I think of* Papers, Please *again. The other games weren't so...*
> Interviewer: *What about in the room, with the other players?*
> *Um...*
> Interviewer: *Not so much?*
> *Not really.*

Another participant, who had suggested *Papers, Please* was relevant to this attribute in terms of the game's content, agreed that his co-players' various backgrounds were irrelevant:

> *Well, it doesn't really matter who else is playing, because essentially they're still... they're just another player, so it doesn't really matter who they are.* (Participant K, male, age 18)

Finally, a couple of participants recounted how the games played in the lab provided moments wherein the morality or ethics of their in-game actions affected their fellow players. For example, one participant reflected on how she had treated a fellow player:

> *…I could have been a bit better in helping that girl in the first week, I felt kind of bad after I went back. I suppose I'm kind of used to playing with my friends who've played lots of games before and know what to do, especially as it was* Borderlands. […] *But then it was like she couldn't even walk in a straight line and I was like 'oh no', how to explain, how to work video games at all. You know, I'm not terribly patient, so…* (Participant G, female, age 22)

Meanwhile, another participant was aware that there were consequences – however trivial – to their in-game actions when playing cooperatively:

> *…when playing with* Warcraft… *or if you, for example, take a gold mine near your colleague or the other character, you leave him without the gold he will need. So, yeah, you have to think very, very well what you are going to do because it will affect the others.* (Participant P, male, age 27)

Beyond the games played in the lab, some participants speculated that playing video games in general might expose players to new cultures and new ways of thinking. One participant, who had previously singled out *Papers, Please*, had this to say:

> *I think the whole idea of placing a person into an environment unknown to them – virtual included – makes them look around and consider what's happening. It's impossible to ignore what's happening around you when you're learning about a place, because in order for survival you need to learn and understand this new place you've been placed in. Taking this into account, I think most games would make someone more ethically and socially aware if they were playing it properly, specifically if it was the case that a new world has been created in the game which is made to mirror the issues within real life.* (Participant F, male, age 19)

Participant O, while effusive about *Gone Home*, also notes that many of the games played featured stereotypical (male, straight) protagonists. This is a potential issue to explore in any future work and suggests that greater emphasis might be placed on games that represent more diverse characters and cultures. It is true that female protagonists are seriously underrepresented in mainstream video games and people of colour or those from the LGBTQ community are even less common as playable characters (Jayanth, 2014). The study here did actually include games with female protagonists (*Borderlands 2*, *Portal 2*, *Lara Croft and the Guardian of Light*) and depictions of LGBTQ characters (*Gone Home*) but it is notable that titles such as *Team Fortress 2* don't, by default, include any female player characters. When suggesting that games such as *Gone Home* could challenge what a game can be, Participant A also noted that female protagonists are rare in mainstream games:

> *I mean, there's still so few, like, female, lead characters in video games. I remember* Metroid *and...* Perfect Dark*. They're about the only two I can remember. And* Lara Croft*!* (Participant A, male, age 32)

In order to avoid excluding or discouraging students for whom the stereotypical straight, male protagonist is not relevant or appealing, it would be important to include more diverse options in the games used. Furthermore, including such diversity can only help expose students to alternative perspectives and cultures where they might ordinarily choose to accept stereotypical player characters. This was the reasoning behind including a game such as *Gone Home*, and the comments of Participant N above ("I'm not a lesbian, so...") suggest that there is certainly potential for an exercise such as that described here to provide new perspectives for students to consider. And, while mainstream games featuring, for example, LGBTQ characters are few – with a handful of notable exceptions, such as *Dragon Age: Inquisition* (Electronic Arts, 2014) and *The Last of Us* (Sony Interactive Entertainment, 2013) – there are numerous smaller budget 'indie' games besides *Gone Home* that offer greater diversity.

The attainment of this attribute is particularly difficult to evidence, as noted under Research Context above. The qualitative data, however, suggest that students see the potential for games to increase their ethical and social awareness via two means: by experiencing alternative perspectives through the games themselves and by interacting with players from different backgrounds in the context of playing games together. There are clear connections with a number of Gee's principles here, including the 'Cultural Models about the World Principle' and the 'Identity Principle'. Participants' comments also recall points made in 'The Civic Potential of Video Games' (Kahne, Middaugh, & Evans, 2009, pp. 51-53) wherein the authors call for educators to help young people "reflectively engage with video games" to increase civic and political awareness. They also note that educational games such as *Real Lives* (Educational Simulations, 2001) can "help foster empathy and understanding of the lives of others and teach about dynamics associated with different political systems, economic structures, cultural beliefs, and religions". This idea very closely mirrors what George Eliot had to say about novels, which she believed could offer an excellent understanding of moral sentiment: "The greatest benefit we owe to the artist, whether painter, poet or novelist, is the extension of our sympathies" (Eliot, 1881). Eliot suggested that a good novel could provide insight into the true social, moral, and political beliefs of the "social classes", noting that we "want to be taught to feel, not for the heroic artisan or the sentimental peasant, but for the peasant in all his coarse apathy, and the artisan in all his suspicious selfishness". In assuming the role of, for example, the border official in *Papers, Please*, video games might well be considered "a mode of amplifying experience and extending our contact with our fellow-men beyond the bounds of our personal lot", as Eliot says of art more generally. There is also a potential connection with Francis Bacon's belief that "Reading maketh a full man, conference [discussion] a ready man, and writing an exact man" (1625). Games, as evidenced here, can certainly form the basis of useful discussion, so perhaps 'playing' could be substituted for 'reading' in Bacon's aphorism.

Kahne *et al.* also cite the commercial game *Democracy* (Positech Games, 2005) as an example of a game that might be of interest to educators tasked with developing students' social awareness. Rusnak (2015) has shown that a purpose-built serious game can be used to effect affective learning and change students' attitudes to social issues (in this case, homelessness). Based on interview responses given here, and bearing in mind that the proportion of games selected for this study that were intended to relate directly to this attribute was small (two of eight), it may be that there is still untapped potential for commercial games to be used in this capacity, too.

5.3.9 Reflective Learners

- *Use feedback productively to reflect on their work, achievements and self-identity.*
- *Set aspirational goals for continuing personal, professional and career development.*
- *Identify and articulate their skills, knowledge and understanding confidently and in a variety of contexts.*

Of all the attributes considered, Reflective Learners was perhaps that which was least obviously relevant to participants beyond the games played. Whereas many of the responses above clearly imply a transferable dimension to the skills and experience gained from playing, the responses below largely refer to how participants reflect on what they have learned about the games played, and how this reflection influences subsequent play ("You need to learn from your mistakes in the game" – Participant B, female, age 21). There is evidence of reflection, then, but the participants' ability to articulate their skills and understanding in other contexts is perhaps better evidenced in the discussions relating to other attributes.

While a single participant (Participant O, female, age 18) responded with a flat "no" (accompanied by laughter) in response to the question of whether games could make players more reflective learners, the occurrence of reflective learning – pertaining to the games – was evidenced in numerous other responses:

> *Yes. Every single game method ever can be attributed to the learning from your mistakes ethos. It's practically how gaming works – it's part of what keeps people hooked.* (Participant F, male, age 19)
>
> *...learning from mistakes actually in the games themselves, plenty of that, that's the only way you can play these games is by getting them wrong the first time* [...] *it's very trial and error...* (Participant T, male, age 19)
>
> *Yeah, I think so, because I was pretty rubbish at all the games to begin with but by the end I felt I'd made some progress!* (Participant D, female, age 18)
>
> *Um... yeah. Again, in* Portal*. It's all about* Portal*. It was literally like learning from your mistakes. Also, all the others but still, like, you get another lives if you die in the game so you have always a second chance. So you had to learn from your mistakes.* (Participant S, female, age 18)

The idea of a "second chance" (Participant S) was echoed by several other participants, highlighting that games provide an environment in which it is acceptable to fail and try again, following some period of reflection. As Participant I (female, age 21) describes:

> *Yeah. Like, in relation to the games, if you made a mistake you tried to correct it the second time. And in the game you had more lives.*
> Interviewer: *It didn't matter if you died...*
> *Yes. So I think in this matter I can be more confident, going back to confidence, because you don't have anything to be afraid of. Because if you die...*
> Interviewer: *You can just start again?*
> *Yes.*

Aside from *Portal 2*, another game mentioned specifically here was *Team Fortress 2*, wherein a player may choose to play as a different class of character when they die and momentarily return to the game, or 'respawn', as Participant J (female, age 29) previously suggested when discussing adaptability. The adaptability implied in Participant J's response was mentioned more specifically by another participant, suggesting another association between attributes:

> *Yes. In every game we played, if you are losing, it is sometimes because you are not doing well enough, but more often because you are not doing it in the best way possible. You are forced to find better ways to confront problems, and adapt.* (Participant Q, male, age 18)

Some participants made observations relating to the timescale on which reflection occurred. While the *Team Fortress 2* example above indicates that reflection on the game could occur in mere moments, others suggested that a longer period of reflection, away from the game, was beneficial:

> *…the trial and error, being able to look back reflectively on what you've done or if you play for one hour and go away and come back another day for like another hour you can kind of base your next hour on how you did the last hour and kind of figure out what to do.* (Participant M, female, age 17)
>
> *I definitely noticed if I did an hour or half an hour then went away and then came back the day after, I was a lot better than getting better playing over a two-hour stint.* […] *Just having that time out, rather than, you know, reflecting while a load screen is up - that's just not enough time, for me. But, yeah, going away and having 24 hours where I didn't play, even if I'd played it for a very short amount of time, initially, I was a lot better when I came back in.* (Participant A, male, age 32)

Meanwhile, another participant suggested that playing a new game for a total of two hours was probably insufficient for players less experienced than he to meaningfully reflect on what they had learned:

> *I think I probably reflected on the games that I'd played before and then learned from that coming into this. But I'm not sure how others would be able to reflect, only playing each game for two hours and not going back to them.* (Participant K, male, age 18)

While, as noted above, most participants confined their discussion of reflection to game play alone, a few did attempt to connect this reflection with the world beyond. One participant, who notably disagrees with Participant K's suggestion that two hours of play per game was insufficient, had this to say:

> *I know it sounds kind of stupid, but…* [laughs] *Because you actually have to think* […] *about what you're doing while you're playing the game* […] *but you sort of think back to it after you've played. Not just to prepare for other games but it's just because a lot of those skills help you in all kinds of aspects, I think, of like logic, sense of direction, reflexes, all these things, like confidence, being able to communicate and cooperate with others. So I definitely think that, even just two hours a week, helped a lot.* (Participant H, female, age 23)

Confidence and teamwork were cited by other participants in relation to reflection, too:

> *It's something that sort of sits with you, like, the experiences that you've had, the team work and the sort of problem solving that you've done, you become more confident in your ability to be able to do that kind of thing in other situations. So it's not a case of, like, actually, literally applying what you've done but it does give you that, the self-confidence to sort of be flexible…* (Participant R, female, age 18)

Finally, however, one participant was keenly aware that the trial and error approach that many games encourage was not applicable to university life:

> *…usually I'll look at a game and I'll play it and even if I make a mess of it, you can always go back again and re-do it. You can't do that with your semesters* [laughs]. (Participant G, female, age 22)

Dewey (1933, p. 17) suggested that reflection "enables us to direct our actions with foresight […] It enables us to know what we are about when we act". In learning from their mistakes, it can certainly be argued that these players are better able to direct subsequent actions, suggesting that reflective learning has taken place. However, as the range of responses given here indicates, some forms of reflection are more productive than others. Moore and Ash (2002) identified four types of "reflective activity" in their study of trainee teachers:

- ‘Ritualistic reflection’, wherein reflection comprises little more than ‘going through the motions’ of reflection, to meet some requirement to reflect, i.e. reflection may be performative in nature;
- ‘Pseudo-reflection’, where there is a genuine intention to reflect but no development or change results;
- 'Constructive', 'productive' or, 'authentic' reflection, which actively seeks to problematise situations and to challenge existing views, perspectives and beliefs, promoting or leading to development or change;
- ‘Reflexivity’, whereby reflection extends beyond the situation at hand, and includes considerations of previous experiences, and responses to these.

There are echoes of deep and surface learning here, with ‘reflexivity’ representing the deepest form of reflective learning. Based on interview responses, the forms of reflective learning that were most commonly observed in this study might be the second and third forms identified by Moore and Ash. Where players have genuinely learned from their mistakes and altered their approach to solving an in-game problem, then the reflection might be described as ‘constructive’ or ‘productive’. However, where players recognise the need to learn from their mistakes but fail to come up with an alternative approach to solving the problem, they might be said to be engaging in ‘pseudo-reflection’. There is little impetus to engage in ‘ritualistic reflection’ when playing these games, aside from a desire to placate fellow players in a cooperative game by acting as though one cares enough about the game to reflect on their actions. And, since there was little agreement that reflections on game play were of utility beyond the games, it cannot be said that ‘reflexivity’ has occurred.

So, much of the reflection discussed here relates only to the games played. This is not to say, however, that the data are not interesting: the participants’ comments clearly support several of the ideas put forward by Gee, for example, and if reflective learning – albeit about playing a game – is taking place, then the students involved are, at least, exercising this attribute. Perhaps the two most relevant of Gee’s learning principles are the Probing Principle (2007, p. 105) and the “Psychosocial Moratorium” Principle (2007, p. 59). The participants here make numerous references to trial and error and imply that games provide a safe space in which to fail. Gee’s principles, respectively, refer to carrying out some action, reflecting on the outcome, and acting again; and, learners being able to risk taking certain actions without serious consequence. The data here provide evidence for the existence of these principles in commercial video games, even if the transferability or wider applicability of the game play experience is less obvious.

5.3.10 Other skills and experience

While the interviews were quite rigidly structured around the specified graduate attributes, a number of additional themes or ideas recurred in the discussion, which did not fit perfectly with any particular attribute.

5.3.10.1 Games as an ice breaker

The usefully sociable aspects of gaming are touched upon throughout the interview data, and related to, for example, confidence, communication, or collaboration. Amongst these comments, however, a somewhat distinct notion of games as 'ice breakers' emerges (echoing an observation made during the pilot project in relation to *Minecraft* – see 4.1.1 above). Indeed, the Cambridge Business English Dictionary definition of this term refers to games: "a game or activity that is used to introduce people to each other so that they feel more relaxed together"[79], so it perhaps not surprising that participants in this study made a similar connection. One participant, who referred to "the ice breaker stuff" when discussing the Ethically and Socially Aware attribute, used the term specifically when describing his experience of playing games in the lab. He described how this required him to interact with the strangers with whom he was playing:

> *It's a very strange, like, ice breaker, but it's good. It's so much more, like... you have to do so many ice breakers for your classes, especially in first and second year... I wish all of the ice breakers were just sitting 20 people in a room and getting them to play these games, because they will immediately learn what they do and don't like about each other.* [...] *So yeah, it's a very fun ice breaker... it's a very disguised ice breaker as well. It didn't seem like we were playing these games to get to know each other. It seemed like we were just playing the games and also, by collateral damage, ended up having to talk to each other.* (Participant T, male, age 19)

While she did not use the term 'ice breaker', another participant described how games might allow one to talk to, and build up relationships with, strangers in a room:

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[79] Ice breaker Meaning in the Cambridge English Dictionary, retrieved from http://dictionary.cambridge.org/dictionary/english/ice-breaker 10 October, 2016.

Yeah, because I don't really know anyone, you just sort of chat to people. I mean, how often do you really kind of walk into a room where you don't really know anyone? So it's quite good in that sort of sense, in that you could kind of, build that kind of up. (Participant G, female, age 22)

Finally, while Participant T noted the potential for games to facilitate interactions with overseas students, Participant L (female, age 18) described how the gaming lab had introduced her to a fellow student who hailed from the same region of Scotland as she:

There was a girl who was from just along the road from me basically at one point.
Interviewer: *But you didn't know her before?*
No, she was like "I'm from Dumfries and Galloway" and I'm like "You are?"

In a sense, there is nothing unique about the games played that makes them especially suited to introducing people or making them feel more relaxed together, aside from the broad focus on multiplayer titles. As Participant T observes, icebreakers of one form or another are commonplace at university, as they are in the workplace. So, what is it about video games that this participant values over more traditional icebreaker activities? Care must be taken not to read too much into a handful of comments, but it is notable that this participant places emphasis on the fact that the games are designed to be fun. For this participant, playing video games is a perfectly natural form of entertainment and, as such, playing them in a formal context such as a university feels less contrived than taking part in an exercise that is obviously designed as an icebreaker. Furthermore, the richness of the game-playing experience seems to be important: the necessarily complex interactions between players allows those such as Participant T to quickly get the measure of his teammates. The use of commercial games as icebreakers, then, may have the advantage of appearing authentic and natural to students, rather than a contrivance for training or personal development purposes. This advantage may be extrapolated to the other positive outcomes described here, including improved communication skill and experience of collaboration: communication and collaboration are essential components of multiplayer video games, which, in turn, are a familiar and accepted pastime for a great many students.

5.3.10.2 Team building

Closely related to the notion of using video games as an icebreaker, the idea of playing games as a team building exercise was also raised. Initially coded as being synonymous with ‘team work' and frequently associated with the Experienced Collaborators attribute, on reflection it was thought that 'team building' was a subtly different concept. Being an experienced collaborator is about working as part of a team – any team, even one that is dysfunctional. To build a team, however, is to help develop the relationships between a particular set of individuals, with a view to ensuring comfortable and efficient collaboration. In the following example, both team building and teamwork are mentioned, suggesting a distinction between the two:

> *Games like* Portal 2 *and* Lara Croft *were fairly reliant on teamwork so I wouldn't be surprised if team building and team work skills were initiated and advanced.* (Participant F, male, age 19)

Team building was mentioned by another participant when asked if they had enjoyed the lab-based game play sessions:

> *Yeah, I did, I looked forward to coming into the labs because it was a nice change of pace from just studying and, like, university work and stuff so I think it could be quite good for, like, team building stuff as well.* (Participant D, female, age 18)

Another participant suggested that the lab sessions could be repurposed as a form of team building exercise:

> *Yeah. I guess if it was a kind of like a team building workshop type thing, like a confidence building workshop, a team building workshop where you'd play games with people you'd never met before. I know it would work for me, so I guess it could work for other people... if you want to be better at team building, if you want to be better at communication, come and do this workshop.* (Participant R, female, age 18)

Notions of icebreakers and team building are often associated with the corporate world, but, as Participant T notes above, they are also common in Higher Education. Perhaps what links these types of activity is that they relate to specific teams, as described above. These are not personal attributes but, rather, phenomena associated with particular groups of people.

Games – albeit not usually of the digital variety – are commonly used as team building exercises. Individuals such as Sivasailam "Thiagi" Thiagarajan and organisations such as the North American Simulation and Gaming Association have published books and other material on the subject (see, for example, Thiagarajan & Parker, 2008; Blohm & Piltz, 2012). However, perhaps what video games offer would-be teams is the mixture of authenticity (commercial video games are intended to be fun, rather than consolidate teams) and complexity (in terms of the variety of roles and experiences afforded by modern video games) described under 'games as an icebreaker'. Furthermore, video games appear to be under-utilised in this regard, as illustrated by Salopek's (1999) overview of employee training games that covers "board games, experiential learning, creativity techniques, personal computer simulations, card games, case studies, and structured sharing" but falls short of including video games *per se*.

5.3.10.3 Relaxing or dealing with stress

A theme which emerged spontaneously from the interviews, particularly in response to the open question about the value of playing video games at university, was that of games providing a means of 'de-stressing' or relaxing ("It's also great to get frustration out, and stabilize people emotionally" – Participant Q, male, age 18). The stress of university life was mentioned specifically by several participants:

> *For me, it's an outlet for adrenaline, stress, so I think it would be very beneficial to university students, especially those that are still getting accustomed to university life.* (Participant H, female, age 23)

> *Yeah, I think there definitely is* [value in playing games at university]*, both in, like, the skills you're gaining and also having a bit of down time from studies as well. Because uni is stressful, so it would be nice if students had somewhere they could go to just play some games. That way you're relaxing and getting some benefit out of it as well.* (Participant L, female, age 18)

> *Yeah, like I suppose there's value in the sense that it was quite nice to come in for a couple of hours and almost like de-stress, you just play something and you don't have to think about your coursework for a little while.* (Participant G, female, age 22)

However, the same participant noted, "you can play too much", suggesting that a balance must be struck between study and play. Another participant noted that while she personally was not "really that stressed", she could see the value in playing games if she were:

> *Well, it's good for like if you're really stressed out about something that's going on and you want to just, like, not have to focus on anything important for a while, just play a video game.* (Participant O, female, age 18)

Other participants expressed similar ideas in terms of the games offering an opportunity to relax ("I think people need to relax and it's a good way of doing it" – Participant P, male, age 27), and welcomed the idea of being able to play games on campus:

> *...I would like it, I think it would be good because, for the aspect of it being kind of restful* [...] *It would be nice to be able to spend a very reasonable amount, an hour or so, just go always, and be in that setting and not need to go home.* [...] *It would be nice to be able to go 'I'm going to go and play for an hour and then go back to studying'.* (Participant C, male, age 19)

> *Yeah. Even if it should just be for like relaxing... Because I remember one day it was kind of the beginning of the study, maybe second or third week, and I was really upset. I can't remember why. Because of school I had, I think, some problem with lessons... and I came here and I played - I think it was* Minecraft *and* Borderlands *- and it really helped me like... I immediately felt better and I remember that I think I spent three or four hours here. So, yeah, PC games helps!* (Participant S, female, age 18)

The contrast between study and play was thought to be beneficial, too:

> *I looked forward to coming into the labs because it was a nice change of pace from just studying and, like, university work and stuff.* (Participant D, female, age 18)

> *That would be really cool, like, if you could go and play games with some mates. I would enjoy it.* [...] *Like, I don't know, you have your mind in another thing for a while. So you're not thinking all the time about the lectures and you still have to think things.* (Participant B, female, age 21)

The cathartic effects of playing video games have been debated and documented elsewhere, at least in terms of short-term effects. Bonus *et al.* (2015), for example, showed that playing violent games could reduce feelings of frustration and improve mood in players, although such improvements were also associated with a tendency to perceive the real world in more hostile terms. Furthermore, Bourgonjon, Vandermeersche, Wever, Soetaert, & Valcke (2015), in their analysis of online discussion forums dedicated to games, found that one of the many benefits players associated with playing was stress relief, and identified mention of catharsis in 16.3% of the forum messages analysed. The potential for games to offer students an opportunity to relieve stress, however, was not explicitly explored in this study, which makes it all the more striking that this idea has emerged from the interview data. It might be related, perhaps, to some of the salient features of video games that both Gee (2007) and Squire (2011) identify in relation to learning: that failure is an option, the player received immediate feedback on their actions, and progress can often be made on a variety of fronts. These features may position games in stark contrast to some students' experience at university, and offer beneficial respite from the occasional but unavoidable challenges of university life.

Regardless of the evidence for or against such effects in the literature, many of the students interviewed here certainly hold the belief that playing games can reduce stress. If this is the case, then, as suggested above, it is possible that the stress-reducing effects of playing games is – to some unknown extent – responsible for the marked differences in the control and intervention groups' attribute scores. Any future work in this area should attempt to gauge stress levels in participants, in an effort to ascertain if playing games on campus might reduce stress and not only underlie the gains in attribute scores made by the intervention group, but also help explain the loss of function observed in the control group. It might also be significant that the games are played on university premises, with the tacit approval of the institution, as this might ameliorate stress-inducing concerns that playing games is frowned upon by the university, and at odds with academic success.

5.3.10.4 Experimentation

A trial and error approach to in-game progression is mentioned, particularly in relation to the Reflective Learners attribute ("...the only way you can play these games is by getting them wrong the first time" – Participant T, male, age 19). However, taking a wider view of experimentation, one that fully embraces Gee's Probing Principle, reveals that this is related to many of the attributes considered here. For example, trial and error was considered one way of honing communication skill:

> *...you'll learn by trial and error the best ways to communicate with people. The best ways to quickly and efficiently sort of 'you do this, I'll do this'. Especially in* Warcraft*,*

> *in sort of like tight time-constrained situations the best way to go 'look, you go there, I'll go here and do this'.* (Participant R, female, age 18)

Participant T's account of experimenting with tactics that ran counter to prevailing wisdom recalls how another participant described an approach to problem solving that, again, was perhaps more about random experimentation than creative thinking: "maybe if I fire that there and I fire that there, maybe that'll open up a new area or something like that" (Participant M, female, age 17).

Arguably related to the aspect of the Ethically and Socially Aware attribute that suggests students should welcome new opportunities, Participant T felt that simply taking part in the study was, for him, an experiment:

> *…for me, last year in particular I didn't do anything like this, I just kept myself to myself, I didn't go out and take this sort of opportunity and try experiments out and things. So, when* [another participant] *said 'hey, do you want to come and play some video games'* [I signed up] *because I thought it was a mistake last year to not have done as much as I could. Taking these sorts of opportunities, because they could be fun. As they proved to be, so, yeah, I made a point of doing this, just because it was something I felt like I hadn't done enough.* (Participant T, male, age 19)

While the last of these examples is too personal to generalise, it may signal that the novelty of taking part in a university-based video game study was part of what motivated participation. If video games were to become *de rigueur* at university, their appeal as a somewhat novel, experimental experience may be lost. However, this is an isolated comment and the possibility that the novelty of the exercise might have had some bearing on its outcome should be considered in subsequent work.

That games facilitate experimentation is not a new idea, but it is interesting to note how the participants interviewed here could readily associate this idea with a number of positive pedagogical outcomes, in line with what other authors and researchers have suggested. In addition to illustrating Gee's Probing Principle and "Psychosocial Moratorium" Principle, the evidence here supports Johnson's (2005a) claims that the successful navigation of video games relies upon the player's application of the scientific method. The participants' comments also align with Steinkuehler and Duncan's (2008) study, which demonstrated that 65% of online discussion forum posts “displayed an evaluative epistemology in which knowledge is treated as an open-ended process of evaluation and argument”.

5.3.11 Sentiment analysis

As noted above, interview responses were coded in terms of sentiment, indicating whether the opinion expressed by a participant in relation to a topic was positive or negative in nature. This coding facilitated broad analyses of study participants’ attitudes to the relationship between games and graduate attributes, and to the usefulness of individual games in this context.

‘Moderately positive’ was used to identify statements which were less certain or enthusiastic but still broadly positive. ‘Very positive’ was used to signify particularly effusive responses. ‘Positive’ was used to identify the majority of positive statements, representing the ‘middle ground’ between ‘Moderately positive’ and ‘Very positive’. An equivalent approach was taken to the use of negative sentiment nodes, but the ‘Moderately negative’ and ‘Very negative’ codes were not thought necessary.

Table 15 below summarises positive statements made about the games played helping to develop each attribute. Table 16 summarises responses coded as negative, where respondents have indicated they do not believe the relevant attributes were enhanced by playing the games. As might be expected from the preceding qualitative analysis, the number of positive responses clearly outweighs the negative.

Table 115: Participant statements about the relationship between video games and developing graduate attributes coded as positive, ordered by total number of positive comments.

	Total Positive	Moderately positive	Positive	Very positive
Ethically and Socially Aware	24	9	14	1
Confident	22	5	16	1
Effective Communicators	21	7	12	2
Experienced Collaborators	21	5	12	4
Investigative	20	1	16	3
Adaptable	19	6	12	1
Independent and Critical Thinkers	19	7		1

Reflective Learners	**18**	8		0
Resourceful and Responsible	16	6		0

Table 16: Participant statements about the relationship between video games and developing graduate attributes coded as negative, ordered by total number of negative comments.

	Total Negative
Adaptable	4
Resourceful and Responsible	4
Confident	3
Effective Communicators	2
Independent and Critical Thinkers	2
Investigative	1
Reflective Learners	1
Ethically and Socially Aware	0
Experienced Collaborators	0

The Ethically and Socially Aware attribute – not measured by any quantitative means here – comfortably tops the list of positive mentions, while attracting zero negative comments. This is borne out in the qualitative analysis above, which revealed that students believed this attribute was developed either by playing with others from different social backgrounds, or by experiencing in-game content that provided a window into some other culture. Confidence is also cited as being positively influenced by the game-playing experience, although this attribute also attracted one of the greater numbers of negative comments. Of the attributes measured by quantitative means, Resourceful and Responsible fares least well in these data, with the smallest number of positive comments and the highest number of negative comments – a position shared with another of the measured attributes, Adaptable. Collaboration and communication – particularly the former – are generally thought to have been improved by playing these (largely multiplayer) games.

However, care must be taken when interpreting these results. First, the total number of comments coded as negative in sentiment is so small that it is difficult to say with confidence that the hierarchy implied by Table 16 above is valid. Second, the ordering of Table 15 does not take into account the degree of positivity expressed in the sentiment. An alternative means of presenting these data is used in Table 17 below, where a 'Weighted positive' value is calculated by halving the value of 'Moderately positive' comments and doubling the value of 'Very positive' comments. This affects the ordering of the attributes such as to position Experienced

Collaborators at the top of the list, closely followed by the Investigative attribute. The Ethically and Socially Aware and Effective Communicators attributes still fare well but the Resourceful and Responsible attribute remains at the bottom of the table. There seems little doubt that this attribute is less closely associated with gameplay in the minds of participants. This sentiment may be complicated by the fact that the attribute is composed of two distinct (and not obviously related) concepts, but also by the fact that several participants seemed unsure about the intended meaning of the word 'resourceful'. Certainly, participants' less positive attitudes towards this attribute are not reflected in the increased scores on the corresponding quantitative measure.

Table 17: Positive participant statements about the relationship between video games and developing graduate attributes, ordered by weighted number of positive comments. The 'Weighted positive' value is calculated by halving the value of 'Moderately positive' comments and doubling the value of 'Very positive' comments.

	Weighted positive
Experienced Collaborators	26.5
Investigative	25.5
Ethically and Socially Aware	21.5
Confident	21.5
Effective Communicators	21.5
Adaptable	18
Independent and Critical Thinkers	17.5
Reflective Learners	14
Resourceful and Responsible	13

6. Cross-sectional Survey

The cross-sectional survey, which followed the experimental study, involved the collection of demographic and gaming-related data from a student population in order to determine if there is any correlation between measures of graduate attribute attainment and game play habits at a single point in time. It was thought useful to conduct a survey of a larger population to enable comparisons between results obtained under experimental conditions, and those that may be observed 'in the wild'. By surveying the game play habits of a broader student cohort, in conjunction with collecting scores on each of the attribute-measuring instruments, it was possible to determine if there is any correlation between existing game play habits and self-reported graduate attribute attainment.

A cross-sectional survey of students required a larger sample size than the controlled experiment, and consideration of the target population and the make-up of the study sample. The *target population* for this study is potentially very large – almost anyone can play, and therefore potentially benefit from, video games – but the *study population* may reasonably be limited to university students, in line with the specific graduate attribute focus of the work. For practical reasons, the study population was limited to students at the University of Glasgow and it is from this population that the study sample was drawn. Ideally, the study sample would have been selected at random from the study population (e.g. a random sample of all students at the University of Glasgow) to ameliorate sampling errors (Coggon *et al.*, 2013). In practice, since the study relied on volunteers, the study sample was, to some extent, self-selecting and therefore prone to bias. It is reasonable to assume, for example, that students with an active interest in video games are more likely to volunteer to take part in a study that concerns games. In order to reflect the target population, the survey had to include not just active players but also 'lapsed' players (those who have fallen out of the habit of playing video games) and non-players. To address this potential bias, volunteers from each of these groups were recruited by means of appropriately worded advertisements that encouraged even non-players to participate. Further, background data collected on each participant included a robust set of items that pertain to gaming habits in addition to the essential demographic information (age, gender, etc.) and that relating to their university studies (subject, year of study, etc.). As noted by Coggon *et al.* (2013), "epidemiology thrives on heterogeneity" and these data allowed observations to be made about particular groups of participants with varying characteristics and exposure to video games.

6.1 Methods

The cross-sectional survey began with a significant recruitment drive to enlist student participants from a wide range of backgrounds, including those who play games and those who do not. Students across all levels at the host institution were recruited by email and a prize draw for Amazon vouchers was offered as a means of incentivising respondents. In total, 2145 responses were collected, accounting for 8.4% of the total student population at the University of Glasgow ('University of Glasgow - About us - Facts and figures - Student numbers', 2015).

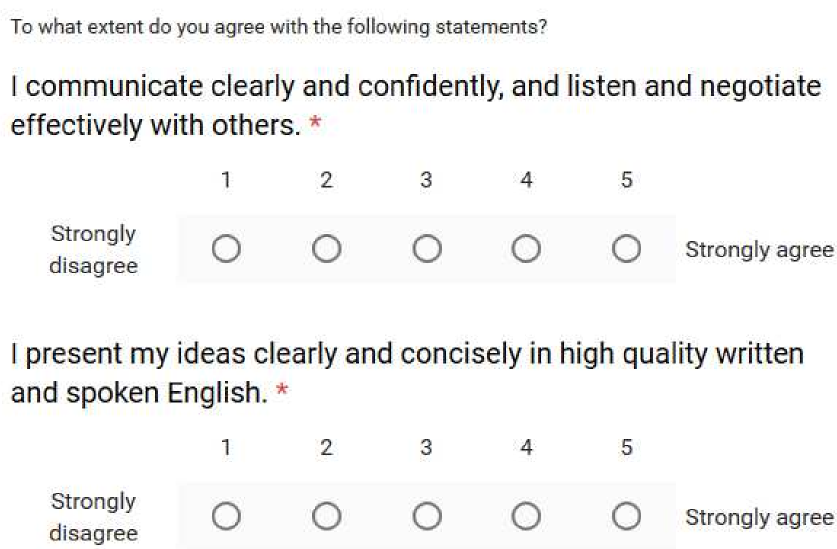
The primary objective of the survey was to determine if there is an association between playing commercial video games and the attainment of the measured graduate attributes. Subsidiary objectives included examining the type of games played by these participants, and for how long, as well as looking for any demographic patterns that emerge. Data were collected by means of an online questionnaire that reproduced the instruments used to measure graduate attribute attainment on the experimental study to facilitate comparison. It was thought impractical to record and analyse the individual games played by respondents, given the sheer number of possibilities. Instead, game genres were, as with the experimental study, used to gauge gaming preferences.

A number of questions were added to the survey in light of the quantitative and qualitative data obtained in the main experimental study, relating to preference for multiplayer and cooperative play. The survey, then, was designed *a priori* to determine:

1. Is there a correlation between game play habits and self-reported communication, adaptability, and resourcefulness scores? Specifically, are there correlations with:
    a. Preferred genres and games and/or hours played per week (including non-players),
    b. Preference for multiplayer gaming,
    c. Preference for co-op gaming?
2. Do students believe video games might help develop any useful skills, or provide any valuable experience? And, if so, what skills or experience?

Survey items relating to the first set of questions allow statistical correlations to be calculated, while those relating to the second question are qualitative in nature, allowing student attitudes to game-based learning to be explored. As noted elsewhere, it is important to understand how students might feel about games being used to develop their skills and competencies, should an intervention in the vein of this work be carried out on an institutional basis. The data collected here – from across an entire university and all of the disciplines it comprises – should help identify any barriers to games being used in this context.

The survey also comprised a number of additional questions derived from the university definitions of the three attributes being measured, based on the stated Personal and Transferable dimensions of each. Each of these dimensions was arranged as a statement and the participant asked to indicate on a five-point Likert scale the extent to which they agreed or disagreed with the statement. For example, "I communicate clearly and confidently, and listen and negotiate effectively with others." This provided an alternative means of measuring these attributes – incontrovertibly tied to the university's conception of each – that may also be correlated with measurements obtained via the instruments drawn from the literature. Figure 54 below shows how the questions based on the Effective Communicators attribute were presented. Links to the complete survey used in the cross-sectional study are provided in Appendix D.


To what extent do you agree with the following statements?

I communicate clearly and confidently, and listen and negotiate effectively with others. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I present my ideas clearly and concisely in high quality written and spoken English. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Figure 54: Survey questions based on the Effective Communicators attribute. The first question relates to the transferable dimension of the attribute, the second refers to the personal dimension.

As the survey also included the adaptability and resourcefulness measures, and the two communication measures, it is possible to determine how closely the participants' scores on these measures correlate with those for the attribute-based questions. Calculating such correlations allows a broad assessment of the relevance and applicability of the chosen measures to be made, which may be instructive when considering the differences between results for the two communication measures, for example. To this end, Spearman's rank correlation coefficient (Spearman's rho) was calculated using R statistical software to determine the correlation between CAS and SPCCS scores and responses to the above attribute-based questions (discussed in more detail under 5.3 below). It is notable that CAS correlated more strongly with scores on the attribute definition-based questions scores (transferable dimension, rho = 0.52; personal dimension, rho = 0.48) than those for the SPCCS measure (transferable dimension, rho = 0.48; personal dimension, rho = 0.33).

The attribute-based questions are not validated in any way, and all measures discussed here are self-report in nature, so the correlation values are somewhat arbitrary in terms of the strength of correlation they imply. However, it may be noted that the measure of communication skill that showed the greater post-test improvement for intervention group participants in the main experimental study is also that which correlates more closely with the university definitions of effective communication.

6.2 Description of survey respondents

71.9% of respondents indicated that they were pursuing an undergraduate programme of study, with 14.5% on a taught postgraduate programme and 13.6% pursuing a postgraduate research degree (28.1% total postgraduate population). The proportion of undergraduate and postgraduate respondents closely mirrors those figures for the university as a whole, which reports a 71% undergraduate population and 29% postgraduate population ('University of Glasgow - About us - Facts and figures - Student numbers', 2015). 59% of respondents were female and 39.8% male, with 0.8% of respondents not identifying as female or male. This matches the 59% female population reported by the university for the relevant academic session ('University of Glasgow - Services A-Z - Planning and Business Intelligence - QlikView Student Headcount Profiles - Gender - Headcount of Students by Gender 2011-12 to 2015-16', 2016). In terms of these simple demographic data, then, the sample is remarkably representative of the university population as a whole. Year of study, as depicted in Figure 55 below, seems to suggest an unusually high proportion of first year students, which may skew the graduate attribute scores if it is assumed that these improve over the course of a degree (typically four years for an undergraduate Honours degree in Scotland). However, university data that might indicate whether these figures are representative is not available. The mean age of respondents was 22.76, the median age was 21 and the age range was 16-65.

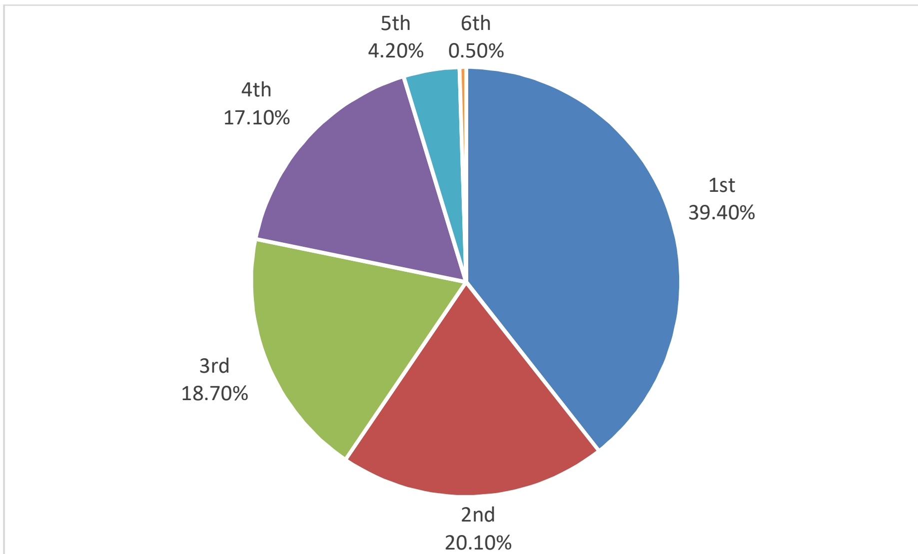


Figure 55: Survey respondents' year of study

As depicted in Figure 56, around 63% of respondents stated that they play video games, while the majority of those who do play video games report that they do so for between one and four hours per week. These figures are somewhat dissimilar to those released by GameTrack (GameTrack (ISFE/Ipsos Connect), 2016), which indicate that just 40% of the UK population played video games in Q1 2016, albeit for an average of 8.8 hours per week. However, while these figures are reproduced by UKIE (the Association of UK Interactive Entertainment), they also note alternative figures produced by Newzoo, which suggest that 57% of the UK population plays games ('The games industry in numbers | Ukie', n.d.).

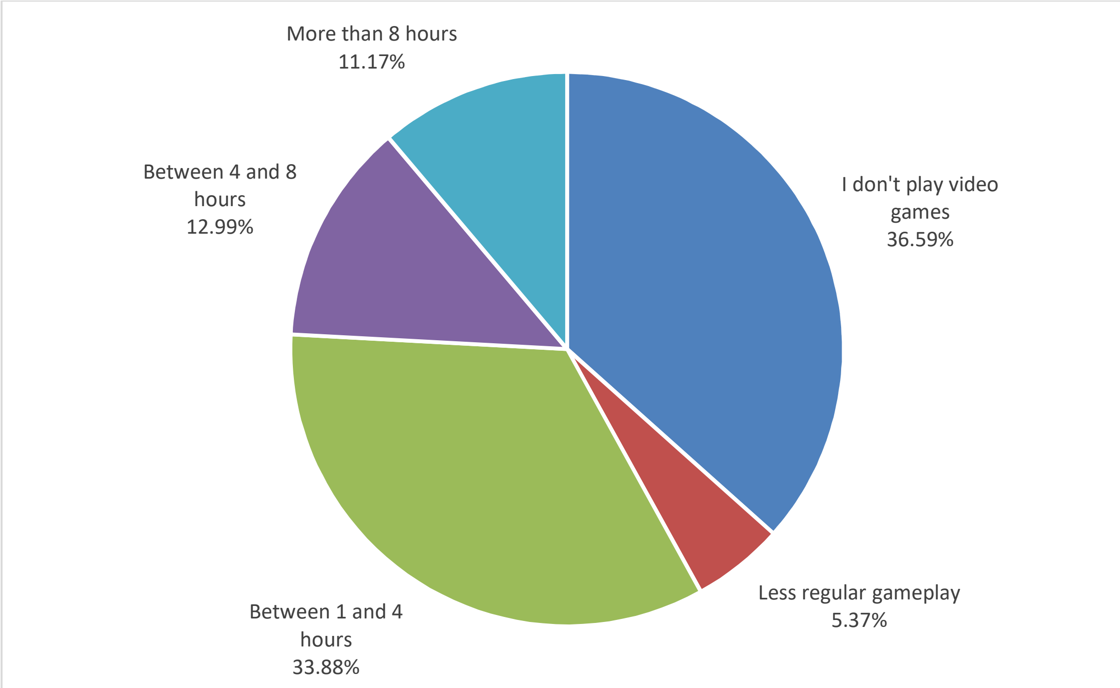


Figure 56: Time spent playing video games per week, as reported by survey respondents.

The proportion of respondents who selected the option "I don't play video games" on subsequent questions, however, varied slightly. For example, in answer to the question "What kind of games do you like to play?" 35.3% of respondents stated they did not play video games, compared to the 36.59% of respondents who claimed they did not play games in the earlier question. This difference is assumed to reflect the fact that a small proportion of respondents do not *currently* play games (accounting for the higher proportion of non-players when asked directly) but have played in the past and are thus in a position to suggest what types of game they prefer. In subsequent analysis, such contradictory responses are removed from gameplay totals and treated as an 'unknown' group. For example, in the violin plots below that summarise answers to questions relating to multiplayer and cooperative play, those respondents who selected 'I don't play video games' in the initial question but subsequently indicated that they played a particular form of multiplayer or co-op are treated as 'unknown'.

6.3 Quantitative survey results

As described above, additional questions derived from the university definitions of the three attributes being measured were included in the survey. These related to the personal and transferable dimensions of the Effective Communicators attribute; the personal and transferable dimensions of the Adaptable attribute, and; the personal and transferable dimensions of the Resourceful and Responsible attribute.

With the addition of new measures and a greatly increased number of respondents, it was thought useful to determine the degree of correlation between each measure. As with the pilot project, this permits a general assessment of the measures' intuitive sense to be made and, in particular, to provide a crude measure of how closely the instruments used to measure the three attributes correlate with the university definitions. The correlogram in Figure 57 below summarises these correlations. Variables were clustered based on their co-variance, and are ordered in Figure 57 based on this clustering (see Friendly (2002) for an explanation of the formula used by the R statistical package to calculate clustering). More precisely, variables are clustered based on their "distance" from each other, which in this case was a measure of how closely the variables correlate (co-vary) to each other. Three distinct clusters emerge from these data, which may be observed on the correleogram below.

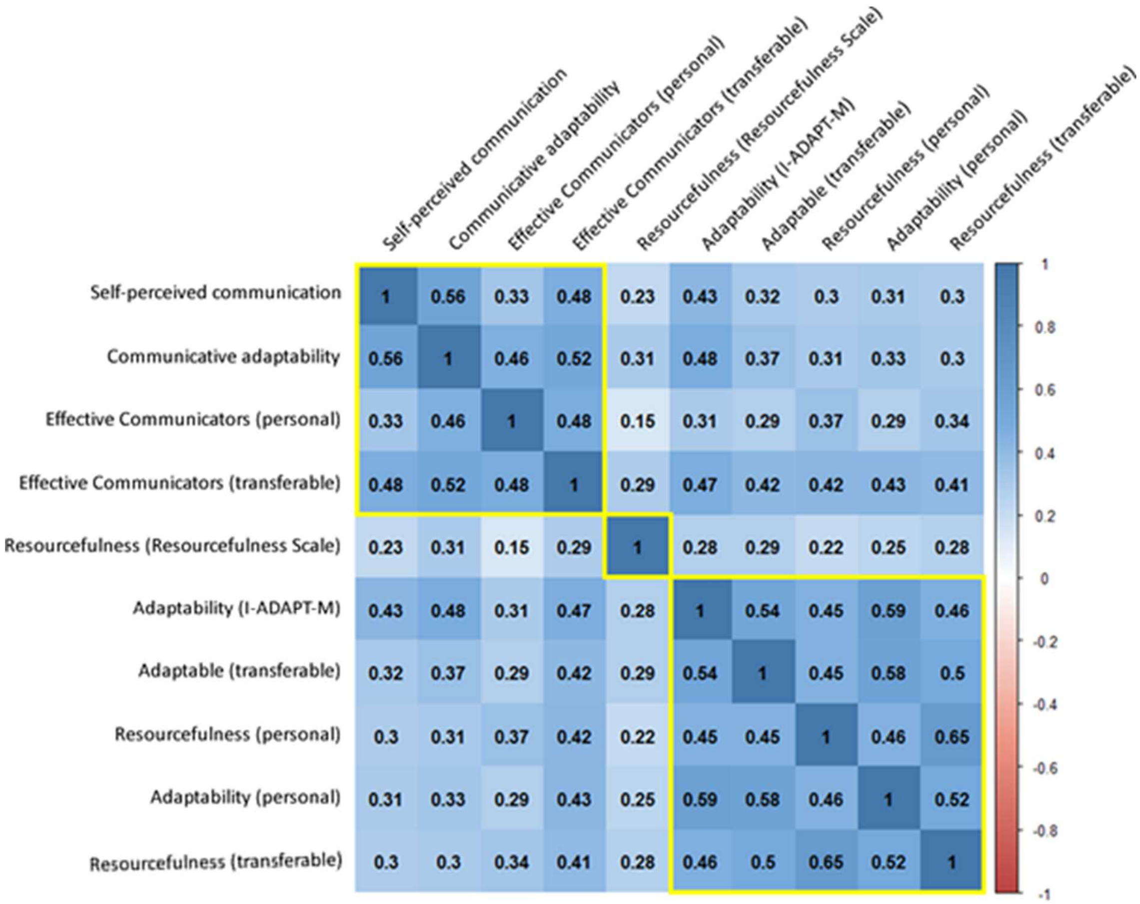


Figure 57: Correlations between graduate attribute measures. Correlation coefficients are Spearman's rank correlation coefficient. Variables were clustered based on their co-variance, and are ordered based on this clustering. Yellow boxes demarcate clusters.

Perhaps the most striking observation that may be made about the correlogram is that all of the correlations are positive: as the scores on any one attribute measure increase, so too do the scores on every other measure, to varying degrees. This overall relationship suggests that the graduate attributes measured here are all related, or that they could be facets of the same phenomenon. Looking more closely, however, it is notable that the Resourcefulness Scale scores are generally those that correlate most weakly with all other scores, including measures based on the university definitions of this attribute. This is evidenced by the appearance of a lightly shaded (low correlation) cross that emerges from the intersection of the row and column depicting correlations with the Resourcefulness scores. As noted above, the plotting of the correlogram also attempts to group variables that are most closely related; that is, the order of variables along the axes is not random. Bearing this in mind, it is apparent that all four measures of communication are closely related, positioned here in a contiguous block (or cluster) at the top left of the correlogram. The dendrogram in Figure 58 below illustrates this clustering more clearly.

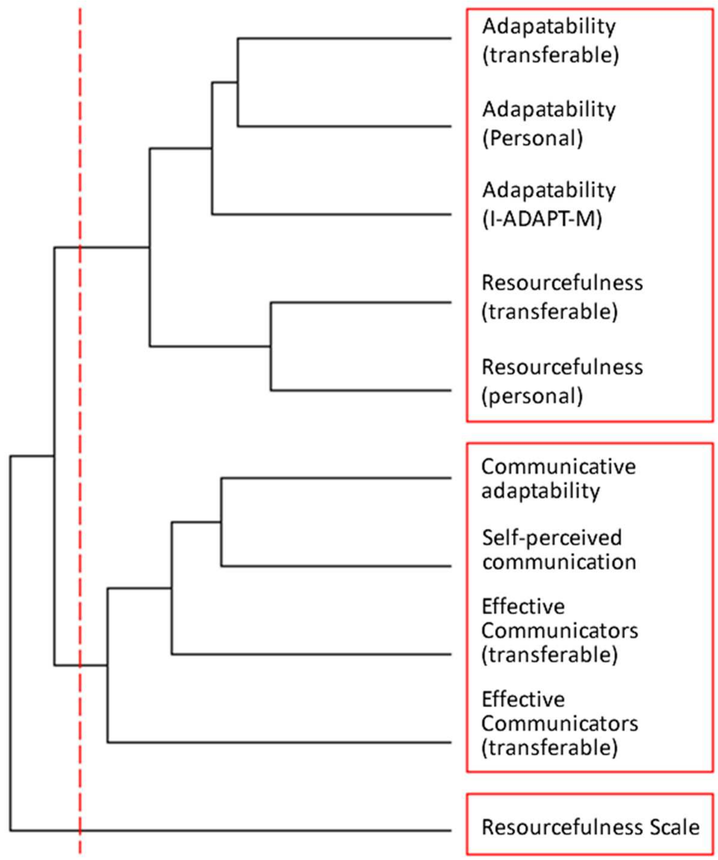


Figure 58: Hierarchical clustering dendrogram. Horizontal distance on the tree represents distance of correlation between branches (based on correlation coefficients shown in figure above).

Much like a family tree, the dendrogram illustrates the degree of relatedness between 'family members', which is expressed by the horizontal distance between elements. Elements may be grouped at any level in the hierarchy, but the level selected here (indicated by the dashed line) results in three distinct groups of measures. Communication measures fall into one group, and adaptability and resourcefulness measures fall largely within another, with the Resourcefulness Scale scores forming a distinct group of their own. There are some further subtleties – the personal dimension of the university's Effective Communicators attribute is slightly more distantly related to the other communication measures, for example – but overall it is clear that a high degree of correlation exists between communication measures, and that adaptability and resourcefulness, as defined by the university, are closely related to one another. Furthermore, all three measures of adaptability are closely related, suggesting that I-ADAPT-M is a suitable instrument for measuring adaptability in this context. However, the Resourcefulness Scale does not appear to correlate closely with the university definition and, perhaps more significantly, these scores are something of an outlier if each attribute is thought of as a component of a larger notion of 'graduateness'.

Aside from asking respondents to complete the graduate attribute-measuring instruments, perhaps the most pertinent of the survey questions was 'Do you think playing video games might help develop any useful skills, or provide any valuable experience?' to which nearly half of those surveyed (48.3%) responded in the affirmative. As shown in Figure 59 below, a large proportion (31.8%) of respondents weren't sure if games could be helpful in this regard, while just under one fifth (19.9%) of those surveyed were certain that games could not develop useful skills or provide valuable experience. Based on these data, it might be expected that around half of the student population would immediately see the value of any proposal for games to be played on campus, in the event that such an initiative was introduced. The other half may require some persuasion, although it might be assumed that the one third or so of students who responded, "Don't know", may be open to the idea. The remaining fifth of the student population is likely to prove difficult to persuade and, even if these students were required to attend game-based sessions, their scepticism may offset any positive effect.

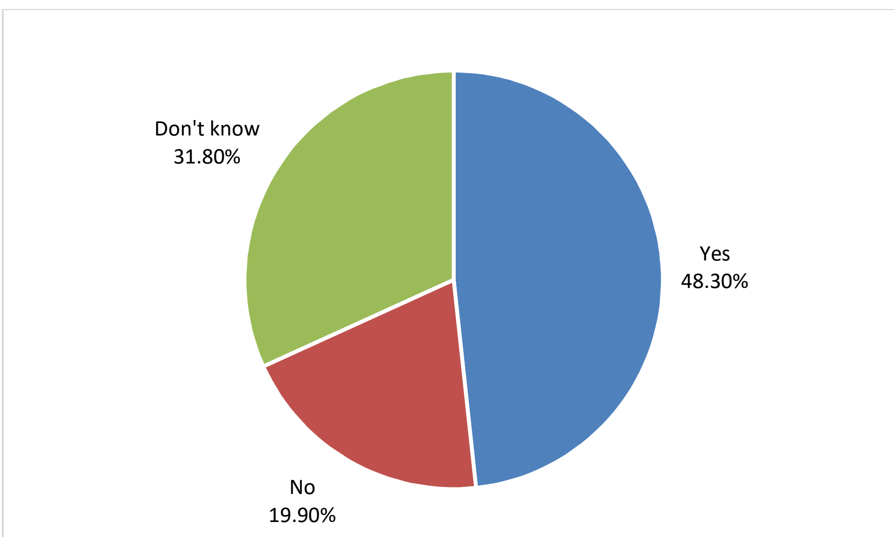


Figure 59: Survey responses to the question 'Do you think playing video games might help develop any useful skills, or provide any valuable experience?'

Tables 15 and 16 below summarise the categorical and continuous survey data, respectively, and treat contradictory data in the same manner as outlined above.

Table 18: Summary of categorical survey data

		n	Resourcefulness	p	SPCCS	p	CAS	p	IADAPTM	p
Gender (mean (sd))	Female	1271	86.47 (15.80)	<0.001	75.42 (16.38)	0.011	108.04 (13.50)	<0.001	198.07 (22.79)	0.003
	Male	857	82.19 (16.74)		74.46 (16.56)		105.89 (13.83)		200.26 (22.18)	
	Other	17	76.94 (17.94)		64.18 (14.25)		98.47 (13.62)		184.47 (27.64)	
Level of study (mean(sd))	Postgraduate Research	287	84.60 (17.92)	0.08	76.67 (16.02)	0.022	106.64 (13.33)	0.311	202.75 (22.70)	0.001
	Postgraduate Taught	303	86.62 (13.97)		76.41 (16.48)		106.17 (12.47)		200.78 (19.99)	
	Undergraduate	1555	84.32 (16.44)		74.34 (16.51)		107.37 (13.97)		197.74 (23.02)	
Year of study (mean(sd))	1	836	84.72 (16.03)	0.352	74.69 (16.59)	0.068	106.32 (13.51)	0.094	198.87 (21.87)	0.017
	2	431	84.77 (17.16)		73.72 (17.72)		106.76 (14.40)		196.65 (23.66)	
	3	407	85.15 (15.95)		74.58 (15.41)		107.79 (13.05)		198.60 (21.74)	
	4	371	83.44 (16.81)		76.48 (16.25)		107.82 (14.18)		200.27 (24.44)	
	5	90	87.37 (13.76)		77.86 (13.78)		109.23 (12.17)		202.26 (20.46)	
	6	10	80.60 (23.37)		81.17 (16.57)		113.50 (13.48)		216.60 (14.89)	
Weekly gameplay (mean(sd))	I don't play video games	783	86.14 (17.35)	<0.001	76.22 (17.14)	0.003	108.28 (13.95)	0.01	199.34 (22.36)	0.754
	Less regular gameplay	115	86.15 (16.69)		73.59 (16.21)		106.80 (13.54)		197.97 (24.20)	
	Between 1 and 4 hours	725	84.42 (14.88)		74.99 (15.18)		106.63 (13.36)		198.11 (23.16)	

	Between 4 and 8 hours	278	84.79 (15.42)		74.70 (16.65)		107.19 (13.51)		199.89 (22.15)	
	More than 8 hours	239	79.87 (17.28)		71.53 (17.51)		104.82 (13.89)		198.74 (22.01)	
Multiplayer gameplay (mean(sd))	No video games	774	86.01 (17.36)	0.021	76.14 (17.13)	0.033	108.26 (13.89)	<0.001	199.26 (22.40)	0.04
	Single-player only	465	85.18 (14.95)		74.33 (15.31)		106.36 (13.09)		197.59 (22.99)	
	Local multi-player	183	83.32 (14.51)		74.58 (15.78)		107.26 (12.65)		195.87 (23.41)	
	Online multiplayer	433	82.83 (16.01)		73.70 (15.36)		104.62 (14.36)		198.62 (21.98)	
	Local and online multi-player	243	83.72 (17.08)		75.76 (17.26)		109.16 (13.45)		202.61 (22.69)	
	Unknown (contradictions)	47	85.30 (16.52)		69.98 (22.35)		106.96 (11.51)		198.28 (24.21)	
Cooperative gameplay (mean(sd))	No video games	773	85.88 (17.48)	0.001	76.64 (16.41)	0.009	108.25 (13.93)	0.012	199.22 (22.79)	0.023
	No cooperative games	767	85.05 (14.72)		73.91 (16.04)		106.76 (12.94)		197.07 (22.41)	
	Team-based shooters	222	81.03 (17.04)		73.12 (15.49)		104.50 (15.00)		198.60 (24.92)	

	Other cooperative video games	162	84.85 (16.02)		74.52 (17.48)		107.60 (12.49)		200.36 (20.46)	
	Team-based shooters and other	209	82.48 (16.60)		75.05 (17.08)		106.50 (14.57)		203.08 (21.80)	
	Unknown (contradictions)	12	87.25 (14.68)		69.85 (28.60)		107.00 (13.02)		197.08 (17.73)	

Table 12: Summary of continuous survey data. Correlation coefficients are Spearman's rank correlation coefficient.

	Resourcefulness	**p**	**SPCCS**	**p**	**CAS**	**p**	**IADAPTM**	**p**
Age (correlation coefficient)	0.0258	0.232	0.1232	<0.001	-0.0222	0.305	0.1551	<0.001
Year of study (correlation coefficient)	-0.0004	0.987	0.0414	0.055	0.0584	0.007	0.0357	0.099

6.3.1 Results by gender

Female students (N = 1271) scored slightly higher than male students (N = 857) across three of the four measures, with male students recording a slightly higher score on the I-ADAPT measure. However, for students who did not identify as male or female, scores were consistently lower than those for other genders. This pronounced difference has resulted in very significant p-values for the difference between genders, but the absolute number of students in this category (N = 17) represents less than one percent of the total cohort. Figure 60 below clearly illustrates these relative scores (in all but I-ADAPT-M, there is a clear downward trend in median scores from Female, to Male, to Other) but the insufficient number of data points for the Other (non-binary) category is also highlighted by the truncated shape of the violin plots.

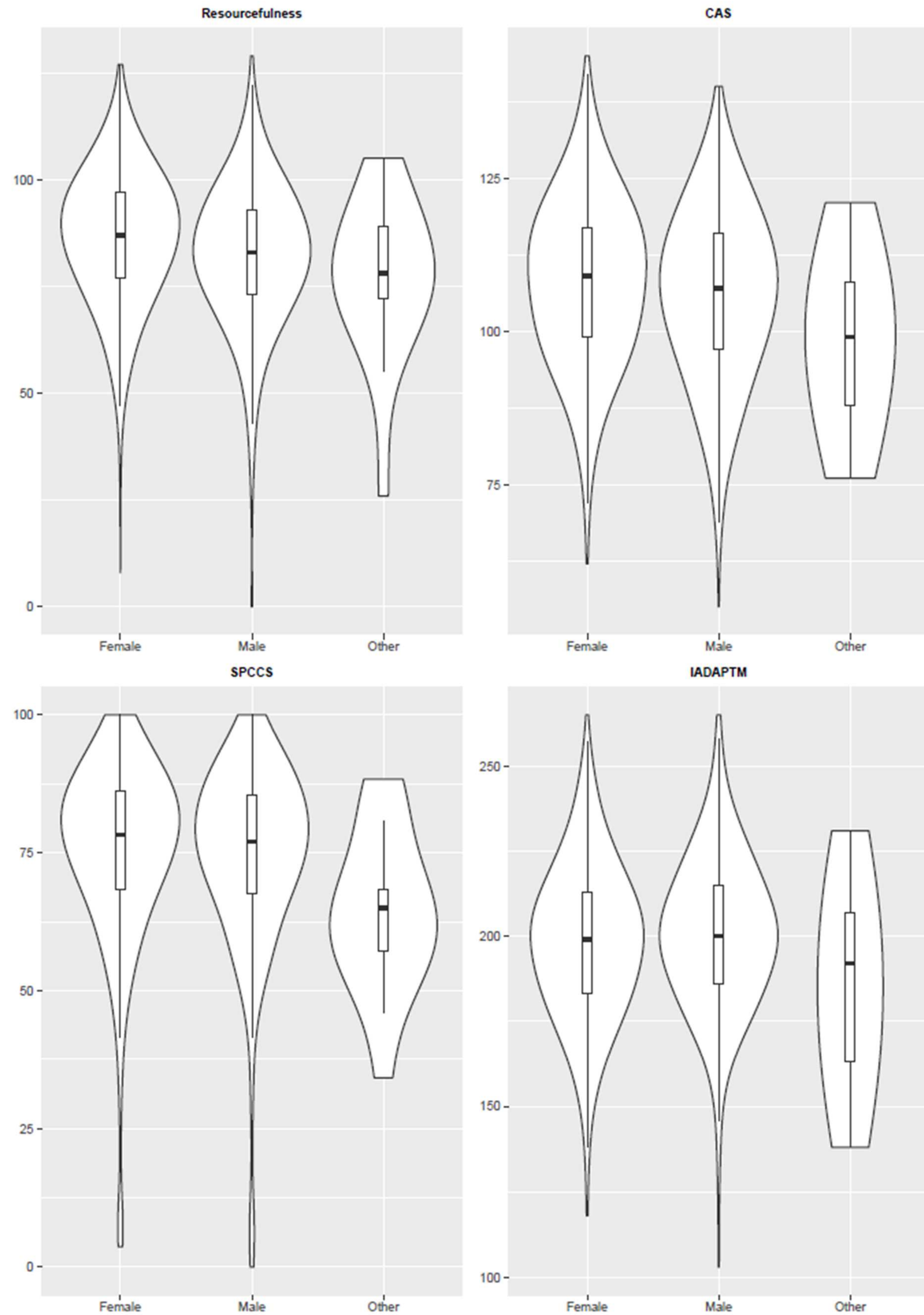


Figure 60: Distribution of four main graduate attribute scores by gender. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.1 Results by level of study

Graduate attribute scores do not vary consistently across levels of study. Only the I-ADAPT-M and SPCCS scores demonstrate what might be considered the expected pattern, with scores increasing from undergraduate (UG), to taught postgraduate (PGT), to postgraduate research (PGR) students. Looking at measures of communication, CAS scores somewhat contradict those for SPCCS, with undergraduate students scoring best, but the difference across all three levels is slight and not significant ($p = 0.311$). Taught postgraduate students scored best on the Resourcefulness Scale, although the differences here are not highly significant ($p = 0.08$). Therefore, it may be observed that the most significant differences between levels of study are those that conform to the expected downward trend from PGR to UG, as illustrated by the violin plots for SPCCS and I-ADAPT-M in the figure below.

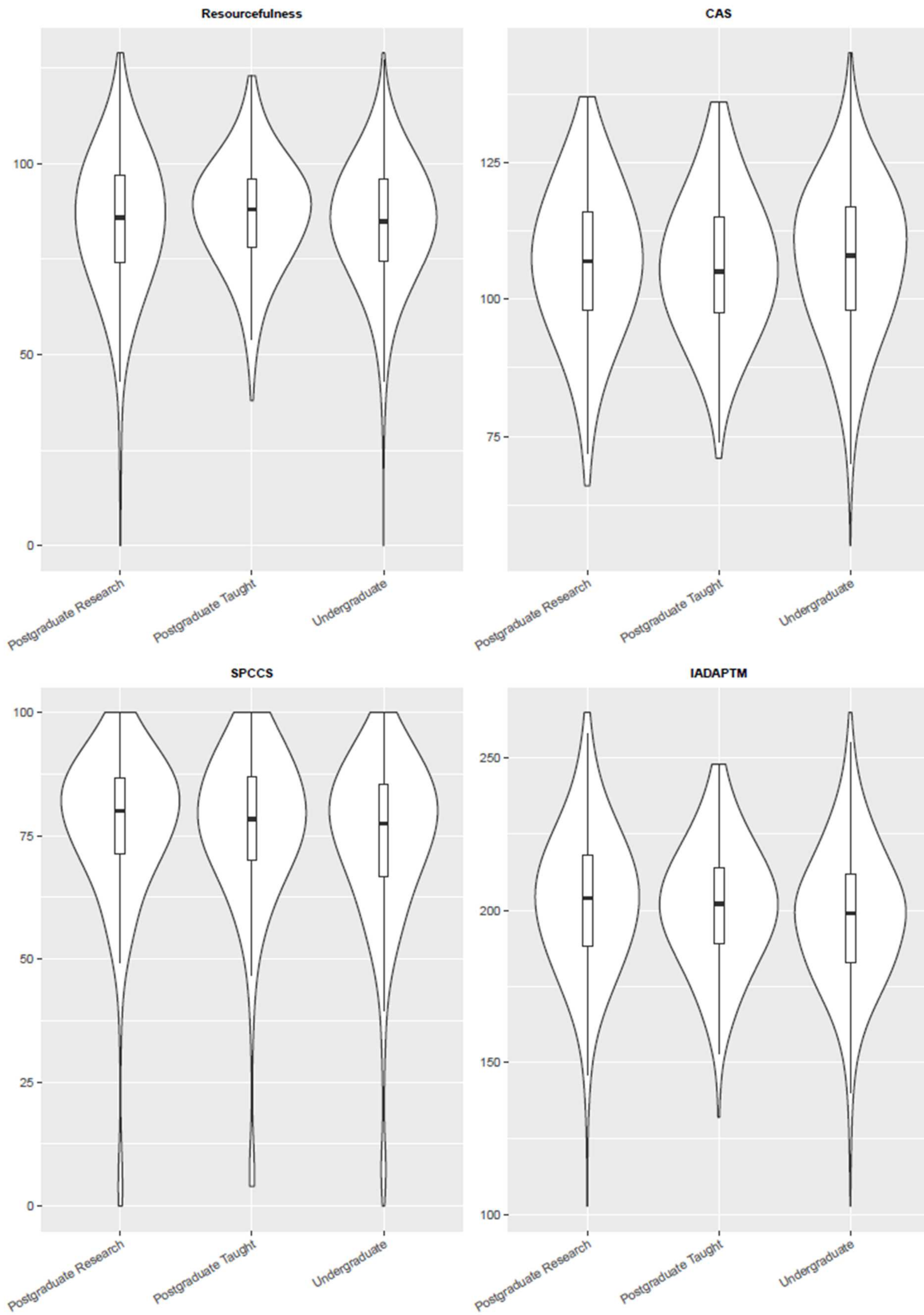


Figure 61: Distribution of four main graduate attribute scores by level of study. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.2 Results by year of study (as a categorical variable)

A number of factors complicate analysis of these results. The large proportion of first year students (N = 836, 38.97% of cohort) may skew the results and this effect may be exacerbated by the very small proportion of respondents in their fifth (N = 90) or sixth (N = 10) years. Furthermore, in reality, there is not a simple trajectory from year one to year six. The typical undergraduate honours degree in Scotland is four years in duration, so respondents in year five or six are either undergraduates who have repeated one or more years, and are thus atypical, or they are postgraduate students who may have followed any number of routes to arrive at this university. The violin plots in the figure below illustrate the fluctuations that occur in years five and six where, for example, the highest Resourcefulness Scale scores may be observed (in year five), as well as the lowest (in year six). For these reasons, undergraduates in years one or four are analysed separately below.

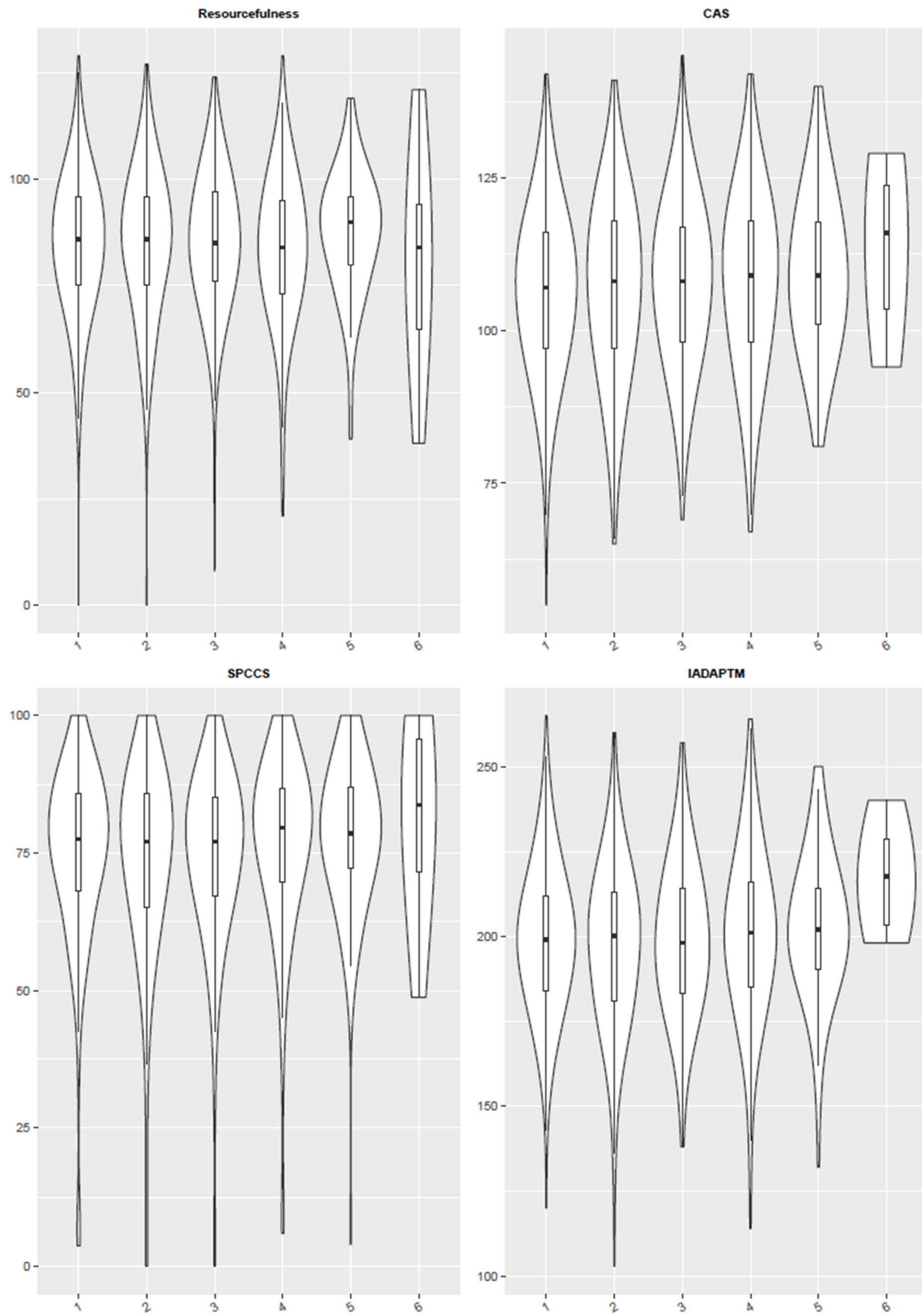


Figure 62: Distribution of four main graduate attribute scores by year of study. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.3 Results by year of study (as a continuous variable)

As year of study may also be viewed as a continuous variable, at least theoretically, these data were also plotted as such (see Figure 63 below) and analysed in terms of correlation (see Table 19 above). These analyses revealed that the apparently negative correlation between year of study and resourcefulness is so weak (Spearman's rank correlation coefficient = -0.0004) and statistically insignificant (p = 0.987) that it is meaningless. The positive correlations between year of study and the other three measures are statistically significant in all cases, suggesting that adaptability and communication skill improve over time, but the correlation is extremely weak. Again, however, there is reason to examine the undergraduates as a distinct cohort because of the variable nature of postgraduate study (see below).

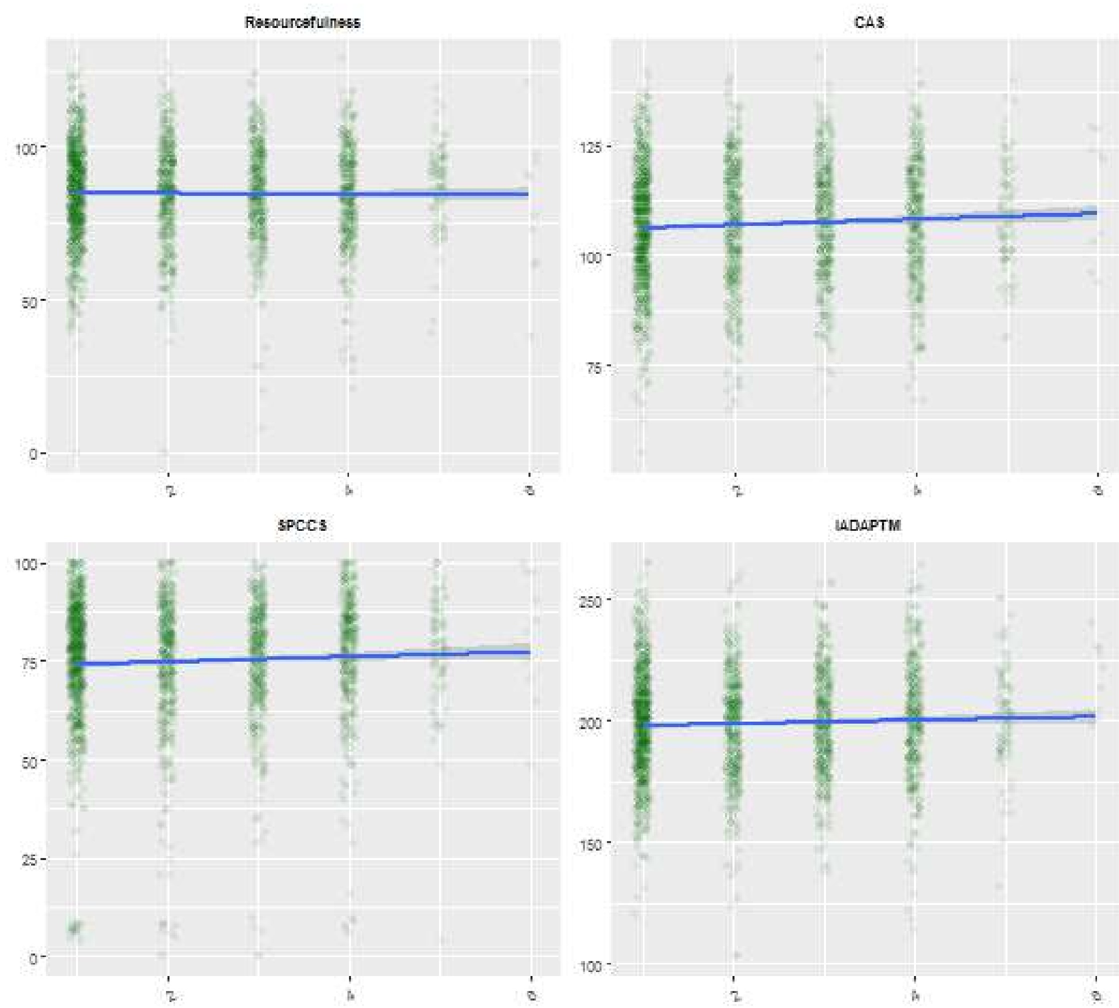


Figure 63: Distribution of graduate attribute scores by year of study. A line of best fit with 95% confidence interval is shown.

6.3.4 Results by form of multiplayer

This question asked whether respondents played multiplayer games, or if they played only single player games. If the former, they were asked if they played local multiplayer (playing with others in the same room) or online multiplayer (playing with others over the Internet), or both. For two of the four measures (Resourcefulness and the SPCCS communication measure), respondents who do not play video games scored best. On the other two measures (I-ADAPT-M and the CAS measure of communication), those who played both local and online multiplayer scored more highly. This summary ignores contradictory answers, as outlined above.

What begins to become apparent here is that there is no significant relationship between existing gameplay habits and graduate attribute scores, further supporting the idea that the significantly improved scores recorded for participants in the experimental study were the result of a combination of factors. It seems plausible that being adept at both online and face-to-face interaction would be beneficial and it is perhaps not surprising that scores for adaptability and communicative adaptability were positively correlated with playing both online and local multiplayer. However, given the one-time, cross-sectional nature of the survey, it is not possible to say that there is a causal relationship between multiplayer gaming and these scores. This must also be borne in mind when considering the generally higher scores for non-players, but it is notable that these relatively high scores may be observed for non-players across all three gaming-related items (multiplayer, cooperative play, and hours played per week).

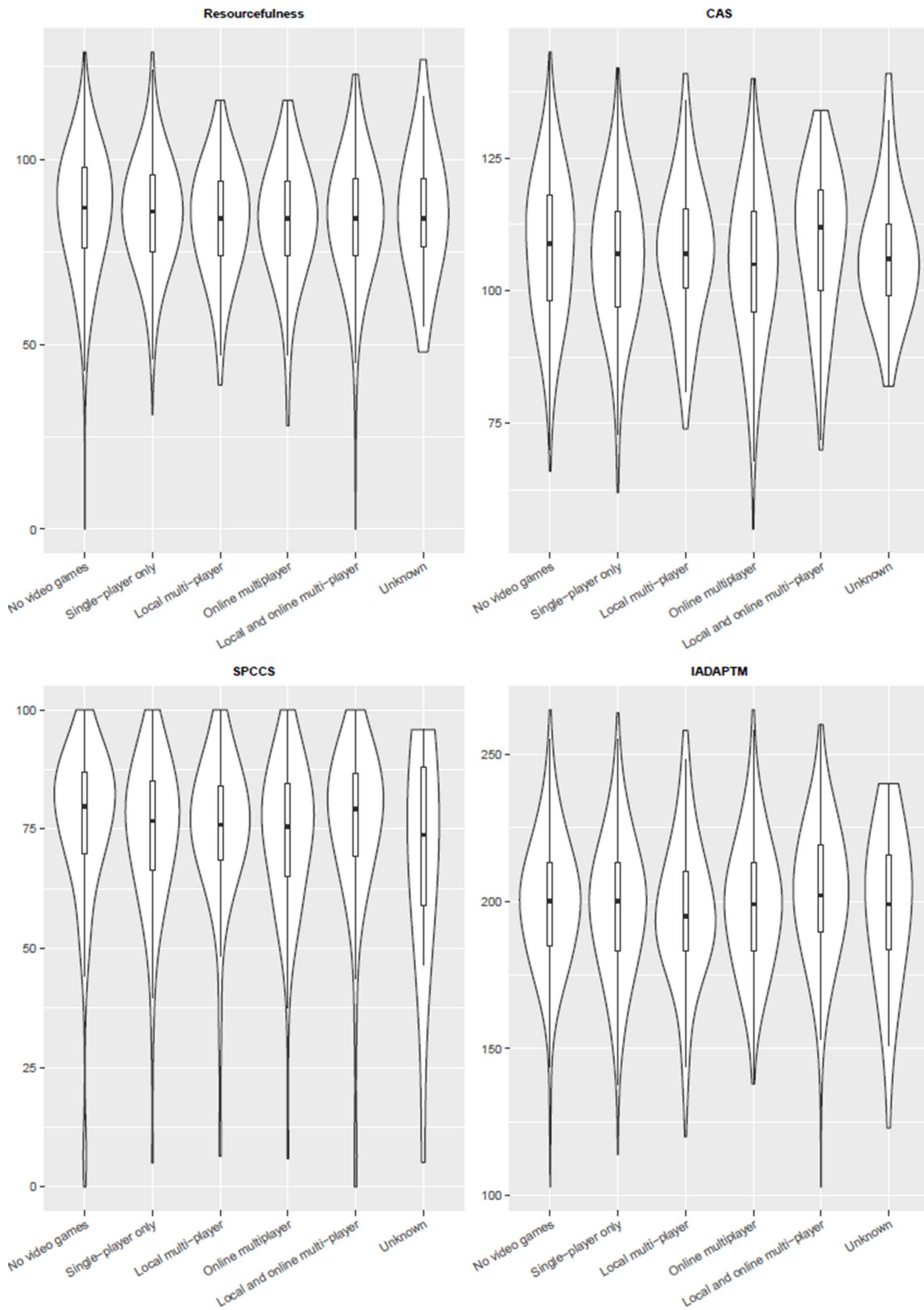


Figure 64: Distribution of four main graduate attribute scores by form of multiplayer. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.5 Results by form of cooperative play

This question asked whether respondents played cooperative games. If so, they were asked if they played cooperative or team-based shooters, of the sort played in the experimental study (e.g. *Team Fortress 2*, *Borderlands 2*), or if they played other games in cooperative mode (e.g. *Portal 2*, *Lara Croft and the Guardian of Light*, *Minecraft*), or both. There is no consistent pattern in how these responses relate to attribute scores, but a number of observations may be made. It is clear that non-players continue to score relatively well in these measures; however, the violin plots for adaptability (I-ADAPT-M) and communication (CAS and SPCCS) exhibit a slight U-shape in the distribution of median scores across categories, with non-players on the left and those players who engage in both types of cooperative play on the right. This suggests that those players who play a more diverse set of games may be more adaptable than those who play, for example, only team-based shooters. The relationship is most pronounced in scores for adaptability where both the mean and the median scores are higher for players in this category than for non-players. Again, this summary ignores contradictory answers, shown as Unknown on the violin plots below.

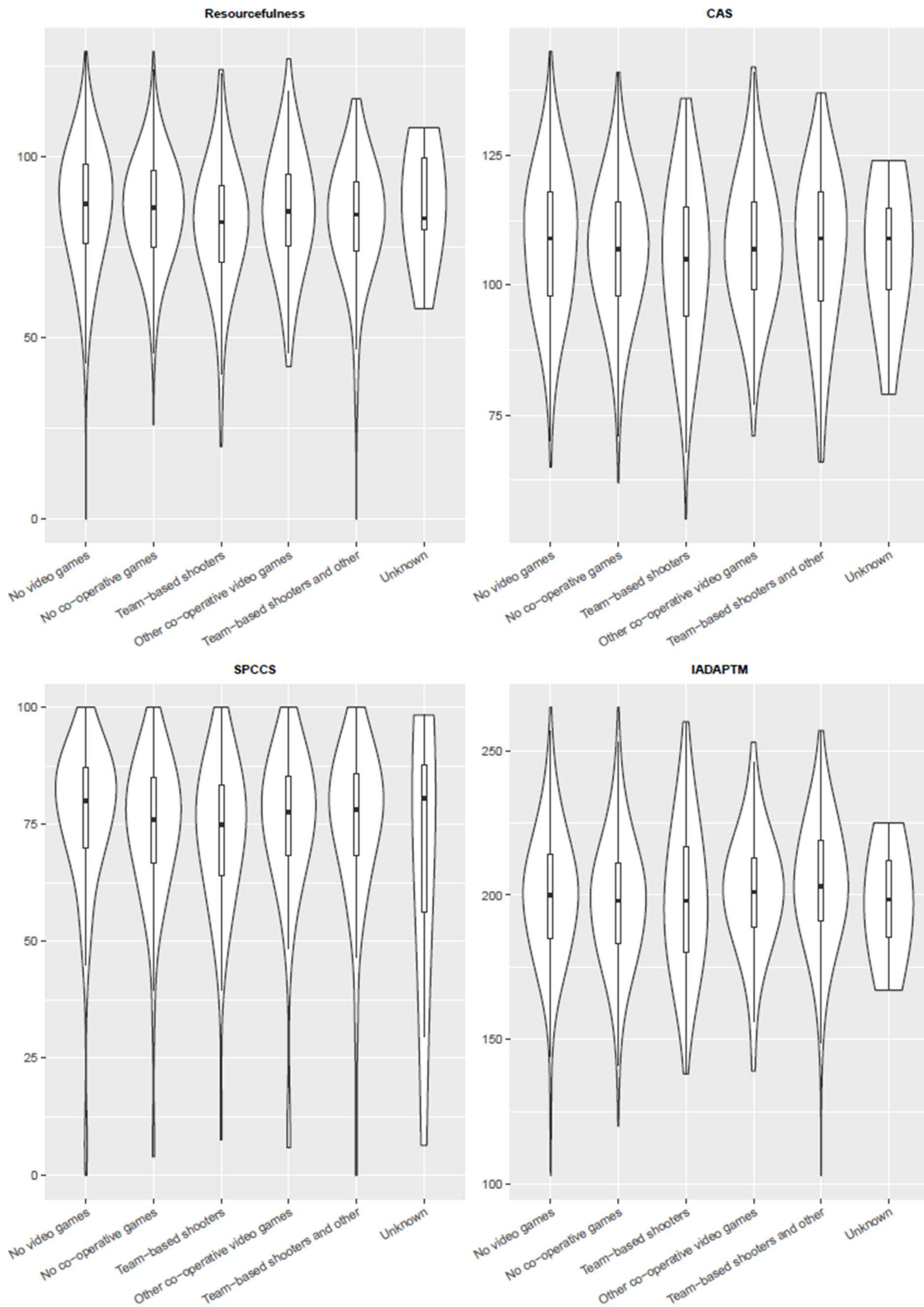


Figure 65: Distribution of four main graduate attribute scores by form of cooperative play. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.6 Results by hours played per week

While non-players again score well here, the most striking feature of these data is that those who play video games for more than eight hours per week score worst across all measures, except for adaptability, where there is no significant difference in mean scores across categories ($p = 0.754$). Thus, moderate and non-players score better than ‘excessive’ players do.

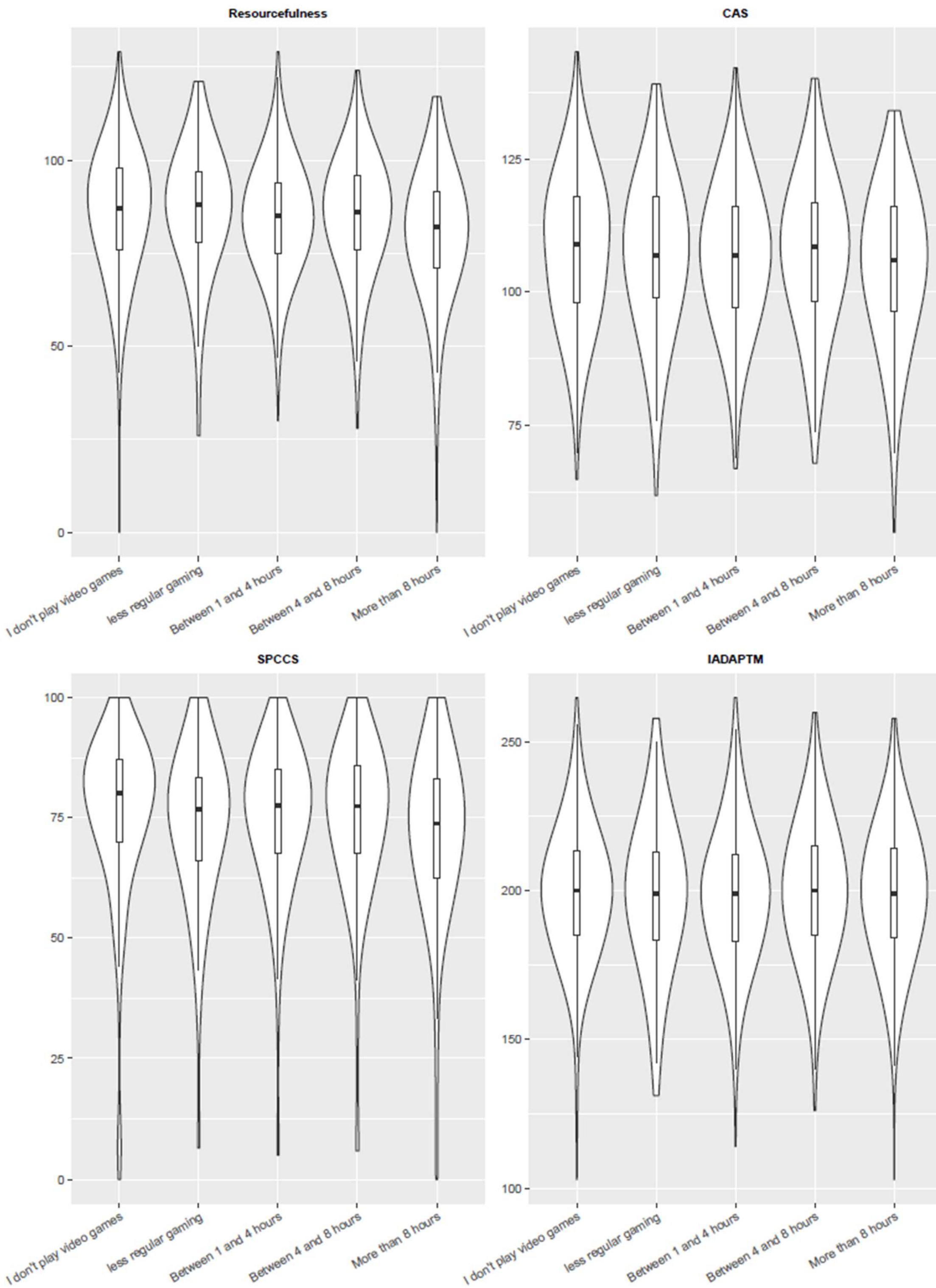


Figure 66: Distribution of four main graduate attribute scores by hours spent playing video games per week. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.7 Results by player vs. non-player

Based on the observation that non-players appeared to score better across most measures, data were collapsed into two categories, player, and non-player. Summary survey data for these two categories is provided in Table 20 below. The table data shows that non-players are disproportionately female (82.9%, against 59% for the overall cohort and the university population). It also highlights that players score less well on all measures of graduate attribute: this difference is real, as indicated by most of the associated p-values but is very small when absolute scores are compared to the standard deviation for each measure. For example, there is a difference of 1.88 between players and non-players for the CAS measure of communication, but the standard deviation in absolute scores for players and non-players is 13.49 and 13.85, respectively.

Table 20: Summary of survey data by player vs. non-player

	Non-players	Players	p
N	753	1351	
Gender (%)			<0.001
Female	624 (82.9)	617 (45.7)	
Male	124 (16.5)	723 (53.5)	
Other	5 (0.7)	11 (0.8)	
Level of study (%)			0.011
Postgraduate Research	117 (15.5)	165 (12.2)	
Postgraduate Taught	119 (15.8)	176 (13.0)	
Undergraduate	517 (68.7)	1010 (74.8)	
Multiplayer (%)			<0.001
No video games	753 (100.0)	0 (0.0)	
Single-player only	0 (0.0)	457 (33.8)	
Local multi-player	0 (0.0)	181 (13.4)	
Online multiplayer	0 (0.0)	430 (31.8)	
Local and online multi-player	0 (0.0)	243 (18.0)	
Unknown	0 (0.0)	40 (3.0)	
Games useful (%)			<0.001
Don't know	326 (43.9)	336 (25.2)	
No	241 (32.5)	165 (12.4)	
Yes	175 (23.6)	830 (62.4)	

Weekly game play (%)			N/A
I don't play video games	748 (100.0)	0 (0.0)	
Less regular gaming	0 (0.0)	115 (8.5)	
Between 1 and 4 hours	0 (0.0)	719 (53.2)	
Between 4 and 8 hours	0 (0.0)	278 (20.6)	
More than 8 hours	0 (0.0)	239 (17.7)	
Cooperative play (%)			<0.001
No video games	753 (100.0)	0 (0.0)	
No cooperative games	0 (0.0)	748 (55.4)	
Team-based shooters	0 (0.0)	221 (16.4)	
Other cooperative video games	0 (0.0)	161 (11.9)	
Team-based shooters and other	0 (0.0)	209 (15.5)	
Unknown	0 (0.0)	12 (0.9)	
Year of study (mean (sd))	2.33 (1.30)	2.28 (1.27)	0.457
Age (mean (sd))	23.45 (6.55)	22.37 (5.32)	<0.001
Attribute measures (mean (sd))			
CAS	108.37 (13.85)	106.49 (13.49)	0.002
SPCCS	76.56 (16.46)	74.19 (16.06)	0.001
Effective Communicators (transferable)	3.93 (0.87)	3.83 (0.86)	0.007
Effective Communicators (personal)	4.00 (0.95)	3.92 (0.94)	0.066
Resourcefulness Scale	85.93 (17.44)	83.93 (15.64)	0.007
Resourcefulness (transferable)	4.05 (0.85)	3.90 (0.86)	<0.001
Resourcefulness (personal)	4.21 (0.84)	4.02 (0.87)	<0.001
I-ADAPT-M	199.35 (22.61)	198.66 (22.69)	0.506
Adaptable (transferable)	3.92 (0.86)	3.86 (0.86)	0.161
Adaptable (personal)	3.88 (0.83)	3.85 (0.84)	0.469

The four main attribute measures are visualised as a set of violin plots, shown in the figure below. These plots highlight the small but observable difference between the two groups on measures of communication (CAS and SPCCS) and resourcefulness. As suggested by the more granular plots, however, adaptability (I-ADAPT-M) is largely unrelated to game play.

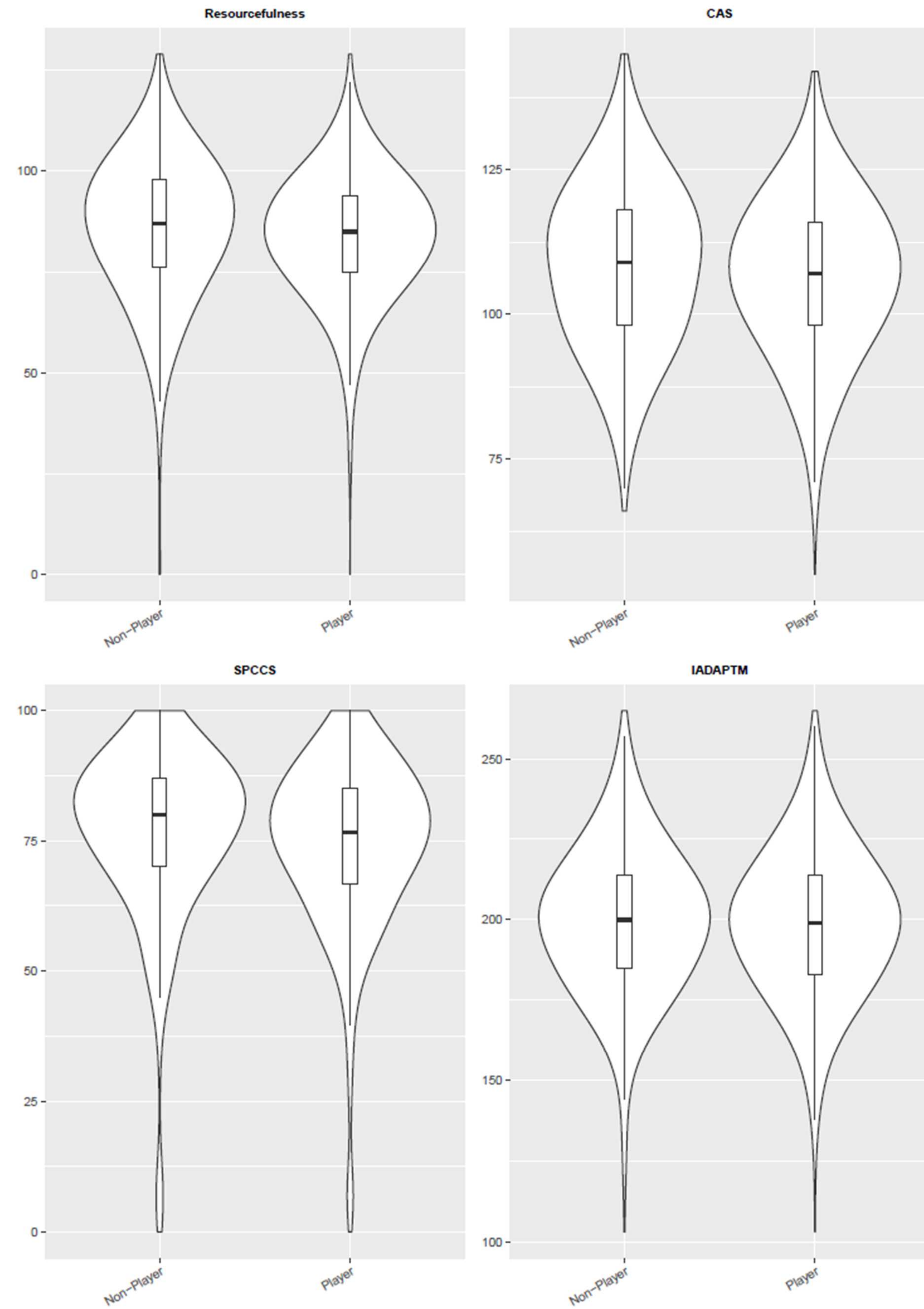


Figure 67: Distribution of four main graduate attribute scores by player versus non-player. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

6.3.9 Results by age

It might be expected that the attributes measured here would generally increase with age. The graphs below show that this is not necessarily the case, with Resourcefulness Scale and CAS communication scores remaining flat when plotted against age, while the other communication measure (SPCCS) and I-ADAPT-M show clear increases with age, as depicted by the line of best fit. However, caution must be exercised when interpreting such increases, or the absence thereof, as the median age for the study was 21 – as would be expected in a university cohort, particularly one that is dominated by undergraduates. As a result, there is very little data for older students and small variations at the upper end of the age range may therefore skew the line of best fit somewhat. As can be seen on the CAS plot below, for example, just a handful of outliers with relatively low communication scores at the upper end of the age range may be responsible for flattening the trajectory of the line of best fit.

As continuous variables, it is more appropriate to examine these data in terms of correlation, as shown in Table 19 above. The Spearman's rank correlation coefficient for the two most positive correlations, SPCCS and I-ADAPT-M, are 0.12 and 0.16, respectively, with p-values of <0.001. This indicates a highly significant but very small positive correlation between age and these attribute measures. Correlation coefficients for the other two measures are negligible (0.0258 for the Resourcefulness Scale and -0.0222 for CAS), which confirms the above observation that there is no obvious relationship between these measures and age, bearing in mind the limitations imposed by a relative lack of data at the upper end of the age range.

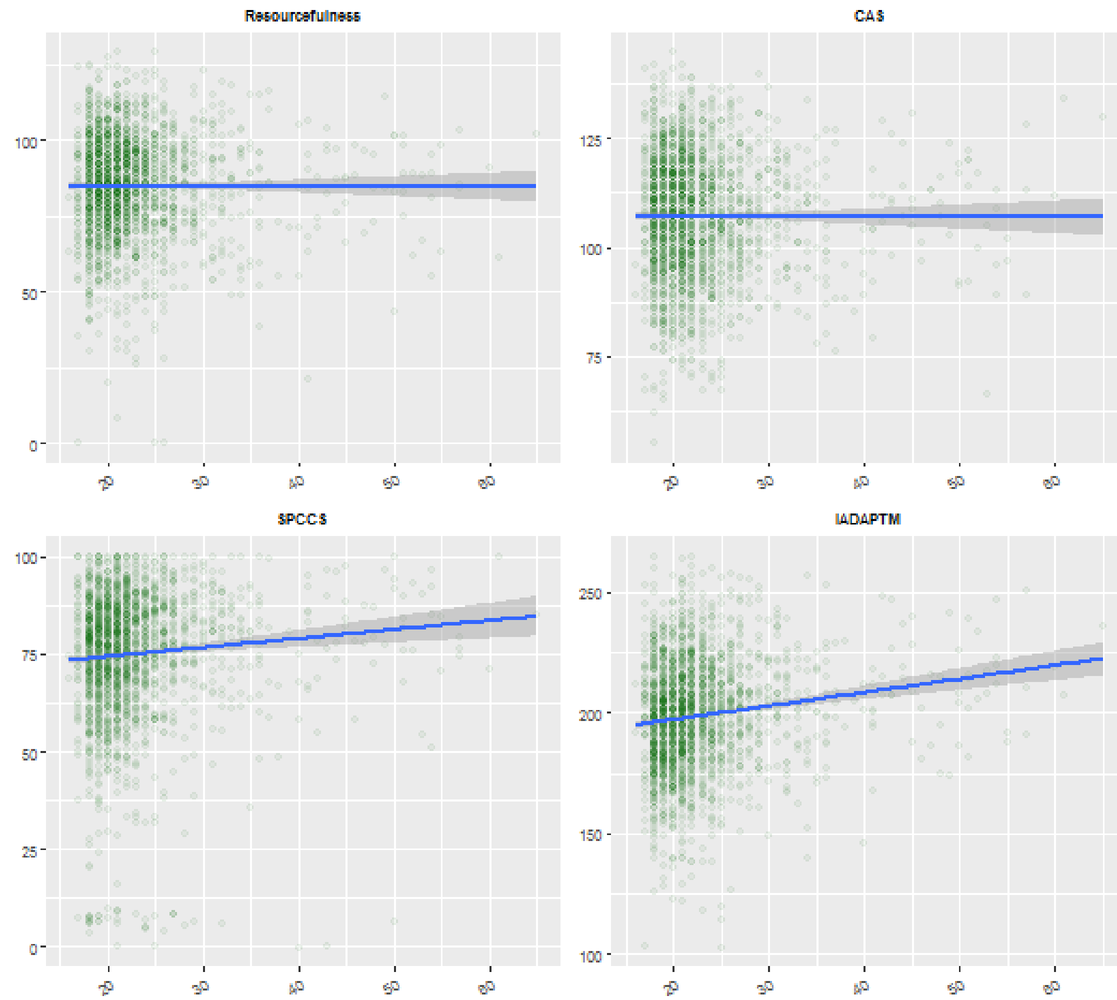


Figure 68: Distribution of graduate attribute scores by age. A line of best fit with 95% confidence interval is shown.

6.3.10 Results by college

The host university is comprised of 52 subject areas, arranged into four colleges (Arts, Medical, Veterinary & Life Sciences, Science & Engineering, and Social Sciences). Respondents here were asked to select their degree subject. This question is complicated by the fact that Scottish undergraduates do not typically finalise their choice of degree until the beginning of their third year, having studied up to three subjects in their first two years. However, most students possess an understanding of their 'main' subject or their intended degree subject, and those on vocational degree programmes, such as Medicine, are not given the option of choosing three subjects when they first matriculate. Examining 52 categories of study is clearly too broad an approach to be useful (subject-level results are included in Appendix E), so subjects were mapped to their respective college for analysis. An 'Other' category was created to accommodate the 4.2% of respondents who stated they were not studying any of the subjects offered by the university.

Mean absolute scores for all measures across all four colleges are shown in Table 21 below, with distribution, median and range shown in the box plots in Figure 69.

Table 21: Mean absolute scores for all graduate attribute measures across all four colleges.

	CAS (mean (sd))	**SPCCS (mean (sd))**	**Resourcefulness (mean(sd))**	**I-ADAPT-M (mean, sd))**
Arts	108.69 (4.52)	74.7 (4.93)	85.18 (3.45)	196.29 (7.6)
Medical, Veterinary and Life Sciences	108.31 (2.48)	77.65 (3.81)	85.06 (5.95)	203.75 (6.92)
Science and Engineering	105.05 (2.4)	73.98 (2.96)	83.1 (2.58)	196.07 (3.25)
Social Sciences	106.35 (1.89)	76.46 (3.42)	84.61 (3.49)	197.95 (6.86)

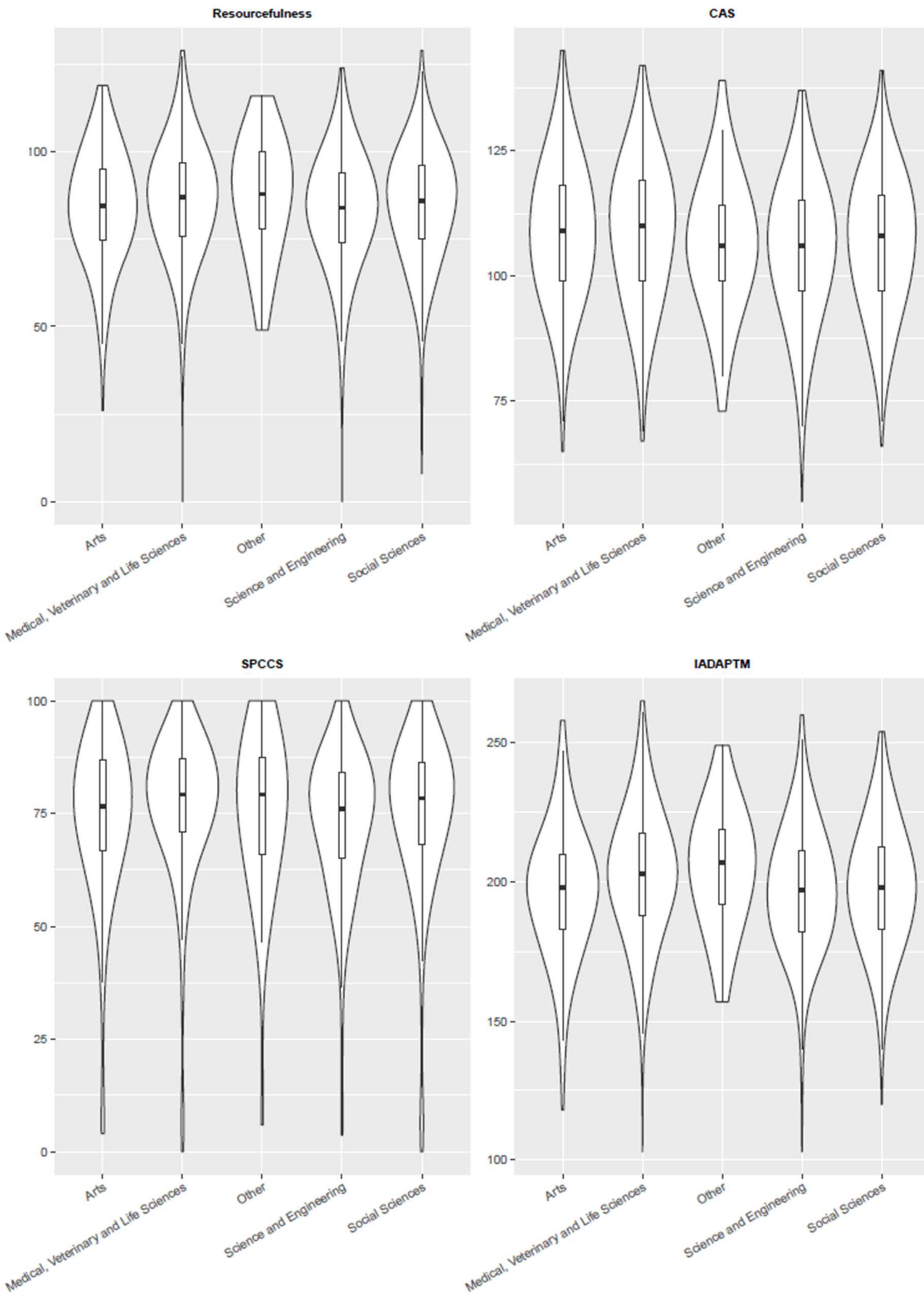


Figure 69: Distribution of graduate attribute scores by college. Box plots show range, interquartile range, and median.

Differences in graduate attribute scores are not pronounced at college level. Despite the logical grouping that a college might imply, there are, in reality, large differences in attribute attainment at subject level. For example, within the College of Arts, which boasts the highest mean CAS score for communication (108.69, SD = 4.52), the Translation Studies subject area has a mean CAS score of 100.2 (SD = 15.09) while French has a mean CAS score of 118.76 (SD = 10.08).

The nature of the 52 subjects is too disparate to allow for deeper analysis within the scope of this work. It may be useful to split subjects by means of assessment employed, such as essays versus lab or numerical work, for example, although such an exercise would require detailed understanding of every subject area and may be considered somewhat arbitrary. However, some general observations may be made. For example, language-based subjects generally score well on communication, as might be expected. Table 22 below shows the ten highest CAS scores by subject. Not only is the table entirely populated by the colleges of Arts and Medical, Veterinary and Life Sciences, it is dominated by subjects that involve the study of language, with five of the ten falling into this category and two more, Scottish Literature and Theatre, Film and Television Studies, closely related.

Table 22: Ten highest Communicative Adaptability Scale (CAS) scores by subject, ordered by mean CAS score.

Subject	College	CAS (mean(sd))
French	Arts	108.21 (13.61)
Hispanic Studies [including: Spanish]	Arts	107.49 (0)
Scottish Literature	Arts	104.06 (13.23)
Dentistry, Dental School	Medical, Veterinary and Life Sciences	109.46 (14.25)
English Language and Linguistics	Arts	108.5 (9.51)
Medicine	Medical, Veterinary and Life Sciences	106.42 (14.24)
Celtic and Gaelic	Arts	111.43 (10.36)
German	Arts	107.99 (12.61)
Health and Wellbeing	Medical, Veterinary and Life Sciences	107.65 (14.46)
Theatre, Film and Television Studies [including: Cultural Policy, Drama, Dramaturgy, Journalism, Media Management, Performance Studies, Playwriting]	Arts	103.74 (12.79)

6.3.11 Results by genre

The challenges associated with video game genre classification are discussed elsewhere and, as might be expected when the boundaries between genres are ill defined and differently understood, there is little of note to report in terms of the relationship between genres of game played and graduate attribute attainment. Figure 70 below shows mean graduate attribute scores by genre and, while it is possible to make some very slight observations – sports game players seem to score marginally higher on the CAS measure of communication; strategy game players are the most adaptable, etc. – these data do not merit further analysis here. Dobrowolski, Hanusz, Sobczyk, Skorko, & Wiatrow (2015) have shown that game genre may be correlated with the development of certain cognitive abilities, such as object tracking and task switching. However, Dobrowolski *et al.*'s study was focused on just two genres – first-person shooters and real-time strategy – and was experimental in nature, rather than observational (as was the was the case with the survey conducted here). This design afforded much greater control over the conditions under examination. Therefore, such a design should be employed if any serious attempt were made to examine the relationship between skills development and video game genre.

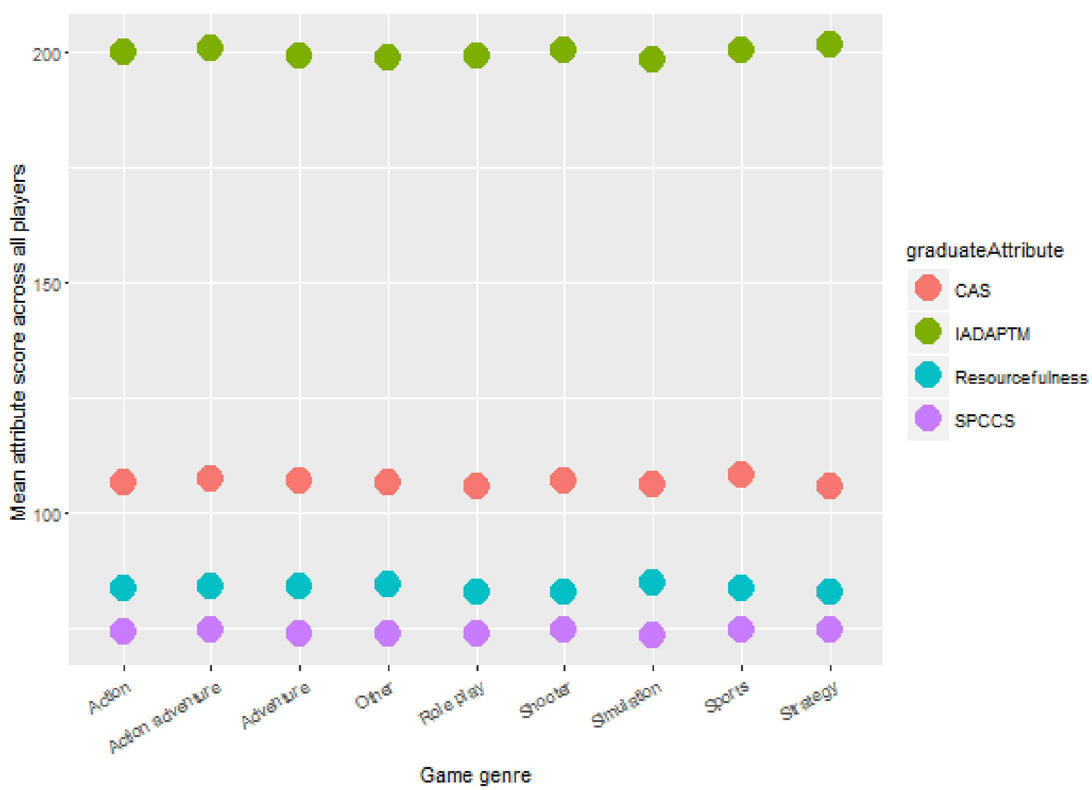


Figure 70: Mean graduate attribute by game genre played.

6.3.12 Undergraduates only

As noted above, the inclusion of postgraduate students in analyses may introduce a degree of undesirable variability, not least because postgraduates may be at university for as short a period as one year or as long as six, and may come to the institution from a range of backgrounds. Therefore, focusing on the typical four-year undergraduate degree, over which graduate attributes are said to develop, might provide more useful insight. Table 23 below summarises categorical variable data for undergraduates only. Table 24 shows the relevant continuous variable, year of study.

Table 13: Summary of categorical survey data (undergraduates only)

		n	Resourcefulness	p	SPCCS	p	CAS	p	I-ADAPT-M	p
Weekly gameplay (mean(sd))	No video games	508	85.51 (17.08)	<0.001	75.61 (17.25)	0.012	108.68 (13.84)	0.003	197.86 (22.78)	0.882
	Moderate (up to 8 hours per week)	761	84.28 (15.83)		73.95 (15.78)		106.84 (13.96)		197.24 (23.60)	
	High (less than 8 hours per week)	174	79.14 (17.00)		71.42 (16.98)		104.75 (14.56)		197.84 (21.87)	
Multiplayer gameplay (mean(sd))	No video games	503	85.44 (17.09)	0.019	75.62 (17.24)	0.033	108.72 (13.75)	0.012	197.74 (22.82)	0.123
	Single-player only	309	84.65 (15.72)		72.59 (15.57)		106.14 (14.10)		195.23 (24.04)	
	Multiplayer	631	82.75 (16.38)		73.92 (16.27)		106.59 (14.17)		198.49 (22.81)	
Cooperative gameplay (mean(sd))	No video games	500	85.24 (17.32)	0.016	75.86 (17.01)	0.024	108.59 (13.98)	0.019	197.70 (23.38)	0.007
	Non-cooperative	511	84.53 (15.33)		73.41 (15.47)		106.91 (13.68)		195.28 (23.14)	
	Cooperative	432	82.24 (16.81)		73.32 (16.97)		106.07 (14.43)		199.99 (22.51)	

Table 14: Summary of continuous survey data (undergraduates only). Correlation coefficients are Spearman's rank correlation coefficient.

	Resourcefulness	p	SPCCS	p	CAS	p	IADAPTM	p
Year of study (correlation coefficient)	0.010	0.693	0.065	0.013	0.041	0.115	0.062	0.016

Drilling down to undergraduate level does not reveal any more striking relationships. The violin plots shown in the figures below indicate once again that non-players tend to score best on graduate attribute measures. However, a U-shape may be observed on several of the plots for multiplayer, indicating that playing multiplayer games is more positively associated with communication and adaptability (see Figure 71) than single player games. Cooperative play is only better than non-cooperative play on SPCCS and I-ADAPT-M scores, although cooperative play is associated with higher scores on adaptability than non-play. It is quite evident that 'high' weekly game play (greater than eight hours per week) is associated with the lowest scores on all four measures, while moderate play (up to eight hours per week) shows a weaker negative correlation.

Correlations between year of study and resourcefulness and the two communication measures are marginally more positive, but adaptability is slightly less so. This slightly more positive correlation is reflected in the lines of best fit for year of study, as shown in Figure 74 below. Only the correlations between undergraduate year of study and the SPCCS and I-ADAPT-M communication measures might be considered significant ($p < 0.05$). Furthermore, collapsing the multiplayer and cooperative play data into broader categories (for example, both types of multiplayer are treated as one) has little or no effect on the outcome. This brief analysis of undergraduate data, therefore, does not indicate a strong correlation between video game play and gradate attribute attainment.

That players who do not play video games generally fare better on attribute measures than those who do is important to consider, not least because the experimental study described here has shown that, under certain conditions, playing games can have a positive effect. It is worth remembering, however, that the direction of causality is by no means evident in these data: there is no evidence that students playing video games on their own time depresses attribute scores. Furthermore, there is evidence of the opposite relationship in the literature, for example, Posso (2016) found that playing online video games was positively correlated with students' academic performance, while use of online social networks was seen to have the reverse effect.

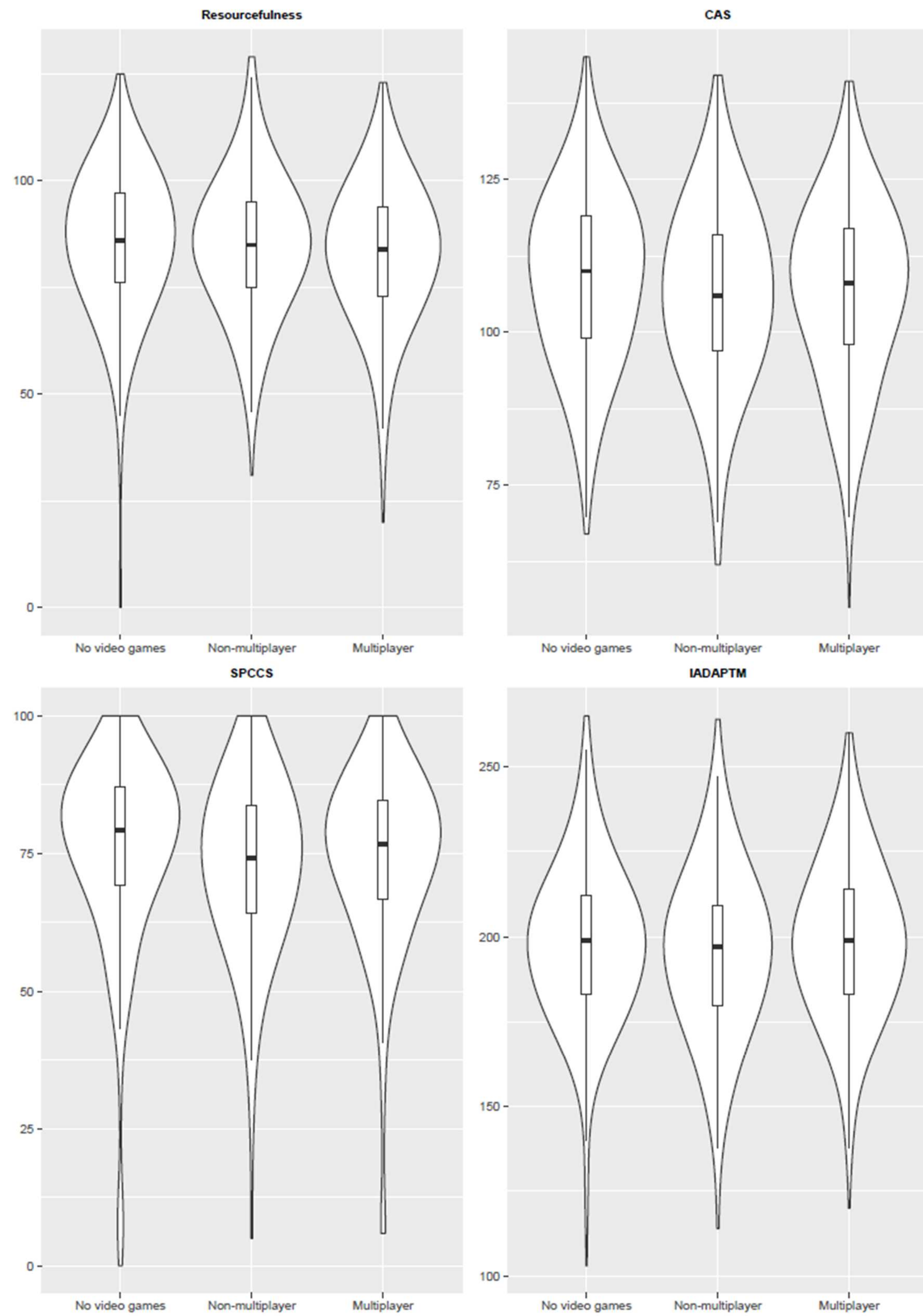


Figure 71: Distribution of undergraduate scores on four main graduate attribute measures by multiplayer play, where 'Non-multiplayer' represents those respondents who do not play multiplayer games and 'Multiplayer' combines both local and online multiplayer. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

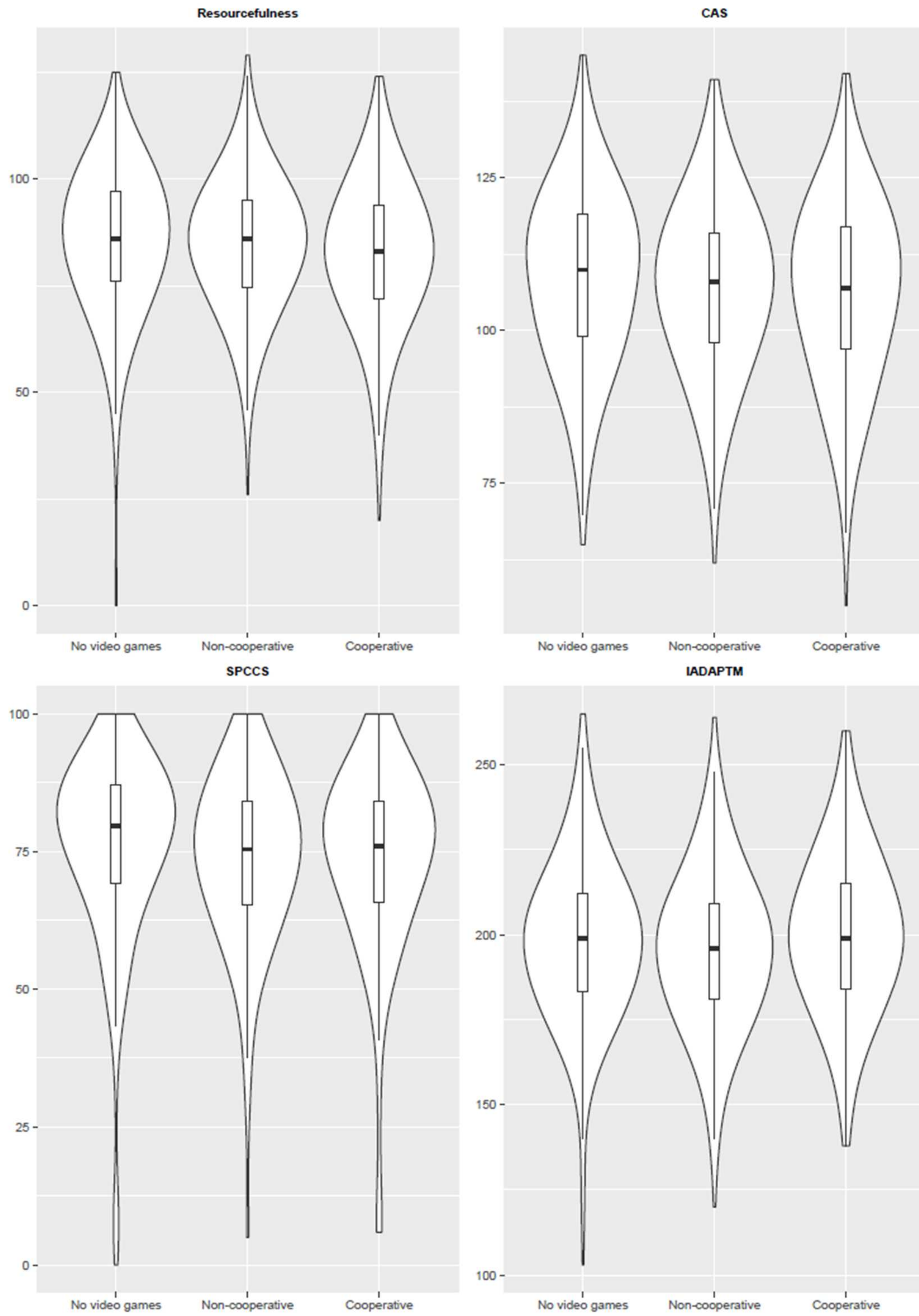


Figure 72: Distribution of undergraduate scores on four main graduate attribute measures by cooperative play, where 'Non-cooperative' represents those respondents who do not play cooperative games and 'Cooperative' combines both categories of cooperative play. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

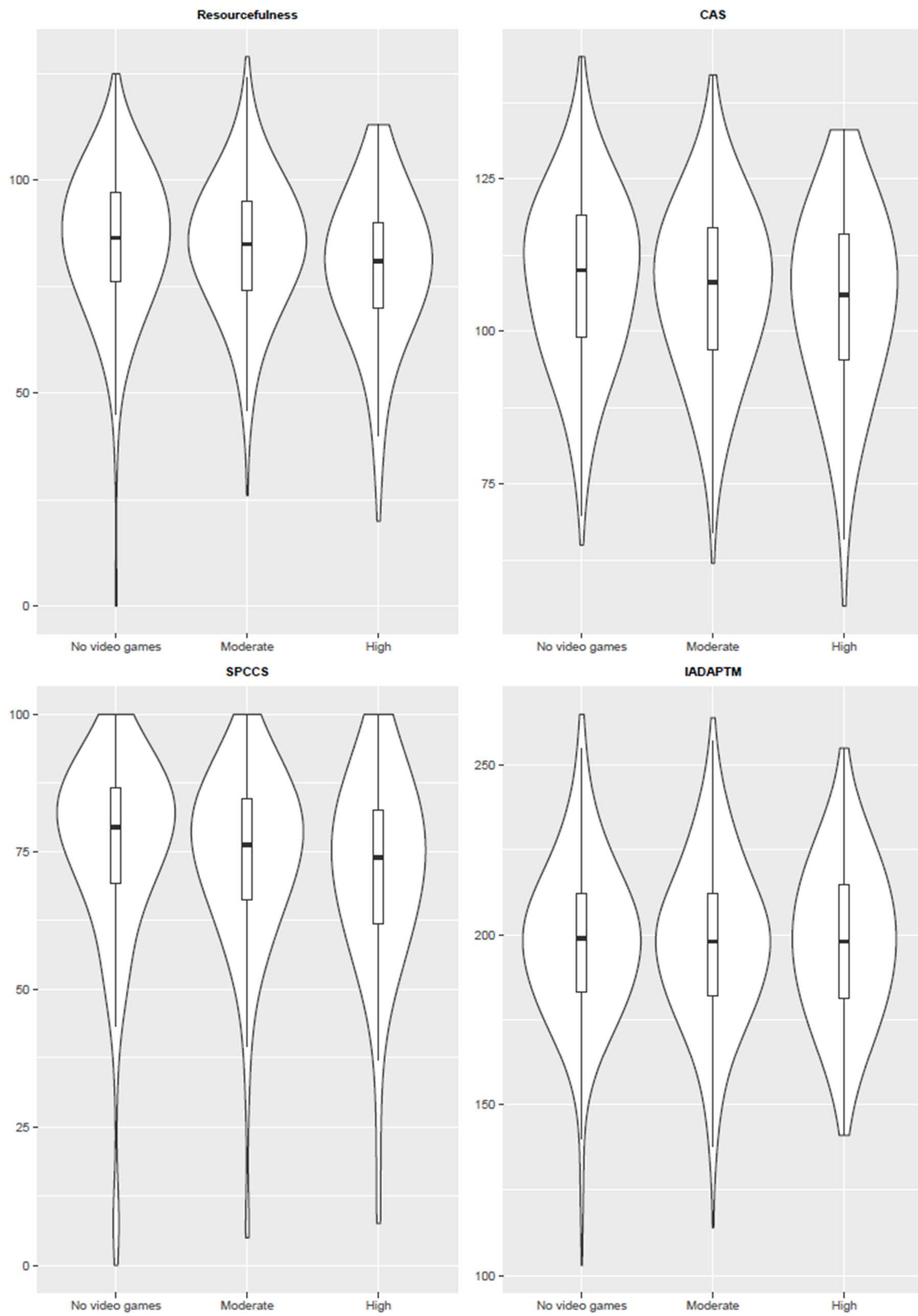


Figure 73: Distribution of undergraduate scores on four main graduate attribute measures by hours spent playing video games per week, where 'Moderate' play combines responses up to eight hours per week and 'High' corresponds to more than eight hours per week. Violin plots represent overall distribution. Box plots show range, interquartile range, and median.

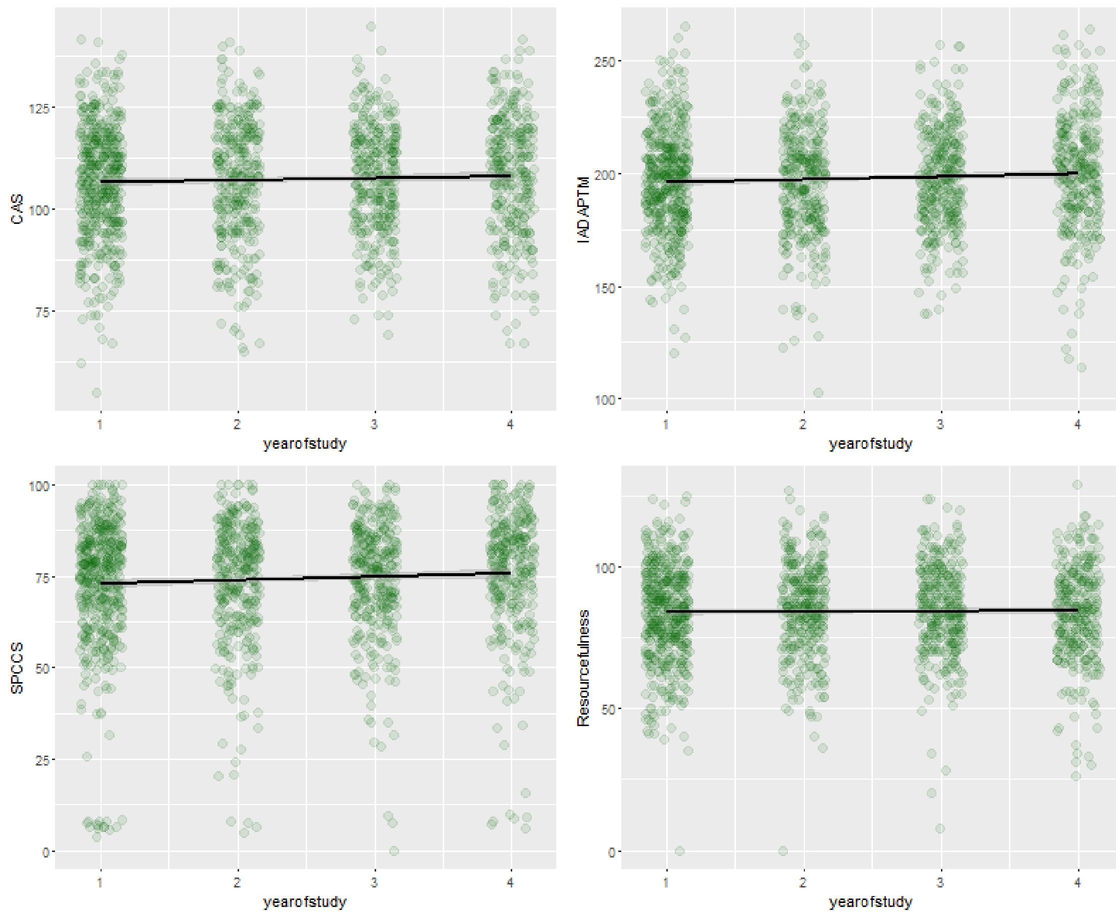


Figure 74: Graduate attribute scores over time by year of study (undergraduates only).

6.4 Qualitative survey results

As described above, a small number of free text questions were included in the survey to gauge student attitudes towards using video games to develop graduate attributes. Table 25 shows the 100 words most commonly used by respondents to describe the useful skills or valuable experience that playing video games might help to develop. The analysis was run using an NVivo word frequency query with the stemmed words option selected, such that those words listed here in the Similar Words column were treated as being synonymous with the word from which they stemmed. In addition to the conjunctions, prepositions, and other less significant words that NVivo already ignores, a number of additional stop words were added for this analysis: 'game', 'video', 'play', 'also', 'way', and 'etc.' An alternative means of visualising these data – a tree map – is presented in Figure 75.

Table 15: 100 words most commonly used by survey respondents to describe the useful skills or valuable experience that playing video games might help to develop. The Weighted Percentage refers to the frequency of the word (including similar words) relative to the total words counted.

Word	Count	Weighted Percentage (%)	Similar Words
problem	343	4.54	problem, problems
solving	319	4.22	solve, solving
thinking	261	3.45	think, thinking
skills	248	3.28	skill, skills
communication	137	1.81	communicate, communicating, communication, communicational, communications, communicative, community
making	128	1.69	make, makes, making
work	121	1.60	work, working
decision	114	1.51	decision, decisions, decisiveness
situations	95	1.26	situation, situational, situations
teams	95	1.26	team, teams
help	92	1.22	help, helped, helpful, helps
quickly	84	1.11	quick, quickly
hand	83	1.10	hand, hands
planning	82	1.09	plan, planning, plans
coordination	78	1.03	coordination
eye	78	1.03	eye, eyes
teamwork	77	1.02	teamwork, teamworking
tasks	75	0.99	task, tasking, tasks
time	70	0.93	time, times, timing
managing	69	0.91	manage, management, managing
stress	64	0.85	stress, stressed, stressful, stressing, stressing'
logical	60	0.79	logic, logical, logically
develop	58	0.77	develop, developed, developing, development, develops
learning	53	0.70	learn, learned, learning, learns

adaptability	52	0.69	adapt, adaptability, adaptation, adapting, adaption, adaptive, adaptiveness
reflexes	52	0.69	reflex, reflexes
differently	51	0.68	difference, different, differently, differing
ability	50	0.66	abilities, ability
people	49	0.65	people
reaction	49	0.65	reaction, reactions
multitasking	48	0.64	multitask, multitasking
improve	47	0.62	improve, improved, improvement, improves, improving
creativity	44	0.58	creative, creatively, creativeness, creativity
critical	43	0.57	critical, critically, criticism, criticizing
strategy	42	0.56	strategies, strategy
patience	42	0.56	patience
perseverance	39	0.52	perseverance, perseverence
concentration	38	0.50	concentrate, concentration
strategic	38	0.50	strategic, strategical, strategically, strategizing
new	36	0.48	new
dealing	35	0.46	deal, dealing
focus	35	0.46	focus, focused, focusing
multi	35	0.46	multi
others	33	0.44	others
pressure	33	0.44	pressure, pressured, pressures
things	30	0.40	thing, things
experiences	29	0.38	experience, experiences, experimenting
social	29	0.38	social, socialization, socializing, socially
life	27	0.36	life
calm	27	0.36	calm, calming, calmness
cooperation	27	0.36	cooperate, cooperating, cooperation, cooperative, cooperatively
many	24	0.32	many
fast	23	0.30	fast

response	23	0.30	response, responses, responsibility, responsiveness
used	23	0.30	use, used, useful, uses, using
language	22	0.29	language, languages
ordination	22	0.29	ordination
motor	22	0.29	motor, motoric
keeping	21	0.28	keep, keeping, keeps
knowledge	21	0.28	knowledge
organisation	20	0.26	organisation, organisational, organise, organised, organising
changing	20	0.26	change, changes, changing
goal	20	0.26	goal, goals
may	20	0.26	may
awareness	19	0.25	aware, awareness
better	19	0.25	better
real	19	0.25	real
resources	19	0.25	resource, resourcefulness, resources
well	19	0.25	well
effectively	19	0.25	effect, effective, effectively, effectiveness, effects
analytical	18	0.24	analytical
provide	18	0.24	provide, provides, providing
dexterity	17	0.23	dexterity
like	17	0.23	like, likely
able	16	0.21	able
achieving	16	0.21	achievable, achieve, achieved, achievement, achieving
actions	16	0.21	action, actions
often	16	0.21	often
one	16	0.21	one, ones
personal	15	0.20	person, personal, personality, personally
possibly	15	0.20	possibilities, possible, possibly

ahead	15	0.20	ahead
building	15	0.20	build, building
challenges	15	0.20	challenge, challenged, challenges, challenging
friends	15	0.20	friendly, friends
good	15	0.20	good
interactions	15	0.20	interact, interacting, interaction, interactions, interactivity
looking	15	0.20	look, looking
multiplayer	15	0.20	multiplayer
relax	15	0.20	relax, relaxation, relaxing
determination	14	0.19	determination, determine, determining
attention	14	0.19	attention
completing	14	0.19	complete, completed, completely, completing
confidence	14	0.19	confidence, confident
give	14	0.19	give, gives, giving
imagination	14	0.19	imagination, imaginative, imagining
player	14	0.19	player, players
require	14	0.19	require, required, requires
solutions	14	0.19	solution, solutions
strangers	14	0.19	strangers

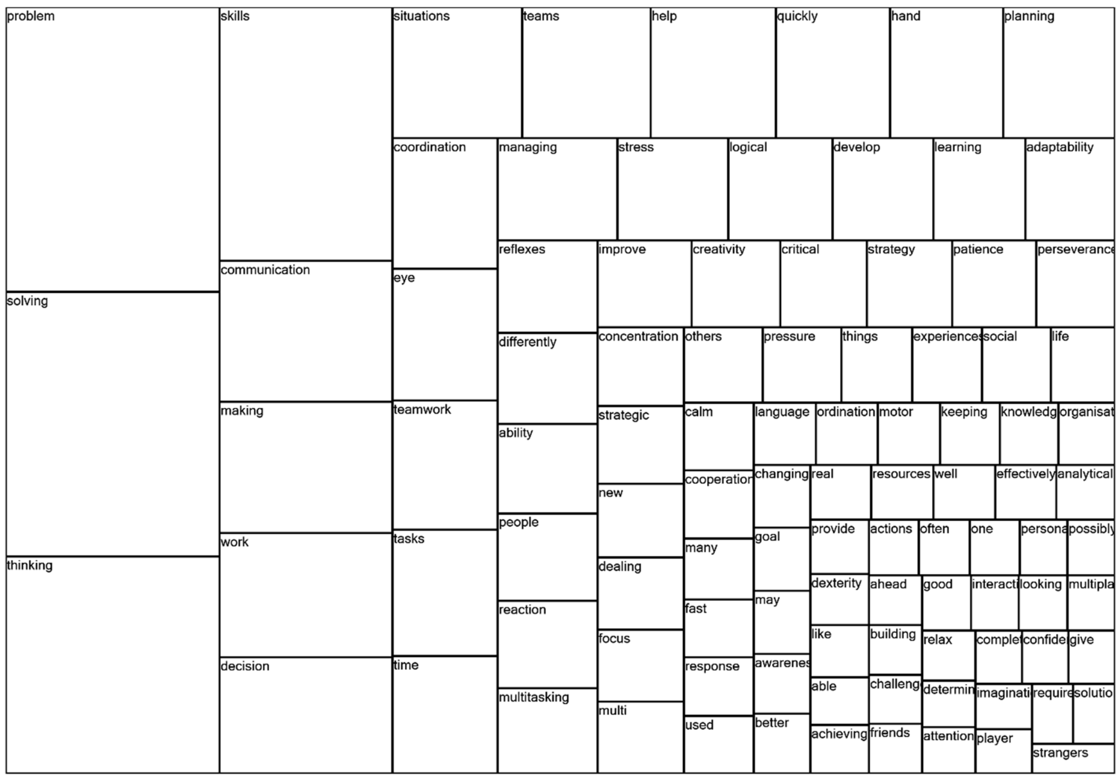


Figure 75: Tree map depicting the 100 words most commonly used by survey respondents to describe the skills or experience that playing video games might help to develop.

While the query operates at the word level, meaning key phrases such as 'critical thinking' are not detected, these are easily and somewhat reliably identified by examining the data. There is little doubt that 'problem solving' is the skill most widely perceived by students as being developed by playing video games. Problem solving was coded as an aspect of the Investigative attribute here, but was also mentioned in relation to critical thinking. Indeed, 'thinking' of some kind was the third most commonly cited skill. Looking at the data in more detail, the word 'think' was occasionally used in a sentence ("I think…") and therefore not relevant here. However, the most commonly used forms of thinking referred to by participants included 'strategic thinking', 'critical thinking', 'logical thinking', 'quick (or fast) thinking', and 'lateral thinking'. Phrases such as 'thinking outside of the box' and other terms that imply 'different ways of thinking' were also used.

'Communication' was also mentioned with considerable frequency (although not, as was first assumed, typically in conjunction with the similarly abundant 'skills'). Broadly speaking, the next most popular skills were variations on 'team work' ('cooperation' also makes the list) and 'decision making', then versions of 'planning' and 'managing', typically of 'time' or 'tasks'. The belief that games help improve motor skills such as hand-eye coordination was also popular. Less often cited words that might still merit attention include: 'adaptability', one of the graduate attributes under consideration here; 'creativity', which might be related to the portion of the Independent and Critical Thinkers definition that calls for creative solutions to problems; and, the related notions of 'perseverance', 'patience', and 'concentration', which directly contradicts the popular notion that video games – and digital media more generally – are damaging attention spans (Watson, 2015).

These data must be considered in terms of what they represent – the *beliefs* of a large cohort of university students. However, it is notable that skills such as problem solving, decision-making and various forms of thinking are thought to be associated with playing video games. On reflection, there is an issue with the survey data that relates to communication (and to adaptability). This more general question about useful skills and experience was positioned towards the end of the survey, after respondents had completed the instruments associated with communication, adaptability, and resourcefulness. Therefore, the prevalence of communication, in particular, may be partially ascribed to the possibility that respondents were led by the nature of preceding questions. Conversely, the prevalence of unsolicited responses relating to problem solving and critical thinking, not addressed by the preceding questions, are all the more striking.

Table 26 shows the 100 words most commonly used to answer the question of what type of video game might develop useful skills or provide useful experience. The same list of stop words as that applied to the previous question was used here, but it is clear that the question ("what sort of games?") has been interpreted in a range of ways, eliciting responses that touch on game genres (e.g. RPG), specific game or franchise titles (*Minecraft*, *FIFA*), and even the skills required by the games (problem solving, communication). This range of interpretations, coupled again with the fact that analysis is conducted at word level and cannot identify multi-word game titles, makes interpretation less straightforward. However, a number of useful observations may still be made.

While strategy games or games involving strategy top the list, most of the main genres of video game are represented in the top ten positions. The picture becomes more complicated on further inspection of the list – NVivo is clearly not capable of detecting such domain-specific synonyms such as RTS (Real-Time Strategy) and strategy, or FPS (First-Person Shooter) and shooters, and game genres are notoriously difficult to pin down (see Wolf's 2001 attempt at distilling the medium down to a mere 42 genres). A game one player describes as an 'action' game may look like a 'shooter' to another and others still may privilege elements of strategy in a multiplayer shooter. MOBA (Multiplayer Online Battle Arena) games might be considered an action-based sub-genre of strategy games and, while the acronym only just makes the top 20 in this list, references to key MOBA titles (*DOTA* and *League of Legends*) feature elsewhere in the list. Multiplayer in itself is not a clearly delineated genre, but it is interesting to note that this game feature places so prominently here, underlining the importance placed on communication and teamwork in the previous list. So, while respondents can see value in a variety game genres, multiplayer functionality may underpin many of these responses: for example, shooters that rely upon their multiplayer modes for continued popularity are mentioned throughout the data, including *Call of Duty*, *Halo*, *Battlefield*, and *Overwatch*. It may also be noted that the *Portal* series is the most popularly cited game or franchise, echoing the overwhelmingly positive response to *Portal 2* in the qualitative interviews that followed the main experimental study. The significance of puzzles in the data also recalls Savery & Duffy's (1995) description of constructivist learning, which was underpinned by the idea that "cognitive conflict or puzzlement is the stimulus for learning" – an intuition that is apparently shared with survey respondents here. Finally, while responses that relate to the skill required to play a game may appear to muddy the waters somewhat, game genre classification based on the skills required to succeed is almost exactly what Egenfeldt-Nielsen, Smith, & Tosca (2008, pp. 40-44) proposed. This observation is not particularly helpful in terms of untangling these data, but the fact that this approach to defining 'sorts' of games has been taken by game scholars may illuminate the thinking behind respondents' interpretation of this question. It may also lend further credence to the approach taken by Egenfeldt-Nielsen *et al.* if this is a natural means by which players classify the games they play.

Table 16: 100 words most commonly used by survey respondents to describe the type of video game might develop useful skills or provide useful experience. The Weighted Percentage refers to the frequency of the word (including similar words). The Weighted Percentage refers to the frequency of the word (including similar words) relative to the total words counted.

Word	Count	Weighted Percentage (%)	Similar Words
strategy	203	4.20	strategies, strategy, strategy'

puzzles	184	3.80	puzzle, puzzles
action	105	2.17	action, actions
adventure	87	1.80	adventure, adventures
multiplayer	82	1.70	multiplayer, multiplayers
shooters	68	1.41	shooter, shooters
teams	67	1.39	team, teams
RPG	66	1.36	rpg
FPS	62	1.28	fps
solving	53	1.10	solve, solved, solving
skills	52	1.08	skill, skills
simulation	51	1.05	simulation, simulations, simulator, simulators
based	50	1.03	based
problem	49	1.01	problem, problems
like	45	0.93	like, likely
RPGs	44	0.91	rpgs
require	41	0.85	require, required, requirement, requires, requiring
MOBAs	38	0.79	moba, mobas
online	38	0.79	online
role	37	0.76	role, roles
portal	36	0.74	portal
help	36	0.74	help, helped, helpful, helps
thinking	35	0.72	think, thinking
time	32	0.66	time, timed, times
player	26	0.54	player, players
RTS	26	0.54	rts
sports	25	0.52	sport, sporting, sports
fast	24	0.50	fast
logic	24	0.50	logic, logical, logically
paced	24	0.50	pace, paced
strategic	24	0.50	strategic, strategical, strategically

develop	23	0.48	develop, developed, developing, development, develops
communication	23	0.48	communicate, communication, communications, communicative
different	23	0.48	different, differently
platform	22	0.45	platform, platformer, platformers, platforming, platforms
story	21	0.43	stories, story
call	20	0.41	call, called
decision	20	0.41	decision, decisions
ones	20	0.41	one, ones
cooperative	19	0.39	cooperate, cooperation, cooperative
duty	18	0.37	duty
minecraft	18	0.37	minecraft
person	18	0.37	person, personal, personally
making	18	0.37	make, making
first	17	0.35	first
well	17	0.35	well
competitive	16	0.33	competitive, competitively
know	16	0.33	know, knowing
lot	16	0.33	lot, lots
shoot	16	0.33	shoot, shooting
situations	16	0.33	situation, situational, situations
types	16	0.33	type, types
work	16	0.33	work, working
world	16	0.33	world
DOTA	15	0.31	dota
MMORPG	15	0.31	mmorpg, mmorpgs
point	15	0.31	point
sims	15	0.31	sim, sims
teamwork	15	0.31	teamwork
kinds	15	0.31	kind, kinds

involve	14	0.29	involve, involves, involving
get	14	0.29	get, getting
hand	14	0.29	hand
improve	14	0.29	improve, improving
life	14	0.29	life
manager	14	0.29	manage, management, manager, managing
planning	14	0.29	plan, planning, plans
quick	14	0.29	quick, quickly
racing	14	0.29	racing
real	14	0.29	real
especially	13	0.27	especially
example	13	0.27	example
war	13	0.27	war, wars
FIFA	12	0.25	fifa
league	12	0.25	league
legends	12	0.25	legend, legends
levels	12	0.25	level, leveling, levels
many	12	0.25	many
overwatch	12	0.25	overwatch
useful	12	0.25	use, used, useful, uses, using
effect	11	0.23	effect, effectively, effects
challenging	11	0.23	challenge, challenges, challenging
click	11	0.23	click
coordination	11	0.23	coordinate, coordination
experience	11	0.23	experience, experiments
need	11	0.23	need, needed, needs
operative	11	0.23	operation, operative
series	11	0.23	series
age	10	0.21	age, ages
anything	10	0.21	anything
good	10	0.21	good
halo	10	0.21	halo

particularly	10	0.21	particular, particularly
something	10	0.21	something
sort	10	0.21	sort, sorts
tactical	10	0.21	tactical, tactics
task	10	0.21	task, tasks
battlefield	9	0.19	battlefield
elements	9	0.19	element, elements
even	9	0.19	even

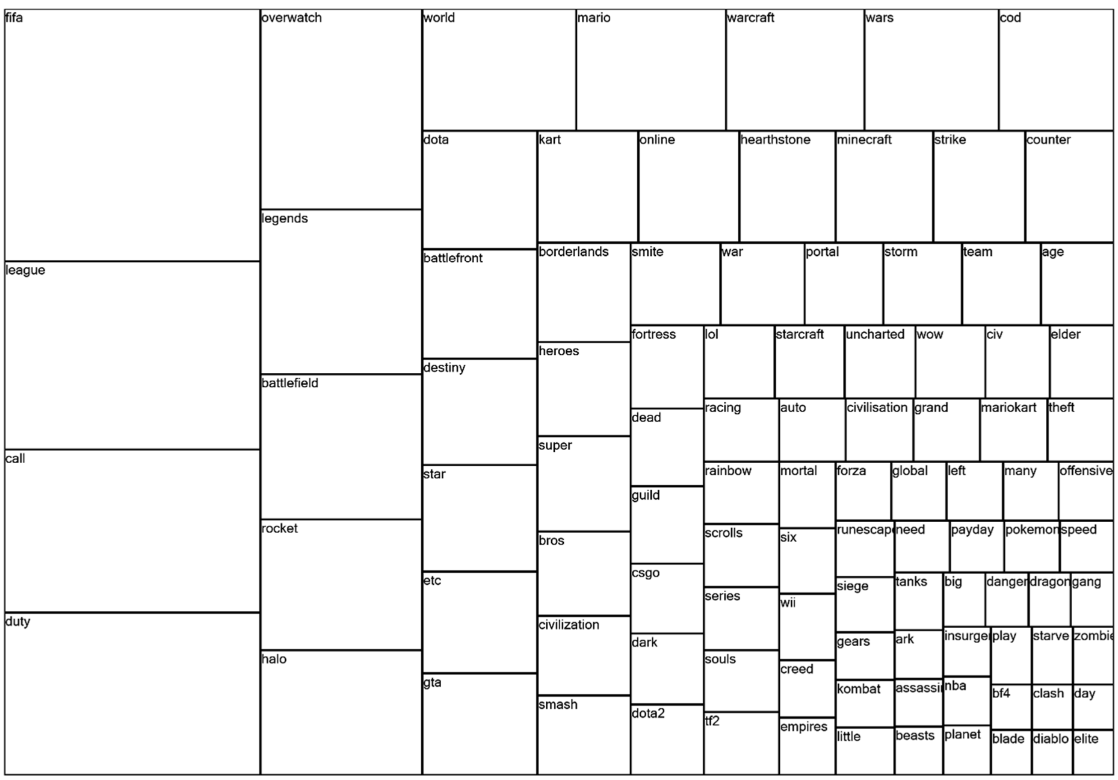


Figure 76: Tree map depicting the multiplayer games most commonly played by survey respondents.

7. Conclusions

7.1 Limitations of the study

7.1.1 Researcher participation

While the issue may initially appear trivial, it may be noted that the need for the researcher often to play along with participants in order to provide a collaborator or competitor resulted in the researcher becoming increasingly weary of the games. This effect was greatest where games featured a narrative structure or level-by-level progression (for example, the opening hours of *Borderlands 2*, as well written as they are, are not intended to be experienced numerous times in quick succession by any individual). Games featuring more emergent gameplay, such as *Minecraft* or *Warcraft III*, proved rather less arduous. There are also potential issues associated with having a known member of staff play along with students: tacit approval of the activity may alter perceptions of its usefulness, for example. Further, it is conceivable that having a single researcher fill this role may have slightly altered the participants' experience, primarily because their co-op partner was intimately familiar with the puzzles and other challenges to be faced. A more subtle effect may have arisen from the relative lack of enthusiasm displayed by the researcher on their *n*th encounter with a given level or narrative beat – this despite the best efforts of the researcher to mask any weariness. The quality of the cooperative experience offered by a video game is inextricably linked with the qualities of the co-operator or co-operators. Such qualities extend beyond mere gameplay competence (although this clearly has an impact – see the discussion of participant interviews above, wherein participants comment on their relative gameplay skill) and most likely include factors which may diminish the shared sense of excitement, surprise, or achievement that relates to cooperative play. Once the researcher has seen everything the game at hand has to offer – on multiple occasions over a short space of time – it is less likely that they will share in the excitement experienced by a newer player, which might dampen somewhat the latter's enjoyment.

7.1.2 Research participation effects

Participants were also aware that they were being measured by means of the online tests, and observed – however informally – by the researcher in the room. As such, the Hawthorne Effect (French, 1953) must be considered. The Hawthorne Effect, particularly where educational interventions are concerned, has been dismissed by some (Rice, 1982). Deslauriers *et al.*, 2011 offer a refutation of the phenomenon, although this relies, in part, on Bauernfeind & Olson (1973), which seems to imply that not being able produce an effect serves as evidence for its non-existence. However, there is little doubt that the atypical circumstances under which the games were played, and their effects measured, could have had some subtle impact, not least due to variations in how the participants interpreted the situation (Draper, 2016). Participants here interpreted their involvement in the study in different ways, as alluded to in the interview data (for example, a small number of participants referred to the experiment as being part of a PhD). In their review of 19 previous studies that might have been susceptible to research participation effects, McCambridge, Witton, & Elbourne (2014), concluded that such effects do exist but such is the range of associated mechanisms and outcomes, their exact nature and magnitude remain largely unknown.

Demand characteristics, or the "good subject effect" (Nichols & Maner, 2008), are closely related to social desirability effects, wherein the participant seeks to provide a response that is pleasing or beneficial to the researcher. In terms of this study, it is thought that participant interviews are most susceptible to this kind of effect. At the end of the eight-week experiment, participants have a very good idea what the researcher is looking for, and may be aware that the completion of the researcher's PhD relies upon this work (see Participant F's comments when discussing responsibility). On the other hand, the quantitative data collected by means of online surveys would be much more difficult for a participant intent on being a 'good subject' to manipulate. In order to produce a 'good' effect in the main experimental study, for example, a participant would be required to recall how they had responded to many dozens of multiple-choice questions two months prior and adjust their post-test responses accordingly. For the large cross-sectional survey, which captured only a snapshot of gaming habits and graduate attribute attainment, a would-be 'good subject' would be unfamiliar with the study or the researcher and have little inkling as to the outcome that might be considered favourable. Furthermore, the effort required to provide spurious answers (for example, significantly downplaying estimated time spent playing video games while achieving a 'good' score on all measures) would be significant, and again require knowledge of the outcome apparently desired by the researcher. Other forms of social desirability effect could possibly be at work here, however, if respondents perceived it desirable or 'cool' to identify as a gamer (or not), for example.

Response fatigue has been shown to "cause measurement error and misclassification problems in survey research" (Egleston, Miller, & Meropol, 2011) and this effect was certainly evident in the pilot project where participants were observed as they completed the post-test questionnaire (see discussion of participants' reaction to the Ennis-Weir test). It is difficult to gauge such effects on the online surveys conducted as part of the main experimental study and the large survey that followed. The repeated testing of the experimental study would probably have exacerbated response fatigue in an already-lengthy survey. With these effects in mind, the large cross-sectional survey was kept as short as possible, eschewing the less pertinent self-esteem and self-efficacy instruments in favour of a tighter focus on the measures that related directly to graduate attributes. On reflection, these measures – and those associated with the Big Five personality traits – could have been omitted from the study as a whole. They have added little to the analysis, while potentially over-burdening the participants, and perhaps even raising suspicions of 'fishing' for relationships that were not defined *a priori*.

In retrospect, perhaps the most problematic aspect of the experiment design was the inclusion of repeated testing after each game was played (nominally on a weekly basis, but depending on exactly when participants finished playing each game for the required duration). Aside from issues of response fatigue, the game-by-game data collected are not straightforwardly analysed and it is apparent that surveys were completed in a manner (for example, two in one sitting) that renders game-by-game analysis meaningless. The main methodological concern, however, is that the intervention and control groups were not treated in an identical manner. The control group completed tests twice, in week one and week eight, while the intervention group completed the same tests on a total of eight occasions. Therefore, it may be argued that the intervention group had more 'practice' in completing the tests, which may, in turn have had a positive influence on their scores. The counter-argument here is that there is little to be gained from multiple exposures to the test, not least because there are no 'correct' answers as such (although it is generally quite clear how to respond in a manner that might be considered favourable, even on a respondent's first attempt) and participants' scores were not revealed at any stage. Therefore, it was impossible for a participant in the intervention group to assess how their answers influenced their overall score, such that they might adapt their answers to improve their performance (the discussion of the "good subject effect" is also relevant). The "testing effect" wherein repeated testing is shown to improve recall of learned material (Roediger III & Butler, 2011), is not applicable here.

7.1.3 Factors not considered in study design

While the demographic information collected at the beginning of the study was thought sufficient, and is complete enough to account for important variables such as gender and year of study, it might have been useful to collect data on participants' previous study and work experience. The randomised nature of the study addresses concerns about the potential effects that variations in such experience might have – a student who has previously attended university or college, or been employed for any substantial period would, presumably, possess more finely-honed graduate or work-related skills – but it raises questions about the impact of the game-playing intervention on these participants. Could gains in attribute attainment as a result of the game-playing invention be tempered by previous exposure to opportunities for their development, for example? Similarly, it may have been useful to ask participants if they have previously taken part, or currently take part, in team-based sports that arguably share many of the characteristics of the games played here.

Less significant factors might include participants' varying PC gaming literacy, that is, an understanding of (and familiarity with) conventions such as the use of the WASD keys for movement and the mouse for looking around in 3D games. Might participants unfamiliar with such conventions be forced to exercise their adaptability and thus gain more from the experience? Or, conversely, might a lack of such literacy act as a barrier to attribute development? The randomised nature of the study controls for variability in gaming experience between the control and intervention groups, at least. Furthermore, studies by Kebritchi, Hirumi, & Bai (2010) and Miller & Robertson (2011) found that prior experience with computers was not an important factor in their game-based interventions.

It is also arguable that the inclusion of an entirely passive control group provided an insufficient means of addressing factors associated with assessing the strength of the game-based intervention. As Boot, Simons, Stothart, & Stutts (2013) note:

> *To draw causal conclusions about the efficacy of a psychological intervention, researchers must compare the treatment condition with a control group that accounts for improvements caused by factors other than the treatment.*

Agreeing that "researchers need to compare any game/treatment condition with a similarly-active control group that has the same expectations of improvement as the experimental group", Shute *et al.* (2015), for example, used another video game, *Luminosity*, as the active control condition, while *Portal 2* was used in the intervention.

7.1.4 Ecological validity

The experiment was designed with ecological validity in mind, but even the more relaxed, drop-in structure of the lab-based game play is not a wholly accurate reflection of how games are played at home. This is of little concern if this work is viewed as a potential model for introducing selected commercial video games to the Higher Education experience, as the arrangements in such cases would necessarily be similar to those described here. However, the nature of the intervention means it is difficult to make claims about the effects of playing video games more generally. The lab experience was often quite social in nature, with participants typically surrounded by those with whom they were playing, or who were playing the same game and thus had a common interest. It is possible that the effects would be different if the games were played alone or online, which might be more typical of the multiplayer games used here. In fact, the cross-sectional study, in which more than 2000 students' game-playing habits were surveyed, suggested there was no obvious (positive) correlation between graduate attribute attainment and game play outside of the lab.

7.1.5 Drop-out rate

While it was reasonable for the study to eschew the 'intention to treat' approach favoured by medical trials, the substantial drop-out rate – even in terms of the number of participants assigned to the intervention group who failed to attend a single game-playing session (14 out of 50) – must be considered. Figure 77 below illustrates the dropout rate in terms of the number of participants who completed the post-game surveys (i.e. on an approximately weekly basis). As discussed previously, for example in relation to the work of Egenfeldt-Nielsen (2007), student engagement with game-based learning may not be assumed and, as Whitton (2007) notes, games do not motivate everyone. In this sense, the intention to treat approach would – if practicable – be appropriate to consider, if only to provide a sense of the proportion and demography of students who may simply disregard any game-based opportunities to develop their graduate attributes. More usefully still, an exploration of the factors which led certain participants to drop out of the study might inform future efforts and ensure that student disengagement is addressed. In particular, it might have been possible to ask those participants who did attend one or more game-play session to provide a reason for leaving the study: for example, was *Borderlands 2* a poor choice for the first game? On reflection, perhaps opening with a fast-paced three-dimensional shooter was off-putting to less experienced players, although the title's humour and high production values were thought to offset the more limited appeal of the stereotypical gun-based gameplay.

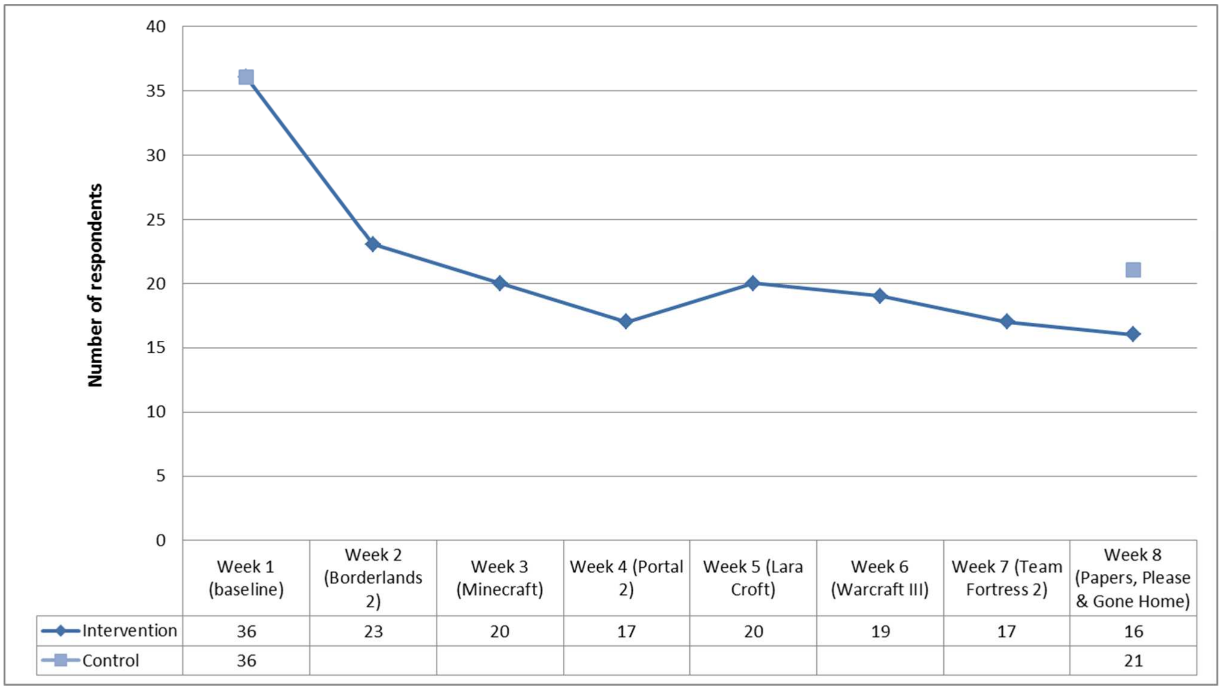


Figure 77: Number of intervention group participants in main experimental study who completed post-game surveys. Number of control group respondents (baseline and week eight) shown for comparison.

7.2 Summary & implications

The primary research question was stated as "Is playing selected commercial video games associated with measurable gains in the desirable skills known as graduate attributes?" Based on the results of this study, the answer to this question is unclear. It must be noted that the effects measured here related to a specific scenario, wherein a relatively small sample of student participants played selected video games under somewhat controlled conditions, analogous to a lab-based or other practical activity at university, albeit one that they could visit as they pleased. The effects associated with the novelty of being allowed – encouraged, even – to play games on university time, and the fact that participants were being tested and observed, must all be taken into account. It can be said with some confidence, however, that the approach taken here – including participant testing – would result in similar gains in self-reported graduate attribute scores if repeated: the game-based intervention was shown to be effective. Furthermore, from an educational standpoint, it is notable that these desirable skills and competencies may, be practised and developed (if not 'taught'), at university, and that significant gains in attribute attainment may be made over a relatively short period. It is also of interest to educationalists that as the scores on any one graduate attribute measure increased, so too did the scores on every other measure, to varying degrees. This suggests that the attributes measured here are all related, or that they could be facets of the same phenomenon, supporting the idea that many of the individual graduate attributes identified by universities are underpinned by some common characteristic.

The positive results are important because, if we recall Drummond *et al.*'s (1998) assertion that "effective skills development is difficult, if not impossible, to achieve in a system of teaching which is fundamentally based on lectures", then the use of video games to develop skills is a potential solution to this problem. We may also recall that Green *et al.* (2009) noted evidence of "polarised student responses" to the addition of dedicated skills development courses to the curriculum. In this regard, we may point to the qualitative interview data obtained from experiment participants that revealed a generally positive attitude towards the deployment of video games in Higher Education, and the quantitative data collected via the large survey, which indicated a majority of students were open to the idea that playing games at university may be useful. However, there are some major caveats here. First, the interview data were obtained from the relatively small number of intervention group participants (N = 20) who saw the study through to its conclusion: it is to be expected that these participants were the most amenable to the idea of playing games on campus, as they had just done so for a semester. Second, the high dropout rate itself is a concern – the intervention group initially comprised 50 participants. So, these data cannot be used to address concerns about the student response to a game-based course in the vein of that trialled here. The survey data are more convincing in this respect, with only around one fifth of the student population rejecting the idea that "playing video games might help develop any useful skills, or provide any valuable experience". That said, it cannot be assumed that the remainder of the population would welcome a game-based course in graduate attribute development, by any means. Furthermore, the potential impact of any intervention that immediately excludes a fifth of the student body is limited from the outset.

That the subsequent cross-sectional survey demonstrated existing game play habits were not associated with gains in the measured skills does not preclude the possibility that they may do so. The survey cannot determine causation, and the apparent absence of an effect in such data does not mean that it is not present in some form. Further, for some measures, slightly lower (though statistically insignificant) scores were associated with more regular game play. There are also implications associated with the relatively small – almost non-existent – gains in graduate attribute scores over a four-year degree. If, insofar as these skills may be measured, a university career does not result in the expected gains in graduate attributes, perhaps more directed, and potentially novel, interventions are required.

As to the question of whether players are aware of, reflect on, or value, the skills developed through video game play, the qualitative interview data here suggests that they are certainly aware of the possibility and somewhat optimistic about the value of such skills. However, this observation comes with the aforementioned caveat that interviews were carried out with students who had spent the preceding eight weeks playing video games, and being tested for gains in skill. The survey data, on the other hand, suggest that a majority of current students find the idea of using games to develop useful skills plausible, or, at least, are not inclined to dismiss the idea out of hand. Thus, the answer to the question of whether games might be used more extensively in Higher Education to develop graduate attributes is also cautiously affirmative: the support of HE policy makers and teaching staff would be required to match the apparent enthusiasm of the student body. Based on the results presented here, it is hoped that university colleagues will be swayed, and further, large-scale experimentation with the game-based approach described above will be possible.

7.3 Future Work

Several avenues for subsequent research are presented by the significant results of the experimental study, the somewhat incompatible survey results, and the limitations of the work as a whole. The most salient of these possibilities for future work is to reproduce the results of the experimental study, wherein students' attribute scores are measured before and after embarking on a programme of playing selected commercial video games. Bearing in mind that the repeated post-game testing of the original study has been identified as a weakness, it may be useful to run the experiment again with one group of participants being tested only at the beginning and the end of the experiment, and another group tested after each game, as in the original study. This might help to determine if the repeated testing was a significant part of the intervention, and partly responsible for gains in attribute scores. It would be useful to follow up with the intervention group involved in the study to see if the attributes gains made over the semester-long experiment were still present. A longer-term study might also allow the effects of the intervention's novelty value to be explored, to determine if the *de rigueur* use of games in a university context might lessen their impact over time.

Future work should also consider more carefully the related or confounding factors that might contribute to attribute development, including previous work experience and involvement in team-based sports, as suggested under 'Limitations of the study' above. Also noted above, the use of an 'active control' group may need to be explored. In addition, it would be interesting to extend the experiment beyond the confines of Higher Education – perhaps the game-playing intervention would be beneficial to cohorts other than undergraduate university students who have already enjoyed a certain amount of education and privilege.

A number of additional areas for further consideration emerge from these results:

- The Ethically and Socially Aware attribute should be explored in more detail, in response to strong qualitative evidence of students supporting the idea that selected games may help develop this attribute. A further study may be conducted, which focuses on games that involve social, cultural, and political themes. Games that feature more diverse characters and cultures would be sought, too. However, more robust means of measuring the impact of such games must be identified or developed.
- The potential benefits of playing games at university as stress relief – and any association with academic development – should be explored. Qualitative data suggests students may value games' utility for stress relief, and this may help explain the difference between intervention and control group scores.
- Video games' relationship with the more detailed conceptions of critical thinking should be explored, based on the qualitative data collected here. Such an exploration, however, will require an alternative means of measuring any gains associated with playing.
- The discrepancy between the experimental results and the survey results should be examined. Attempting to determine a causal relationship between video game habits and attribute development – whether positive or negative – is a daunting task outside of the lab. Such a study would likely need to be longitudinal in nature, rather than a one-off snapshot, and a great many other variables would have to be accounted for.
- Quite apart from the game-based nature of this study, it might be useful to examine measureable gains in graduate attribute attainment over the course of a typical degree programme. The survey data collected here suggest that gains are very slight, if present at all, and that attribute scores do not appear to vary consistently across levels of study. However, a longitudinal study designed specifically to examine graduate

attribute gains over time – with variables such as work experience and participation in team sports accounted for – would be required to address this issue adequately.

I very much hope to have the opportunity to explore some, if not all, of these interesting avenues in the future.

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Appendix A: Gee's 36 Learning Principles

Reproduced from James Paul Gee's *What Video Games Have to Teach Us About Learning and Literacy: Revised and Updated Edition* (2007)

1. **Active, Critical Learning Principle**
All aspects of the learning environment (including the ways in which the semiotic domain is designed and presented) are set up to encourage active and critical, not passive, learning.
2. **Design Principle**
Learning about and coming to appreciate design and design principles is core to the learning experience.
3. **Semiotic Principle**
Learning about and coming to appreciate interrelations within and across multiple sign systems (images, words, actions, symbols, artifacts, etc.) as a complex system is core to the learning experience.
4. **Semiotic Domains Principle**
Learning involves mastering, at some level, semiotic domains, and being able to participate, at some level in the affinity group or groups connected to them.
5. **Metalevel Thinking About Semiotic Domains Principle**
Learning involves active and critical thinking about the relationships of the semiotic domain being learned to other semiotic domains.
6. **"Psychosocial Moratorium" Principle**
Learners can take risks in a space where real-world consequences are lowered
7. **Committed Learning Principle**
Learners participate in and extended engagement (lots of effort and practice) as an extension of the real-world identities in relation to a virtual identity to which they feel some commitment and a virtual world that they find compelling.
8. **Identity Principle**
Learning involves taking on and playing with identities in such a way that the learner has real choices (in developing the virtual identity) and ample opportunity to meditate on the relationship between new identities and old ones. There is a tripartite play of identities as learners relate, and reflect on, their multiple real-world identities, a virtual identity, and a projective identity.
9. **Self-Knowledge Principle**

The virtual world is constructed in such a way that learners learn not only about the domain but about themselves and their current and potential capacities.

10. **Amplification of Input Principle**

For a little input, learners get a lot of output.

11. **Achievement Principle**

For learners of all levels of skill there are intrinsic rewards from the beginning, customized to each learner's level, effort and growing mastery and signalling the learner's ongoing achievements.

12. **Practice Principle**

Learners get lots and lots of practice in a context where the practice is not boring (i.e. in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success). They spend lots of time on task.

13. **Ongoing Learning Principle**

The distinction between learner and master is vague, since learners, thanks to the operation of the "regime of competence" principle listed next, must, at higher and higher levels, undo their routine mastery to adapt to new or changed conditions. There are cycles of new learning, automatization, undoing automatization, and new reorganized automation.

14. **"Regime of Competence" Principle**

The learner gets ample opportunity to operate within, but at the outer edge of, his or her resources, so that at those points things are felt as challenging but not "undoable."

15. **Probing Principle**

Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on this basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking this hypothesis.

16. **Multiple Routes Principle**

There are multiple ways to make progress or move ahead. This allows learners to make choices, reply on their own strengths and styles of learning and problem solving, while also exploring alternative styles.

17. **Situated Meaning Principle**

The meanings of signs (words, actions, objects, artifacts, symbols, texts, etc.) are situated in embodied experience. Meanings are not general or decontextualized.

Whatever generality meanings come to have is discovered bottom up via embodied experiences.

18. **Text Principle**

Texts are not understood purely verbally (i.e. only in terms of the definitions of the words in the text and their text-internal relationships to each other) but are understood in terms of embodied experiences. Learners move back and forth between texts and embodied experiences. More purely verbal understanding (reading texts apart from embodied action) comes only when learners have had enough embodied experience in the domain and ample experiences with similar texts.

19. **Intertextual Principle**

The learner understands texts as a family ("genre") of related texts and understands any one such text in relation to others in the family, but only after having achieved embodied understandings of some texts. Understanding a group of texts as a family (genre) of texts is a large part of what helps the learner make sense of such texts.

20. **Multimodal Principle**

Meaning and knowledge are built up through various modalities (images, texts, symbols, interactions, abstract design, sound, etc.), not just words.

21. **"Material Intelligence" Principle**

Thinking, problem solving, and knowledge are "stored" in tools, technologies, material objects, and the environment. This frees learners to engage their minds with other things while combining the results of their own thinking with the knowledge stored in these tools, technologies, material objects, and the environment to achieve yet more powerful effects.

22. **Intuitive Knowledge Principle**

Intuitive or tacit knowledge built up in repeated practice and experience, often in association with an affinity group, counts a great deal and is honored. Not just verbal and conscious knowledge is rewarded.

23. **Subset Principle**

Learning even at its start takes place in a (simplified) subset of the real domain.

24. **Incremental Principle**

Learning situations are ordered in the early stages so that earlier cases lead to generalizations that are fruitful for later cases. When learners face more complex cases later, the hypothesis space (the number and type of guesses the learner can make) is constrained (guided) by the sorts of fruitful patterns or generalizations the learner has found earlier.

25. **Concentrated Sample Principle**

The learner sees, especially early on, many more instances of fundamental signs and actions than would be the case in a less controlled sample. Fundamental signs and actions are concentrated in the early stages so that learners get to practice them often and learn them well.

26. **Bottom-up Basic Skills Principle**

Basic skills are not learned in isolation or out of context; rather, what counts as a basic skill is discovered bottom up by engaging in more and more of the game/domain or games/domains like it. Basic skills are genre elements of a given type of game/domain.

27. **Explicit Information On-Demand and Just-in-Time Principle**

The learner is given explicit information both on demand and just in time, when the learner needs it or just at the point where the information can best be understood and used in practice.

28. **Discovery Principle**

Overt telling is kept to a well-thought-out minimum, allowing ample opportunity for the learner to experiment and make discoveries.

29. **Transfer Principle**

Learners are given ample opportunity to practice, and support for, transferring what they have learned earlier to later problems, including the problems that require adapting and transforming that earlier learning.

30. **Cultural Models about the World Principle**

Learning is set up in such a way that learners come to think consciously and reflectively about some of their cultural models regarding the world, without denigration of their identities, abilities, or social affiliations, and juxtapose them to new models that may conflict with or otherwise relate to them in various ways.

31. **Cultural Models about Learning Principle**

Learning is set up in such a way that learners come to think consciously and reflectively about some of their cultural models of learning and themselves as learners, without denigration of their identities, abilities, or social affiliations, and juxtapose them to new models of learning and themselves as learners.

32. **Cultural Models about Semiotic Domains Principle**

Learning is set up in such a way that learners come to think consciously and reflectively about their cultural models about a particular semiotic domain they are learning without denigration of their identities, abilities, or social affiliations, and juxtapose them to new models about this domain.

33. **Distributed Principle**

Meaning/knowledge is distributed across the learner, objects, tools, symbols, technologies and the environment.

34. **Dispersed Principle**

Meaning/knowledge is dispersed in the sense that the learner shares it with other others outside the domain/game, some of whom the learner may rarely or never see face to face.

35. **Affinity Group Principle**

Learners constitute an "affinity group", that is, a group that is bonded primarily through shared endeavors, goals, and practices and not shared race, gender, nation, ethnicity, or culture.

36. **Insider Principle**

The learner is an "insider", "teacher", and "producer" (not just a "consumer") able to customize the learning experience and domain/game from the beginning and throughout the experience.

Appendix B: The University of Glasgow graduate attributes

Presented here are the nine graduate attributes considered in relation to the main study. For each attribute, the university's definition is provided: bullet points refer to the **Academic**, **Transferable**, and **Personal** dimensions, respectively. Definitions are current as of December 2015 when the study was conducted. A tenth attribute, Subject Specialists, was not considered as part of this study.

Effective Communicators

- Articulate complex ideas with respect to the needs and abilities of diverse audiences.
- Present their ideas clearly and concisely in high quality written and spoken English.
- Communicate clearly and confidently, and listen and negotiate effectively with others.

Experienced Collaborators

- Engage with the scholarly community and respect others' views and perspectives.
- Are experienced in working in groups and teams of varying sizes and in a variety of roles.
- Conduct themselves professionally and contribute positively when working in a team.

Adaptable

- Experience multi-disciplinary and/or inter-disciplinary learning in an internationally renowned institution.
- Respond flexibly and adapt their skills and knowledge to excel in unfamiliar situations.
- Demonstrate resilience, perseverance and positivity in multi-tasking, dealing with change and meeting new challenges.

Resourceful and Responsible

- Are experienced in self-directed learning and authentic research-led enquiry.
- Are motivated, conscientious and self-sufficient individuals capable of substantial independent work.
- Manage their personal performance to meet expectations and demonstrate drive, determination, and accountability.

Investigative

- Are intellectually curious and engage in the pursuit of new knowledge and understanding.
- Are able to locate, analyse and synthesise information from a variety of sources and media.
- Are able to investigate problems and provide effective solutions.

Independent and Critical Thinkers

- Identity, define and assess complex issues and ideas in a researchable form.
- Exercise critical judgement in evaluating sources of information and constructing meaning.
- Apply creative, imaginative and innovative thinking and ideas to problem solving.

Confident

- Defend their ideas in dialogue with peers and challenge disciplinary assumptions.
- Possess excellent interpersonal and social skills fostered within an internationalised community.
- Demonstrate enthusiasm, leadership and the ability to positively influence others.

Ethically and Socially Aware

- Consider and act upon the ethical, social and global responsibilities of their actions.
- Welcome exposure to the richness of multi-cultural and international experiences, opportunities and ways of thinking.
- Have a practical and contemporary knowledge of relevant professional, ethical and legal frameworks.

Reflective Learners

- Use feedback productively to reflect on their work, achievements and self-identity.
- Set aspirational goals for continuing personal, professional and career development.
- Identify and articulate their skills, knowledge and understanding confidently and in a variety of contexts.

Appendix C: Post-intervention interview script

- Confirm student number and extent of game-playing outside of study.

- Did you enjoy the sessions? Was two hours per week too much or too little, or about right?

- Do you think the games we played might have helped develop any skills or competencies? Did you gain any valuable experience?

- What about the following ‘graduate attributes’ – do you think any of the games we played might have developed any of these?

    - Effective Communicators
    - Experienced Collaborators
    - Adaptable
    - Resourceful and Responsible
    - Investigative
    - Independent and Critical Thinkers
    - Confident
    - Ethically and Socially Aware
    - Reflective Learners

- What might you do in each of the following scenarios?

    - Present a talk to a small group of acquaintances, or strangers.

    - Asked to carry out a difficult or confusing task by an employer or tutor that you’ve never done before.

- Could you see games being played more widely at university? Would there be any value in this? Might you draw on your gaming experience in a job interview?

- Any other comments?

Appendix D: Survey used in cross-sectional study

The complete survey is too long to reproduce here. Instead, screenshots of all of the survey items are presented online, at the following locations.

Page one: https://www.dropbox.com/s/dim3y7f25tixv6v/survey_p1.png?dl=0

Page two: https://www.dropbox.com/s/up6kotopbbsmur7/survey_p2.png?dl=0

Page three: https://www.dropbox.com/s/e7plquiwk4yxgth/survey_p3.png?dl=0

Page four: https://www.dropbox.com/s/khjwfkbtpdokhnu/survey_p4.png?dl=0

Page five: https://www.dropbox.com/s/69m2lni1x42v18y/survey_p5.png?dl=0

Appendix E: Survey results by degree subject

Subject	CAS (mean (sd))	SPCCS (mean (sd))	Resourcefulness (mean (sd))	I-ADAPT-M (mean (sd))
College of Arts				
Archaeology	108.5 (9.51)	81.65 (11.26)	85.7 (14.41)	205.9 (15.96)
Celtic and Gaelic	111.43 (10.36)	79.36 (15.54)	87.29 (14.41)	217.71 (19.53)
Classics	107.25 (12.19)	71.51 (22.69)	85.17 (14.53)	198.92 (20.69)
Comparative Literature	103.8 (11.35)	71.48 (7.85)	91 (12.65)	194.8 (12.38)
English Language and Linguistics	112.29 (16.12)	78.57 (14.93)	84.87 (15.54)	192.68 (28.19)
English Literature [including: Creative Writing]	109.04 (14.11)	73.52 (17.29)	81.87 (15.82)	195.63 (23.4)
French	118.76 (10.08)	79.24 (12.92)	83.41 (18.96)	197.12 (24.01)
German	111.33 (9.61)	77.31 (3.94)	90.67 (8.74)	186 (10.54)
Hispanic Studies [including: Spanish]	116.38 (11.75)	85.78 (11.8)	81.13 (12.47)	196 (23.67)
History	107.65 (14.46)	72.4 (20.66)	85.98 (18.93)	196.77 (26.08)
History of Art [including: Textiles]	107 (8.94)	75.52 (18.93)	85.59 (16.52)	194.77 (21.26)
Information Studies (HATII) [including: Digital Media and Information Studies, Information Management & Preservation, Museum Studies]	101.17 (16.46)	69.16 (19.83)	80.06 (20.34)	194.39 (22.37)
Music	108.05 (14.2)	68.53 (15.08)	84.76 (14.37)	192.43 (25.28)
Philosophy	106.17 (12.45)	68.43 (21.56)	79.89 (13.81)	192.67 (24.99)

Russian	104.67 (5.13)	69.31 (13.14)	80 (8.89)	179.67 (34.36)
Scottish Literature	112.71 (19.09)	78.15 (20.27)	90 (22.14)	205.14 (24.87)
Theatre, Film and Television Studies [including: Cultural Policy, Drama, Dramaturgy, Journalism, Media Management, Performance Studies, Playwriting]	110.22 (11.13)	78.36 (15.07)	86.07 (15.42)	192.52 (19.28)
Theology and Religious Studies	108.41 (15.33)	71.15 (17.94)	85.24 (15.36)	196.53 (23.5)
Translation Studies	100.2 (15.09)	69.83 (11.29)	89.8 (8.96)	199.8 (11.99)
College of Medical, Veterinary and Life Sciences				
Biodiversity, Animal Health and Comparative Medicine	104.52 (16.23)	70.09 (18.65)	83.44 (15.44)	198.64 (22.58)
Cancer Sciences	106.42 (14.24)	73 (22.54)	76.68 (24.55)	199 (28.3)
Cardiovascular and Medical Sciences	107.48 (13.42)	73.14 (23.37)	91.72 (11.27)	201.24 (21.62)
Dentistry, Dental School	112.71 (16.57)	82.13 (11.35)	98.79 (10.35)	203.75 (25.8)
Health and Wellbeing	110.33 (12.67)	82.39 (12.31)	84.67 (13.18)	202 (15.97)
Infection, Immunity and Inflammation	109.46 (14.25)	80.67 (9.51)	81.67 (13.7)	200.83 (24.23)
Life Sciences	106.74 (13.35)	73.25 (18.98)	83.55 (17.64)	196.16 (23.23)
Medicine	111.89 (13.55)	78.13 (13.71)	90.16 (14.84)	208.71 (21.69)
Molecular, Cell and Systems Biology	105.5 (16.1)	77.82 (13.71)	84.93 (15.88)	199.23 (21.24)
Neuroscience and Psychology	109.19 (11.76)	78.66 (14.1)	83.31 (14.07)	198.33 (18.59)
Nursing and Health Care	110.21 (15.13)	79.62 (14.45)	85.32 (15.3)	218.26 (16.22)
Parasitology	105.33 (7.51)	80.69 (11.04)	74.67 (8.08)	218.33 (26.5)

Veterinary Medicine	108.21 (13.61)	79.8 (11.43)	86.83 (16.18)	204.23 (24.47)
College of Science and Engineering				
Chemistry	101.67 (17.28)	71.41 (14.85)	79.14 (17.55)	194.51 (21.71)
Computing Science	102.2 (14.13)	72.4 (14.85)	81.77 (16.92)	198.56 (23.87)
Engineering [including: Aerospace Engineering, Biomedical Engineering, Civil Engineering, Electronics and Electrical Engineering, Mechanical Engineering, Software Engineering]	104.06 (13.23)	72.87 (16.32)	83.09 (17.37)	198.67 (21.58)
Geographical and Earth Sciences [including: Geomatics]	105.9 (13.38)	74.45 (12.79)	87.13 (15.49)	193.67 (19.05)
Mathematics	106.45 (11.78)	70.98 (13.93)	79.82 (14.87)	191.25 (23.73)
Physics and Astronomy	107.48 (13.54)	73.21 (17.55)	83.74 (15.21)	202.13 (20.7)
Psychology	108.93 (12.92)	75.7 (14.84)	85.6 (16.82)	194.26 (21.43)
Statistics	103.71 (16.28)	80.84 (10.1)	84.5 (20.87)	195.5 (27.19)
College Social Sciences				
Accounting and Finance	104.93 (13.46)	73.56 (13.74)	89.48 (14.53)	195.97 (21.85)
Business	105.18 (13.05)	74.95 (19.96)	87.63 (13.93)	194.53 (17.72)
Central and East European Studies [including: Baltic, Estonian, Hungarian, Lithuanian, Russian, Soviet Studies]	106.92 (14.24)	78.36 (17.33)	82.08 (17.89)	196.54 (30.16)
Economic and Social History [including: Global Economy]	103.88 (4.42)	79.82 (7.52)	80.63 (14.33)	186.5 (11.93)
Economics [including: Development Studies, Financial Economics]	106.03 (11.33)	80.87 (10.74)	81.21 (13.46)	197.47 (20.63)

Education [including: Adult Education, Community Development, Drug and Alcohol Studies, Organisational Leadership, Teaching]	107.38 (13.96)	76.3 (18.26)	85.64 (16.27)	201.28 (22.21)
Law [including: Intellectual property, Legal Practice]	107.99 (12.61)	73.84 (19.75)	81.31 (16.79)	197.93 (20.65)
Management [including: Entrepreneurship, International Business, Leadership, Marketing]	105.33 (11.83)	80.89 (11.75)	89.89 (20.29)	215.44 (18.52)
Politics [including: Chinese Studies, Human Rights, International Relations]	109.87 (12.54)	78.03 (12.87)	86.37 (14.74)	202.89 (18.57)
Sociology [including: Criminology, Global Health, Global Security]	103.74 (12.79)	69.13 (21.54)	80.04 (18.3)	193.43 (27.81)
Urban Studies [including: Housing Studies, Planning, Public Policy, Real Estate, Regeneration, Social Policy]	108.64 (14.71)	75.35 (12.82)	86.43 (16.04)	195.5 (14.16)
Other				
Other/not listed	106.16 (12.75)	75.7 (17.32)	87.11 (15.87)	204.76 (20.39)

Appendix F: Weekly (game-by-game) attribute scores over time

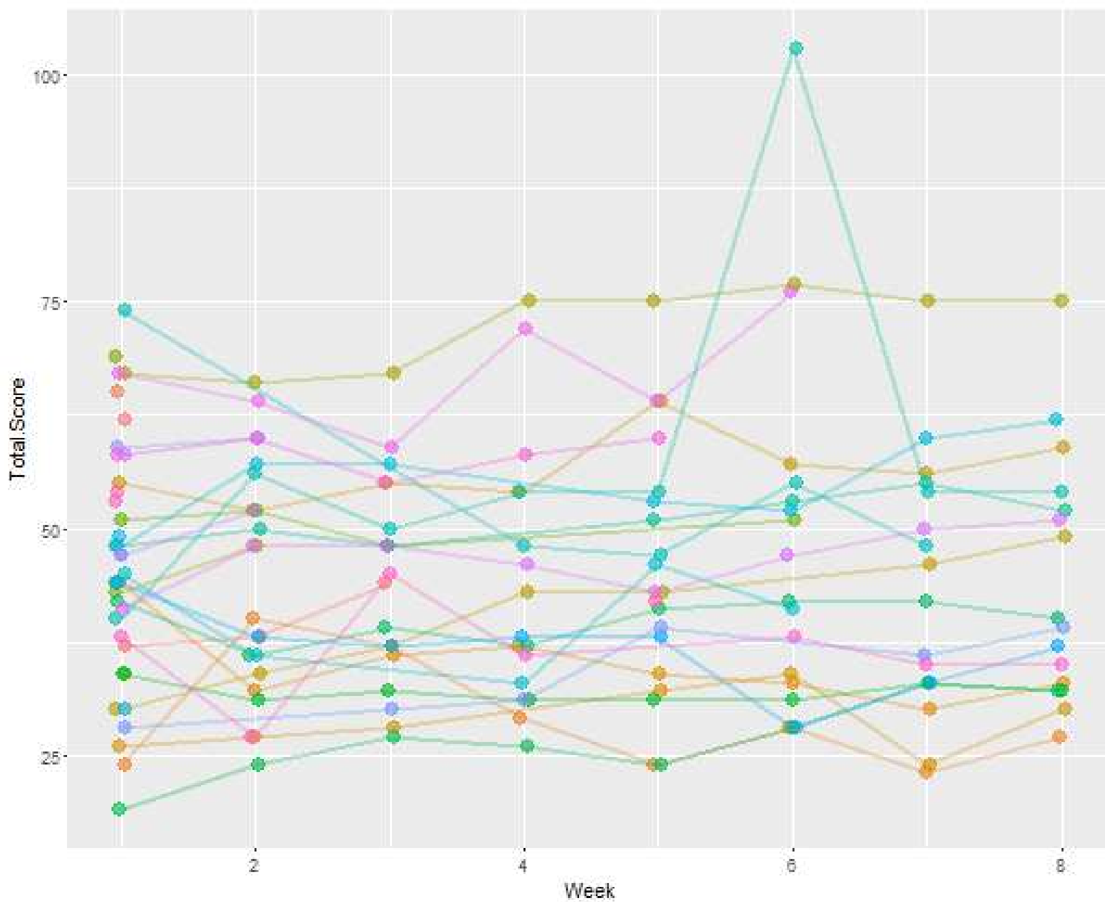

Figure F1: Communicative Adaptability Scale scores over time, by student, in Intervention group.

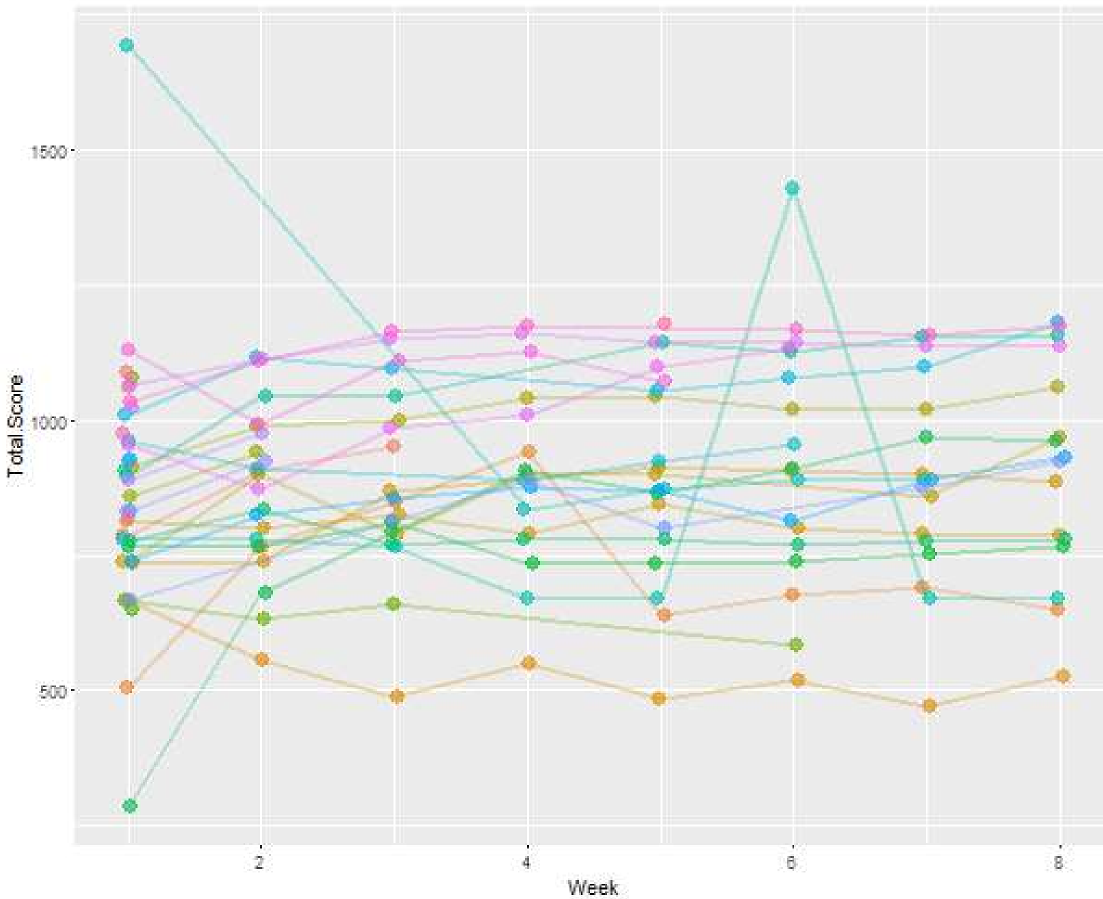

Figure F2: Self-Perceived Communication Competence Scale scores over time, by student, in Intervention group.

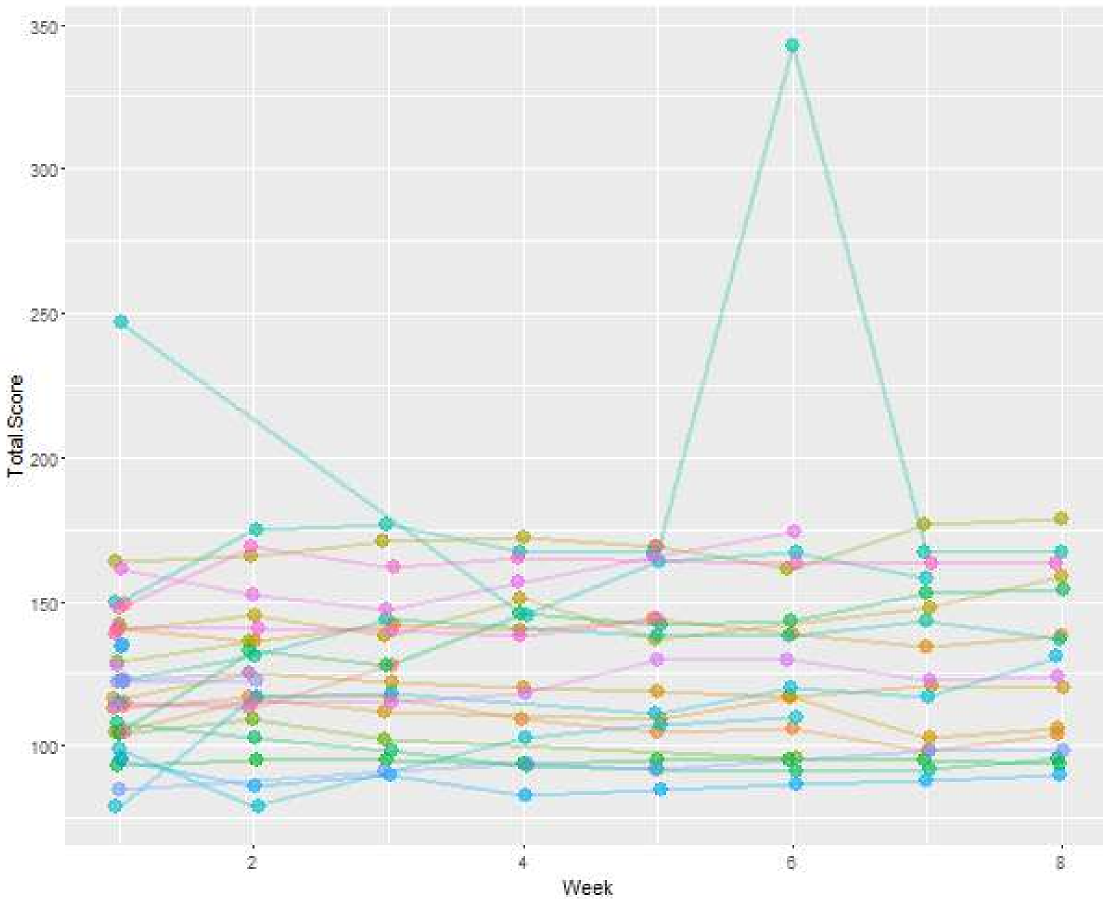

Figure F3: I-ADAPT-M scores over time, by student, in Intervention group.

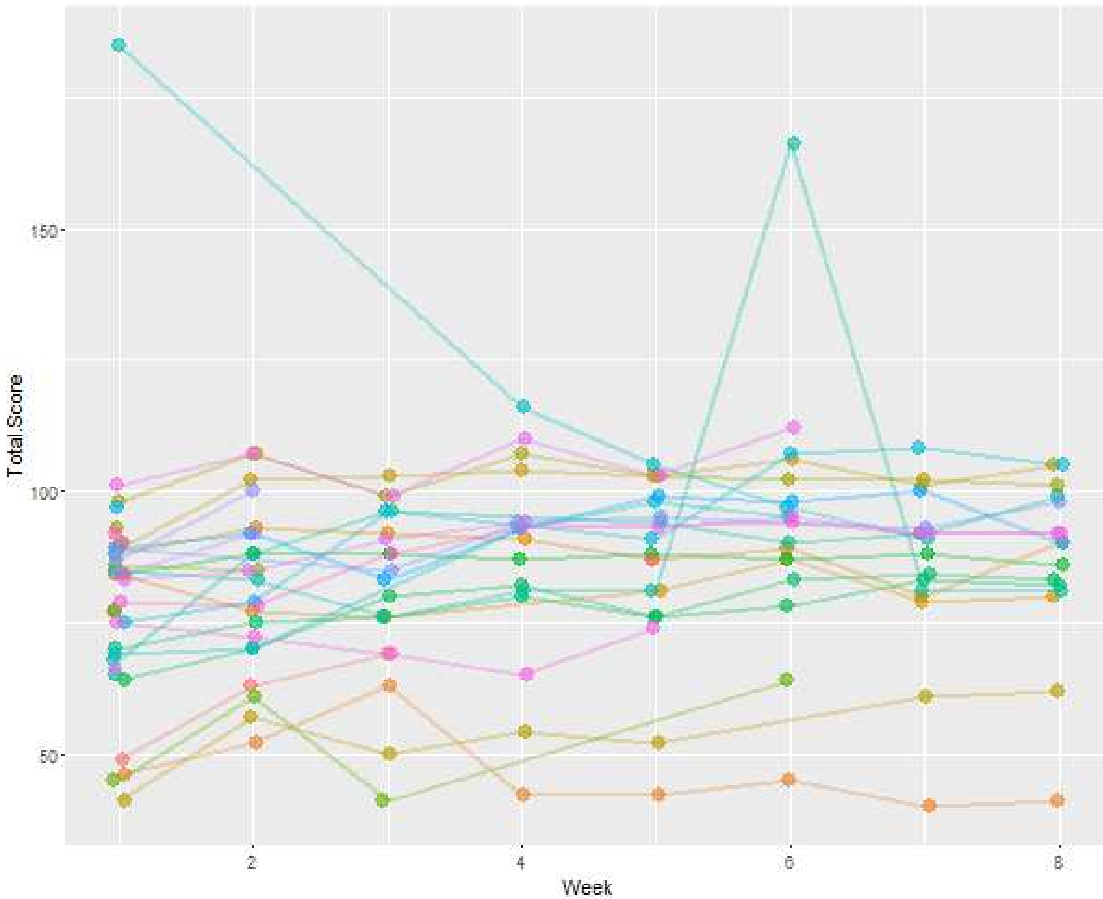

Figure F4: Resourcefulness Scale scores over time, by student, in Intervention group.