

Can games be more than fun?

Dr Paul Cairns

Department of Computer Science

University of York, Deramore Lane, York YO10 5GH, UK,

paul.cairns@york.ac.uk

1 Games are very engaging

Digital games are undoubtedly hugely engaging. Any statistics on how many people are playing games and for how long are staggering. For example, the UK Association for Interactive Entertainment, UKIE, reports that 20m people in the UK aged between 6 and 64 play games, that's about 42% of that age bracket. Furthermore, the age group 11-64 plays on average about 8-9hours of games a week (UKIE, 2017). In the USA, 63% of all households have at least one frequent gamer and there is an even split of men and women.

Given playing games is a voluntary activity that requires a significant investment of time and effort, it is not surprising that people have wondered if such engagement could be directed to more productive outcomes. Serious games, here, very loosely refers to games that are intended to achieve some form of meaningful real world outcome (Ritterfeld et al, 2009). This can range from improving health (Wattanasoontorn et al, 2013), increasing donations to humanitarian issues (Steinemann et al, 2015), training people (*Virtual Battlespace 3*¹) and of course education, where there has been a long interest in using games to improve learning (Malone, 1981). McGonigal (2011) even goes so far as to say that modern approaches to learning, work and productivity are dysfunctional and games hold the key to remedying these problems.

However, though there is considerable enthusiasm amongst researchers and developers for using games to promote out of game outcomes, success in serious games has been mixed, for example Sherry (2015). While studies have shown increased engagement as a result of using games, these results do not always translate into real world success. Energy meters are ignored, exercise apps remain switched off and teachers revert to more traditional methods. There seems to be a substantial disconnect between the high volume of voluntary engagement with games and exploiting that voluntary engagement to achieve real world outcomes.

The goal then of this chapter is to help discuss some of the problems of transferring the success of digital games into other domains and the challenges even of researching this area. This chapter discusses three specific topics: flow, learning and research design. Flow is regularly seen as a key outcome of game that may have important psychological benefits for players. However, flow experience and what is called flow in players of games may be quite different things. Games also seem to

¹ <https://bisimulations.com/>

have a lot of potential for use in education as a way of getting players to engage, voluntarily, with new or difficult concepts. This chapter describes how recent research undermines naive attempts at learning in games because mere exposure to concepts in games is not enough to initiate the learning process via priming players to think about those concepts.

What is needed is more research but we also discuss how players in research projects are susceptible to all sorts of influences that can be very hard to remove and which can influence research results. At the end of the day, it seems that the games are meant to be played and players can see the fun in all sorts of games. But moving games to provide more meaningful experiences presents substantial challenges that we are not yet equipped to address.

2 A note about “games”

Throughout this chapter, the term “games” is used predominantly to mean digital games though it may apply to other sorts of games with caution. This is primarily because it is the core research area of the author and it would be over-reaching the current research in digital games to apply its findings to other sorts of games such as card games, board games, sports and so on. This may be something of an artificial distinction because after all many of the original video games were versions of existing games transferred to computers, for instance, solitaire, chess and football. However, digital games have two fundamental differences from other games. First, the game itself has agency in a way that other games do not. This is most obvious in first person shooter games, like *Call of Duty* where the computer can control a literal army of opponents. But even where much of the action in a game is due to playing against other real players, say in *Starcraft*, the computer also acts independently to enforce complex rule sets such as who owns what things, what can be done with those things and whether you really did shoot the other player or not.

Secondly, digital games offer game worlds that do not rely on the limitations or possibilities of the physical world. Golf in the real world is a balancing act between the design of the course, the skills of the player and the vicissitudes of nature such as a breeze or a particularly springy bit of grass. Digital golf could be all of these things and further offer impossible contexts such as variable gravity, aliens and torpedoes as well, such as in *Wonderputt*. This is not confined to games with an obvious physical underpinning: it is also true of many casual and self-paced games. Take for example *Two Dots*. While it is possible to imagine a table top version of this game, the digital *Two Dots* works because without any set-up cost to the player, there is a board full of dots that refresh themselves during play and there are challenges ready to be tackled. Moreover, the challenges progress far further than any finite stack of challenge cards could.

Thus digital games in this chapter are those distinct games which work because the games themselves have agency and action on the game world. Furthermore, such a game world might not be otherwise realisable. As Wittgenstein famously noted², there is not a crisp categorisation of games but prototypical digital games such as first person shooters, open world real-time strategy games and puzzle platformers are sufficient to characterise our focus in this chapter.

² https://en.wikipedia.org/wiki/Family_resemblance

3 It's not all about flow

In recent times, psychology has developed a strand of work, called positive psychology, looking to understand what makes people happy (Boniwell, 2012). Much of this work has sprung up as a consequence of some seminal work in the 1970s in to the experience of flow, the sense of being fully engaged in a task. Csikszentmihalyi (2002) found that flow provides a sense of fulfillment and satisfaction in doing a task and that this leads to longer term happiness and fulfillment in life. Moreover, people deliberately seek out flow experiences in order to achieve these positive outcomes.

Flow is characterised as an optimal psychological experience arising from eight components (Csikszentmihalyi, 2002), a formulation which has changed little since its inception and is summarised as six aspects here (Engeser and Schiepe-Tiska, 2012):

1. Intense concentration on a limited stimulus
2. Merging of action and awareness
3. A loss of self-consciousness
4. A feeling of control over the situation or activity
5. Coherence in actions, feedback and progression to goals
6. Experience of the activity as intrinsically rewarding (autotelic)

Each of these aspects may occur separately but only when they occur together as a unified holistic experience do you get flow.

Looking at these attributes, there is considerable overlap with the properties of playing a game: games offer clear goals, specific actions and good feedback in a very coherent way. The result is players develop a strong focus on games to the exclusion of the external world, often called immersion (Cairns et al, 2014). Indeed, Chen (2007) argue that games have evolved to generate flow and it is flow that brings people in to play.

Thus, flow is held to be the basis for describing player enjoyment of digital games (Sweetser and Wyeth, 2005) leading to models to help designers build flow into their games. Specific measures of flow are used to study player experiences, for example in the work of Vella et al (2013). Flow is also a constituent of game specific measures of player experiences, for example in the Game Engagement Questionnaire (Brockmyer et al, 2009). Moreover, if games can offer flow and flow can lead to psychological well-being then there is the possibility that merely playing games could be of positive psychological benefit (Vella and Johnson, 2012).

However, even in the early characterisations of immersion (Brown and Cairns, 2004), it was evident that the very intense experiences of immersion in games were fleeting and that often playing a game was immersive but without all of the conditions that might lead to flow. In some sense, flow may be the optimal experience of playing a game but many experiences of play are much more prosaic and sub-optimal (though still valued by players). A quick game of *Candy Crush* or *Monument Valley* as a break from work can still be engaging, somewhat immersive and valued even if flow is not in any sense achieved.

Furthermore, games do not always attempt to engender this optimal experience. Some games are hugely frustrating and yet equally popular with some players, typical

such games being *Super Meat Boy* and *Dark Souls*. And even when frustration is not such a central feature of the game, players can find their failure enjoyable (Ravaja et al, 2008) or important in building up the sum enjoyment of the game (Petalito et al, to appear). Juul (2013) also points out that failure is an important constituent of digital games and this perhaps goes against the coherence aspect of flow where actions are meant to lead towards goals not the failure to achieve them. Even the emotions of instances of play do not match the positive experience of flow but it is only in sum and perhaps on reflection that players find a game to have been a positive experience (Triberti, 2016). There is also growing evidence that players are using games to distract themselves from other concerns and so bring about well-being (Collins and Cox, 2014). It is not clear if flow is necessary or even sought after in these contexts.

The focus on flow also comes with another problem which is how to measure this optimal experience in digital games. Moneta (2012) identifies the three main ways to measure flow. The earliest is the flow questionnaire (FQ) but that really is tailored to understanding the general level of flow experiences that people have rather than their flow in relation to specific experiences and in particular in response to playing a game. The Experience Sampling Methods (ESM) improves upon the FQ by sampling people in their daily tasks and asking about their experiences. However, ESM prompts for flow experiences explicitly which may be biasing and also it is very hard to validate that, when people did report flow, it was in fact a flow experience. The third approach looks like more typical psychometrics in that questionnaires are used to collect people's experiences and identify latent concepts in the questionnaires that correspond to flow. The most well-established such questionnaire is the revised Flow State Scale (FSS-2) (Jackson and Eklund, 2002) and this has been used in several studies of player experience.

Questionnaires like FSS-2 have an intuitive appeal and fit with many other measures used in player experience study such as the Immersive Experience Questionnaire (Jennett et al, 2008). However, if flow is an optimal experience and, for the sake of argument, a questionnaire measures flow on the scale of 1 to 10. What does a flow score of 5 mean? Is this sub-optimal flow (and so not really flow)? Or does it mean it is not flow, in which case attributing it to a flow experience or even aggregating it across players to give a mean level of flow would be meaningless. What if the score of 5 is due to a high score on some factors of flow but very low score on other factors? Then the score is not an indicator of flow at all as flow would need all or at least several factors to be present. Alternatively, the score indicates a player moving towards flow, if not necessarily achieving it. But this interpretation is rarely seen in the player experience literature and even if it were, would a movement towards increased flow in a study actually be a useful measure if flow were never actually achieved?

Thus, despite the prevalence of questionnaire approaches to measuring flow in games, there is substantial research needed to establish that it is indeed flow that players are experiencing. It should be noted, the problems of capturing flow in activities are not unique to player experience in digital games. For instance in elite sports, where flow is believed to be an important constituent of peak performance, it is still unclear which components of flow are essential for a flow experience and what intensity each component needs to attain (Swann et al, 2012). And in the field of music, there are indications that musicians may be experiencing flow differently from athletes and also differently depending on their level of musicianship (Sinnamon et al, 2012).

If we step back somewhat from flow as central to gaming experiences, then flow takes its place alongside other constituent experiences that players have and seek when they play. The promise of games to bring about psychological well-being may still be realised but flow may not be so central to achieving it. For example, self-determination theory has shown promise in explaining the enduring attraction of games (Ryan et al, 2006) and also has the potential to bring about well-being in players (Vella and Johnson, 2012). However, we are still a long way from establishing whether games could be good for people and whether flow in fact has any part to play in bringing about that good.

4 Learning in games

Another way in which games might move beyond mere fun is to use them as educational tools. The rationale for this is, at first glance, self-evident. People clearly have to learn to play games, whether what is learned are motor skills like the rapid responses needed in a first-person shooting game like *Overwatch*, or whether it is explicit, factual knowledge such as the ordering of technologies in the “technology tree” in *Civilization*. Thus, people who play games incidentally have to learn something if they want to play. Secondly, people voluntarily play games and enjoy learning them, something which is not always true of formal education. Bringing the necessity of learning and the joy of learning together in a game seems like a natural opportunity which was identified very early on in the history of computer games (Malone, 1981).

Simulators are effectively a form of game where, for example, a player can fly a simulated Boeing 747 for fun. Often desktop simulators like *Flight Simulator X* have settings and scenarios that allow players to fly planes where they would never be allowed to do so in real life, for example over the Great Pyramids of Giza. At the same time, if the player does play a realistic simulator, then in order to play they must learn the controls of the real aircraft. Learning is happening in a game context. There are clearly games, such as *World without Oil* (in this case non-digital), where simulation is intended to bring home a very real educational message (McGonigal, 2011). And of course, in professional contexts, particularly the aerospace industry, simulators are used as an essential part of training. Even there, though, simulators are only ever a part (albeit substantial) of wider training programmes including traditional classroom learning and formal assessments.

The distinction between simulators and games can be blurry. The game *Eurotrucker* takes professional levels of commitment as the player must do long-distance goods haulage across a virtual model of Europe in real-time. Conversely, the strategic war game, *ARMA 2*, has such realistic battle simulation that there is a professional version, *Virtual Battle Space (VBS)*, that is used worldwide in military training.

Aside from simulators, games hold the promise to teach things that are otherwise difficult in a traditional classroom, such as persistence and moral viewpoints (Gee, 2004). However, it is a different matter to bring about learning of a specific curriculum of knowledge through a game. While a player might well learn about the complexities of societies and their development through playing *Civilization*, it is very hard to direct what exactly players do learn. Indeed, it may need a radical re-thinking of what the goals of formal education are in order to effectively exploit the learning that happens in such games (Squire, 2005).

Nonetheless, there is still a persistent assumption that mere exposure to ideas in games might be sufficient to bring about learning of those ideas. This is possibly most evident in the General Aggression Model (GAM), where mere exposure to aggressive concepts in a game are held to lead, first, to aggressive thoughts and then, over time, to aggressive behaviours (Anderson and Bushman, 2001). The specific route to aggressive behaviours from exposure to violent concepts in digital games comes through cognition. That is, exposure to violent concepts leads players to think about those concepts, which under the influence of other factors increases their propensity to be aggressive.

Learning aggressive concepts may seem a very specific form of learning but the GAM has been expanded almost wholesale to the General Learning Model (GLM) (Buckley and Anderson, 2006). The GLM can be taken as a suitable model for a wide-range of game-based learning (Tang et al, 2009). By analogy, under the GLM, exposure to any concepts through a game leads to cognition around the concept and this leads, again alongside other factors, to learning the concept. While this seems quite natural, it needs careful consideration, particularly going back to the original model where violent games are believed to lead to aggressive behaviours. The key question is: does exposure to in-game concepts really lead to thinking about those concepts?

4.1 Learning via priming

To see whether games can lead to learning through mere exposure to games, we need to know what people are thinking about during or immediately after playing games. Psychologists have refined good methods for identifying what people are thinking about through the principle of priming (Sternberg, 1999). In the context of learning in games, the priming we are concerned with is conceptual priming (Eysenck and Keane, 2010). This occurs whenever a person thinks of a concept. Other concepts related to that concept are made easier to access, that is, they are primed to be used. More concretely, if I refer to concept of “spider” then concepts related to spider like “fly”, “web”, “hairy legs” and so on are primed.

Priming can be measured in various ways but one simple way is that when shown images of concepts related to a primed concept, people are faster to categorise those images. This is called the Image Categorisation Task (Tipper and Driver, 1988). It should be noted that detecting priming is tricky because the ICT is looking to see just a small difference in reaction time to images in an experimental context against a background of all the other stuff rattling around inside our brains. To give an analogy, it is like trying to detect whether there are more hippopotamuses inside one group of lorries over another group of lorries when the only measurement you can make is to weigh each lorry once for a specific instant...And the lorries are all different shapes and sizes...And we have no idea how many hippos could be in each lorry...And the hippos are dancing.

To examine priming through digital games, David Zendle, in his doctorate, conducted a series of experiments where different concepts were represented in different games and then he measured the priming of those concepts in players (Zendle, 2016). Of course, games can vary in a huge number of ways including graphics, sounds, controls, challenges, gameplay and so on. Any one of these could have a subtle effect on the concepts in a player’s mind. Thus, it was important to take tight experimental control and only manipulate the representation of the concepts in very specific ways.

For example, in one of Zendle’s experiments, he had a maze game where players were required to find the exit within a give time limit. To ensure experimental control, there was no exit for players to find but fortunately the time limit was not too long either. To manipulate the concepts, in one version the game was “skinned” to be about a mouse running through a maze, Figure 1 and in the other version the game was about a car driving through a city. Each game had otherwise identical gameplay and controls so it was really only the representation of the concepts in the game that was changed.



Figure 1: Mouse version of maze game, from Zendle (2016)

Priming was measured using the Image Categorisation Task where there were two types of images presented, those related to animals and those related to vehicles. If priming happens in games then people exposed to the mouse version of the game should react more quickly to animal related images than vehicle related images. And conversely, those who played the car version of the game should react more quickly to the vehicle related images. The results are shown on an interaction plot in Figure 2.

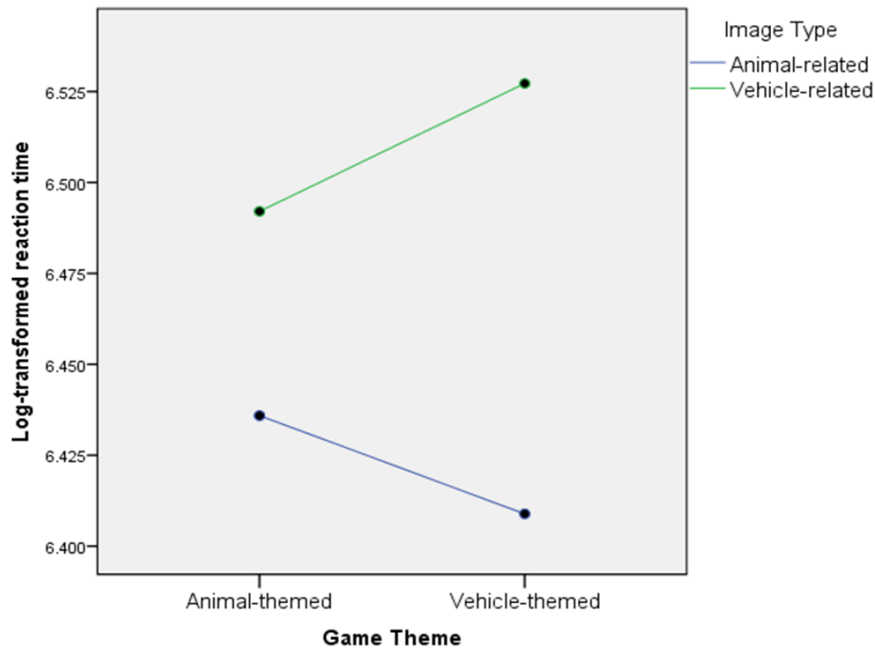


Figure 2: Interaction plot of log reaction times for the two different types of images and the two different versions of the game, from Zendle (2016)

The most obvious difference is the gap between the two lines. People react more slowly to vehicle related images than animal related images but this is not remarkable. Not all concepts are equally salient and so people react less quickly to some concepts than others. What is important in these results is that the lines are not parallel. This reflects a small but significant interaction effect. Further, and more surprisingly, the direction of the interaction is the wrong way for priming: players who played the mouse version version of the game reacted more slowly to animal related images than those who played the car version of the game; and players who played the car version of the game reacted more slowly to vehicle related images.

This is the opposite of priming, named negative priming (Tipper, 1985), where the concepts in the game are actually reducing the ease with which people respond to related concepts. This strongly suggests that if anything, the representation of concepts in the game means that players are less likely to think about them. This strongly undermines the first step in the GLM/GAM of how games lead to learning.

In all fairness, there does need to be some caution. Note the scales on the sides of the graph in Figure 2. The effects seen are small. This is typical of priming experiments because of all the other things a person might be thinking about (remember the dancing hippos). However, across a series of studies, Zendle found no

evidence for positive priming of concepts through games. If anything, negative priming was more likely (Zendle, 2016).

4.2 Learning what in games?

Thus, while people clearly do learn while playing games and simulation games in particular do lead to genuine development of skills, it is not enough to put something in a game and expect players to learn about it. The basic assumptions of the GLM/GAM or any model of learning that relies on mere exposure must be called into question. If learning, and certainly the learning of aggressive behaviours, is attributable to games then there must be other factors that make the learning happen.

Interestingly, many serious games do rely on representing concepts in games as the basis for delivering their message. Indeed, this probably needs to be the first step in any serious game to have a meaningful outcome. However, mere representation seems unlikely to be sufficient for learning to take place. It may be that there needs to be other links between the game and real world situation otherwise players actually suppress the concepts represented in order to get on with the process of playing the game. For instance, it may be that representation in games needs to be tied to the actions of players in games, effectively moving players more to simulating some real world concept. However, we are a long way from having clear models of how this might work let alone proposing mechanisms to bring about effective learning.

5 Where does the time go?

Clearly then, games have the potential to promote well-being in players but is it through flow? And games have the capacity for supporting learning but what exactly are the mechanisms that lead to good learning? And can we achieve these real world outcomes with diminishing the fun that makes people engage with games in the first place? Though it is certainly possible to have isolated systems that use games well to achieve real world outcomes, without good underpinning theories and concepts of how games work, there is little chance of achieving systematic, reliable development of games that are more than just fun. Good research is needed first to identify the concepts and then the theories that explain how the popularity and engagement in games can be transferred to achieving something outside of fun.

However, there are numerous challenges to manipulating games to elucidate what makes games so engaging. The huge variety of components in games including sound, controllers, graphics, mechanics, feedback and so on all interact in complex ways to build up the experience of play. To illustrate this more concretely, let's take the issue of time perception in digital games.

It is commonly stated that, when people are playing games, they lose a sense of time. This is noted in lots of highly engaging activities and is a constituent of flow (Csikszentmihalyi, 2002), but is also seen in other specific measures of player experience including immersion (Jennett et al, 2008) and engagement (Brockmyer et al, 2009). Thus, to understand player experiences, it would seem useful to isolate what influences players' perception of time while they play.

There are various ways in which people are able to perceive time, depending on whether time is being considered on the very small scales of milliseconds or on the lifetime scales of years (Hammond, 2012). In the context of playing a game though, the timescales involved are in the order of minutes to hours. On these scales, two particular paradigms of time perception are relevant (Block and Zakay, 1997):

- retrospective time perception: where players are asked to estimate the duration of playing after having finished playing and without knowing that they would be asked
- prospective time perception: where players are told they will be asked to estimate the duration of play ahead of playing

Both paradigms have been used extensively in psychology research and though challenging, some robust effects do seem to present themselves in how both paradigms are influenced differently. Thus, in order to examine time perception in digital games, Imran Nordin set about a series of experiments intended to manipulate players' time perception over short periods of play of 5 to 10 minutes (Nordin, 2014). Despite a wide variety of manipulations across nearly a dozen experiments covering both paradigms, Nordin was unable to find any systematic influence of digital games on time perception even when there were differences in levels of immersion due to the experimental manipulations.

It seems then that, though players report losing track of time when involved in playing games, this does not naturally map to known mechanisms of time perception. Of course, it could simply be that players are actually insensitive to time when playing and that "losing track of time" is in some way figurative rather than a literal experience.

Alena Denisova therefore investigated this explicitly to see whether time could be used to manipulate players' experiences (Denisova and Cairns, 2015). Players were set to play a survival/shooting game for a fixed amount of time with the timer counting down during play. However, unbeknownst to the players, in one condition of the experiment, the ticking of the timer was adjusted depending on whether players were performing well or performing badly. Better players got less time, worse players got more time. The result was that the players for whom the timer adapted were more immersed in the game than those players where time ran at a steady rate. Thus, players were sensitive to the passing of time but not one player in the experimental condition noticed the adaptation of the timer.

One explanation then of both these findings is that players are indeed sensitive to time but that our experimental measurement techniques were not sufficiently sensitive to detect them. So Denisova did a further experiment where she told some players that there was an adaptive timer and others that there was just a normal timer. And for half of each of these groups, what they were told was true and for the other half false (Denisova, 2017). What she found here was that the players who were told about the adaptation experienced increased immersion *whether or not it was true*. Additionally, as with the previous experiment, players who experienced an adaptive timer were more immersed in the game on top of any effect due to what they were told. This seems to suggest that players perception of time is both reliable and can be fooled at the same time!

After all these studies, we do not know how players' sense of time is altered by playing digital games only that time is relevant to the play experience. The best explanation is that players do experience time in some way but they are not in any position to articulate this clearly as a systematic effect. It may be that there are mechanisms of time perception being used while playing (or indeed engaged in any other task) that are inaccessible to the existing experimental paradigms. What is clear that we are a long way from understanding the experience of time while playing.

Thus, there are considerable challenges in researching how games might have real world outcomes before even turning to developing ways to bring about those outcomes. A concept that is reportedly central to immersive experience of playing games, namely the perception of time, is elusive in experimentation. What then of other concepts that are also said to be crucial to the experience of games, such as challenge and fantasy (sherry20606video)? And when players' experiences of a game are even sensitive to what they are told, whether or not it is true, then how should researchers instruct participants of studies without biasing their results? This is not an issue of sloppy methodology in games-related research but rather a deep problem about how people respond flexibly and openly to the experiences games offer.

6 Conclusions

The success of games is alluring. Where other interactive systems may have luke warm or positively chilly receptions from users, games have huge popularity and seem to go from strength to strength. It would be marvellous to draw on the success of games to provide useful or meaningful real world experiences to players merely as a result of playing. Yet, as this chapter hopefully shows, we are really a long way from understanding what players feel and think about when they are playing. This chapter is primarily a call for more research because not only do we not know how games engender player experiences, we do not even really know what those experiences are or even how to research them. For now, the best we can say is that games are just a bit of fun.

References

- Anderson CA, Bushman BJ (2001) Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological science* 12(5):353–359
- Block RA, Zakay D (1997) Prospective and retrospective duration judgments: A meta-analytic review. *Psychonomic bulletin & review* 4(2):184–197
- Boniwell I (2012) Positive Psychology In A Nutshell: The Science Of Happiness: The Science of Happiness, 3rd edn. Open University Press
- Brockmyer JH, Fox CM, Curtiss KA, McBroom E, Burkhart KM, Pidruzny JN (2009) The development of the game engagement questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology* 45(4):624–634
- Brown E, Cairns P (2004) A grounded investigation of game immersion. In: CHI'04 extended abstracts on Human factors in computing systems, ACM, pp 1297–1300
- Buckley KE, Anderson CA (2006) A theoretical model of the effects and consequences of playing video games. In: Vorderer P, Bryant J (eds) *Playing video games: Motives, responses, and consequences*, pp 363–378
- Cairns P, Cox A, Nordin AI (2014) Immersion in digital games: Review of gaming experience research. In: *Handbook of Digital Games*, Wiley Online Library, pp 337–361
- Chen J (2007) Flow in games (and everything else). *Communications of the ACM* 50(4):31–34

- Collins E, Cox AL (2014) Switch on to games: Can digital games aid post-work recovery? *International Journal of Human-Computer Studies* 72(8):654–662
- Csikszentmihalyi M (2002) *Flow: The classic work on how to achieve happiness*. Random House
- Denisova A (2017) *Adaptive technologies in digital games: The influence of perception of adaptivity on immersion*. PhD thesis, University of York, URL <http://etheses.whiterose.ac.uk/16463/>
- Denisova A, Cairns P (2015) Adaptation in digital games: The effect of challenge adjustment on player performance and experience. In: *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, ACM, pp 97–101
- Engeser S, Schiepe-Tiska A (2012) Historical lines and an overview of current research on flow. In: *Advances in flow research*, Springer, pp 1–22
- Eysenck MW, Keane MT (2010) *Cognitive psychology: A student's handbook*, 6th edn. Psychology Press
- Gee JP (2004) *What video games have to teach us about learning and literacy*. Macmillan
- Hammond C (2012) *Time warped: unlocking the mysteries of time perception*. Canongate Books
- Jackson SA, Eklund RC (2002) Assessing flow in physical activity: The flow state scale–2 and dispositional flow scale–2. *Journal of Sport and Exercise Psychology* 24(2):133–150
- Jennett C, Cox A, Cairns P, Dhoparee S, Epps A, Tijs T (2008) Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies* 66(9):641–666
- Juul J (2013) *The art of failure: An essay on the pain of playing video games*. Mit Press
- Malone TW (1981) Toward a theory of intrinsically motivating instruction. *Cognitive science* 5(4):333–369
- McGonigal J (2011) *Reality is broken: Why games make us better and how they can change the world*. Penguin
- Moneta GB (2012) On the measurement and conceptualization of flow. In: *Advances in flow research*, Springer, pp 23–50
- Nordin A (2014) *Immersion and players' time perception in digital games*. PhD thesis, University of York
- Petralito S, Brühlmann F, Iten G, Mekler ED, Opwis K (to appear) A good reason to die: How avatar death and high challenges enable positive experiences. In: *ACM CHI 2017*
- Ravaja N, Turpeinen M, Saari T, Puttonen S, Keltikangas-Järvinen L (2008) The psychophysiology of James Bond: Phasic emotional responses to violent video game events. *Emotion* 8(1):114
- Ritterfeld U, Cody M, Vorderer P (2009) Introduction. In: *Serious games: Mechanisms and effects*, Routledge, pp 3–9
- Ryan RM, Rigby CS, Przybylski A (2006) The motivational pull of video games: A self-determination theory approach. *Motivation and emotion* 30(4):344–360
- Sherry JL (2015) Formative research for stem educational games. *Zeitschrift für Psychologie*

Sinnamon S, Moran A, O'Connell M (2012) Flow among musicians: measuring peak experiences of student performers. *Journal of Research in Music Education* 60(1):6–25

Squire K (2005) Changing the game: What happens when video games enter the classroom. *Innovate: Journal of online education* 1(6)

Steinemann ST, Mekler ED, Opwis K (2015) Increasing donating behavior through a game for change: The role of interactivity and appreciation. In: *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, ACM, pp 319–329

Sternberg RJ (1999) *Cognitive Psychology*, 2nd edn. Harcourt Brace

Swann C, Keegan RJ, Piggott D, Crust L (2012) A systematic review of the experience, occurrence, and controllability of flow states in elite sport. *Psychology of Sport and Exercise* 13(6):807–819

Sweetser P, Wyeth P (2005) Gameflow: a model for evaluating player enjoyment in games. *Computers in Entertainment (CIE)* 3(3):3–3

Tang S, Hanneghan M, El Rhalibi A (2009) Introduction to games-based learning. In: *Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces: Techniques and Effective Practices*, IGI Global, pp 1–17

Tipper SP (1985) The negative priming effect: Inhibitory priming by ignored objects. *The Quarterly Journal of Experimental Psychology* 37(4):571–590

Tipper SP, Driver J (1988) Negative priming between pictures and words in a selective attention task: Evidence for semantic processing of ignored stimuli. *Memory & Cognition* 16(1):64–70

Triberti S (2016) This drives me nuts! In: Villani D, Cipresso P, Gaggioli A, Riva G (eds) *Psychology and Mental Health: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications*, IGI Global, pp 269–292

UKIE (2017) Uk videogames factsheet. URL [https://ukie.org.uk/research\(hashtag\)fact\(underscore\)sheet](https://ukie.org.uk/research(hashtag)fact(underscore)sheet)

Vella K, Johnson D (2012) Flourishing and video games. In: *Proceedings of The 8th Australasian Conference on Interactive Entertainment: Playing the System*, ACM, p 19

Vella K, Johnson D, Hides L (2013) Positively playful: when videogames lead to player wellbeing. In: *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, ACM, pp 99–102

Wattanasoontorn V, Boada I, García R, Sbert M (2013) Serious games for health. *Entertainment Computing* 4(4):231–247

Zendle D (2016) Priming and negative priming in violent video games. PhD thesis, University of York, URL <http://etheses.whiterose.ac.uk/16463/>