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Game-based learning: latest evidence and future directions

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● independent ● insights ● breadth ● connections ● outcomes

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Introducing The NFER
Research Programme
Innovation in Education

NFER has a worldwide reputation for excellence in research in education and children's services, built up over 65 years of working with a wide range of partners to produce independent evidence to inform change.

As a charity, the Foundation exists to improve the education and life chances of learners through the provision of independent evidence aimed at influencing policy, informing practice in the learning environment and directly impacting learners. To help achieve this, The NFER Research Programme was set up in 2011. Funded by the NFER and its partners, it is developing partnerships with organisations and individuals who share our commitment to solving unanswered challenges young people face in education. The programme targets key areas of education, highlighting gaps in existing evidence and conducting new research to provide the evidence to fill the gaps. Current areas of focus are *From Education to Employment*, *Developing the Education Workforce* and *Innovation in Education*.

Led by *Futurelab at NFER*, the *Innovation in Education* strand of work will provide evidence about new approaches to education, teaching and learning. We aim to provide evidence about rewarding learning experiences that will inspire, challenge and engage all young people, and equip them with the essential skills and attitudes for life, learning and work in the 21st Century.

This review is the first publication from the *Innovation in Education* strand of the Research Programme and provides a better understanding of the impact and potential impact of game-based learning for school-aged learners, identifies the implications for schools and learners and highlights a number of unanswered research questions.

Sarah Maughan
Research Director, NFER

Executive summary

This review is the first output in the Innovation in Education strand of NFER's research programme. This strand will provide evidence about new approaches to education, teaching and learning and aims to identify rewarding learning experiences that will inspire, challenge and engage all young people, equipping them with the essential skills and attitudes for life, learning and work in the 21st Century. Interest around the use of video games in education is high, and following the emergence of new trends like 'gamification', Futurelab@NFER felt that it was timely to provide educators, industry and researchers with an up-to-date analysis of the literature.

To achieve this, we conducted a rapid review of the latest available evidence, seeking to answer these research questions:

- What is game-based learning?

- What is the impact and potential impact of game-based learning on learners' engagement and attainment?

- What is the nature and extent of the evidence base?

- What are the implications for schools?

The research questions are mainly concerned with the notion of 'gameplay' (playing games) rather than 'making games' (how the prospect of creating original video games can be used to interest young people in complex activities like software programming).

What is game-based learning in education?

- 'Game-based learning' broadly refers to the use of video games to support teaching and learning. Although it is a relatively established notion, it is hard to define precisely. We have arrived at a definition by extracting the key principles and mechanisms involved, which Figure 1 shows.

Figure 1: The principles and mechanisms of game-based learning
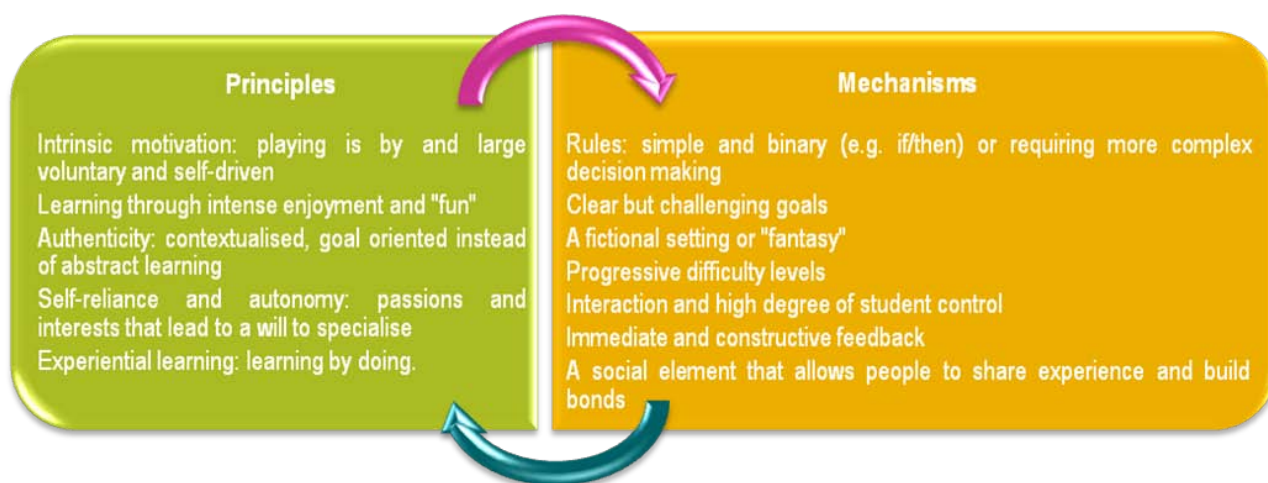
Principles

Intrinsic motivation: playing is by and large voluntary and self-driven
Learning through intense enjoyment and "fun"
Authenticity: contextualised, goal oriented instead of abstract learning
Self-reliance and autonomy: passions and interests that lead to a will to specialise
Experiential learning: learning by doing.

Mechanisms

Rules: simple and binary (e.g. if/then) or requiring more complex decision making
Clear but challenging goals
A fictional setting or "fantasy"
Progressive difficulty levels
Interaction and high degree of student control
Immediate and constructive feedback
A social element that allows people to share experience and build bonds

- 'Gamification' is a much newer concept than game-based learning. It is about using 'elements' derived from video-game design, which are then deployed in a variety of contexts, rather than about using individual video games.

- 'Gameplay' is the treatment of topics and ideas as rules, actions, decisions and consequences, rather than as content to be communicated or assimilated. Video games can be seen to allow learners to engage with topics and ideas through interaction and simulation, rather than through the conventional materials and formats of schooling: textbooks, lessons, assignments and so forth.

Impacts and potential impacts

- The literature was split on the extent to which video games can impact upon overall academic performance. Where studies expressly sought to measure 'academic achievement', five calculated some degree of improvement. Further, a meta-analysis of studies observed significant, but undefined, cognitive gains across studies utilising games versus traditional teaching methods. However, four studies found no impact on academic achievement.

- The studies consistently found that video games can impact positively on problem solving skills, broader knowledge acquisition motivation and engagement. All five studies that specifically focused on problem solving skills found some degree of improvement, and the majority of the studies examining the impact of video games on student motivation and engagement found positive results. However, it was unclear whether this impact could be sustained.

- Relatively few studies explored attitudes to learning as a possible outcome and their findings varied. One found that games promoted a more positive attitude to maths learning. A further study explored mathematics or academic self-concept (the set of beliefs an individual holds about themselves as a mathematician) and found no improvement. However, a meta-analysis found that significantly better attitudes towards learning were yielded for subjects using interactive games or simulations, compared to those using traditional methods for instruction.

- Despite some promising results, the current literature does not evidence adequately the presumed link between motivation, attitudes to learning and learning outcomes. Overall, the strength of the evidence has been affected by the research design or lack of information about the research design.

Some recommendations and 'take-home' points for teachers

- The evidence suggests that game-based learning can improve engagement and motivation, but don't rely on games to improve attainment - there is still a lot we don't know about the impact of video games on learning.

- The best way of integrating gaming into teaching is by using it within a clear pedagogic process. In particular:

- Place learning activities and academic content within the video game's fictional and entertainment context, maintaining a balance between fun and learning.

- Make the academic content integral to the game rather than an add-on. Content-specific tasks work better when embedded in the fictional context and rules ('mechanics') of the game.

- Carefully plan the roles that you and your learners will take on in the game. Teachers should play roles that allow them to mediate the experience for learners: providing guidance when needed; ensuring that rules are followed; and maintaining a respectful atmosphere.

- Don't try to divorce decontextualized components of a game (such as badges, scores or leaderboards) from the fictional context and rules of the game (the 'mechanics')

Implications for future research

- It is important we develop a more analytic approach that considers how the different elements that operate within video games impact in an educational setting.

- We noted a complete lack of evidence about 'gamification', that is, the use of techniques and mechanisms derived from video games, rather than actual games. More research is needed on the impact of such techniques and mechanisms on learning outcomes. Can such elements be detached from the technology, without losing their meaning or potency? Can they be used effectively to add value to traditional teaching and learning?

- Opening up the 'black box' of video games would enable us to focus on specific principles or mechanisms. This finer grained approach could unlock a more rewarding research agenda.

- We have identified three research challenges:

    1. Working towards a consensus about the relationship between academic achievement and game-based learning. Efforts are needed to articulate clear relations between game elements and a range of outcome from a broad level (e.g. platform on which the game runs, single player, multiplayer, and so forth), gradually narrowing down to specific gameplay mechanics.
    2. Unpacking further the relationship between gaming and academic achievement in the context of educational assessment. Games seem to allow more powerful and 'always-on' forms of assessment in which all actions, interactions, successes and failures can be constantly tracked and logged. This raises a number of empirical and ethical issues.
    3. Developing research into the potential of video games that accounts for the realities of schools. In particular, more research is needed into the social, cultural and economic factors that influence attitudes towards the use of game-based learning in our increasingly diverse and multicultural schools.

Methods

- We carried out a rapid review of key literature to identify relevant theoretical contributions and evidence. This involved systematic searching and a consistent, best evidence,

approach to the selection of the literature. We focused on a range of sources, including empirical, practice-based evidence and more speculative literature, published from 2006 onwards.

- The process led to a shortlist of 31 items, which we appraised. This involved extracting key data about the items and assessing their quality and relevance to the study, based on a structured appraisal of their full texts.

1. Introduction and aims

The role of video games in teaching and learning is a source of debate among many educators, researchers and in the popular press. Detractors and advocates have been discussing the influences and the potentials of video games for quite some time, and we feel that sound evidence and informed advice on these topics is still very much needed. Against this background, Futurelab@NFER felt that it was timely to provide practitioners, industry and researchers with an up-to-date account of what the evidence tells us about game-based learning and its potential impact on learning and teaching.

This review is the first output in the 'innovation in education' strand of NFER's research programme. This strand will provide evidence about new approaches to education, teaching and learning and aims to identify rewarding learning experiences that will inspire, challenge and engage all young people, equipping them with the essential skills and attitudes for life, learning and work in the 21st Century.

The review aims to bridge academic and non academic domains, to provide insights that will be of interest to educators, educational researchers, industry and others seeking to engage in a more thoughtful debate about the types of educational values that can be attached to gaming. In particular, we provide accessible advice for practitioners, in the belief that innovation in education is always underpinned by informed and critical teaching.

1.1 Review aims and questions

This review aims to:

- develop a better understanding of the impact and potential impact of game-based learning for school-aged learners;
- identify the implications for schools and learners;
- identify unanswered research questions.

To achieve these aims, in so far as we can from the available evidence, we seek to answer four research questions:

- What is game-based learning?
- What is the impact and potential impact of game-based learning on learners' engagement and attainment?
- What is the nature and extent of the evidence base?
- What are the implications for schools?

The research questions listed above are mainly concerned with the notion of 'gameplay' (playing games) rather than 'making games' (how the prospect of creating original video games can be used to interest young people in complex activities like software programming). We will explore the relationship between gameplay and learning from an

empirical (impacts and effects) point of view. We will also consider promising research areas that could be further explored.

1.2 Methods

We carried out a rapid review of key literature to identify relevant theoretical contributions and evidence. This involved systematic searching and a consistent, best evidence, approach to the selection of the literature. We focused on a range of sources, including empirical, practice-based evidence and more speculative literature, published from 2006 onwards.

To identify relevant items we looked for relevant sources across a number of databases and search engines. We developed a search strategy by using the controlled vocabulary pertinent to each source. The keyword terms included combinations of: 'game-based learning', 'gamification', 'game design', 'attainment', 'good practice', 'outcomes' and others (see appendix for the full search strategy). Table 1 presents the main criteria for the identification of relevant literature.

Table 1: Selection criteria for the inclusion of literature

Publication date:	Work published from the year 2006
Geographical scope:	United Kingdom and international
Language:	Published in English
Study type:	Empirical research and/or evaluation; good practice examples; theoretical items; published literature (peer and non-peer reviewed)

As expected, the search returned a large number of items (485). We reviewed all abstracts to select contributions that were of greatest relevance to the research questions. During the screening and coding phases we also took into account additional criteria:

- Distinctions between different kinds of evidence, such as: quantitative evidence and qualitative evidence; well-established trends and emerging findings.

- The validity or trustworthiness of individual studies' findings according to the research design, sample size, methods of data collection and data analysis, theoretical approach, and relationship between claims made and evidence presented.

The process led to a shortlist of 31 items, which we appraised. This involved extracting key data about the items and assessing their quality and relevance to the study, based on a structured appraisal of their full texts. We applied the following quality criteria:

- **High**: large scale quantitative studies, meta-analyses or in-depth qualitative case studies covering a range of settings and stakeholders where views are triangulated; systematic reviews have also been included in this category .

- **Medium**: quantitative or qualitative studies with smaller samples; qualitative studies not covering a range of settings or stakeholders; non-systematic reviews. We also included in this category more speculative contributions that are based on existing theories and indirect evidence.

NB: In accordance with the 'best evidence' approach, we have adopted a relativistic approach, considering the best available evidence we could identify. As such, the 'high' criterion does not necessarily equate to 'gold standard' evidence, such as Randomised Controlled Trials (RCTs).

1.3 The evidence base

Table two summarises the evidence base in relation to the quality criteria considered:

Table 2: Extent and nature of the core evidence

	High	Medium
Qualitative	N/A	Marković *et al.,* 2007; Salen, 2008
Quantitative	Chuang and Chen, 2009; Delacruz, 2011; Huizenga *et al.,* 2009; Miller and Robertson, 2011	Annetta *et al.,* 2009; Bourgonjon *et al.,* 2010; Brom *et al.*, 2011; Fengfeng, 2008a; Kenny and McDaniel, 2011; Kolovou and Heuvel-Panhuizen*,* 2010; Liu *et al.,* 2011; Papastergiou, 2009; Schaaf, 2012; Spires *et al.,* 2011; Vos *et al.,* 2011; Ya-Ting, 2012
Mixed methods	N/A	Fengfeng, 2008b; Kebritchi *et al.*, 2010
Review and Meta-analysis	Chiu *et al.,* 2012; Vogel *et al.,* 2006; Young *et al.,* 2012	De Freitas and Griffiths, 2008; Kapp, 2012; Williamson, 2009
Speculative	N/A	Bogost, 2011; Buckingham, 2007; Gee, 2008; McGonigal, 2011; Shaffer, 2008

As you can see, Table 2 shows some basic descriptive information about the items that we selected for inclusion in the review. Most notably, just over half of the items we selected to include in the review (16) were quantitative studies. Of these, four items were judged as being of 'high' quality and 12 of 'medium' quality. It is also worth noting that five speculative items were included. These publications focused mainly on theoretical discussion, citing indirect evidence to support claims or trying to suggest a research agenda for the future. We have taken the view that these contributions are important, as they have shaped the theoretical debate about game-based learning and gamification.

Chapter Two, which covers key definitions, draws on eight items of literature: one quantitative study; one edited book (Salen, 2008), classified as qualitative as it features case studies and ethnographic research; one review and five speculative items. The evidence for this chapter is therefore less robust than for the chapter on impact (Chapter Three). Applying

lower inclusion criteria enabled us to discuss highly relevant and influential items that would otherwise have been excluded from the review. Chapter Three, which explores the impact and potential impact of video games on learning, draws on 21 of the items that we systematically selected for inclusion. Of these, 18 items are primary studies (qualitative, quantitative or mixed methods), and three are meta-analyses or reviews. Six of the items are 'high' quality, while the remaining 15 are 'medium' quality. Chapter Four, which focuses on possible research areas for the future, takes into account all of the reviewed literature

2. Definitions

- Game-based learning' broadly refers to the use of video games to support teaching and learning. Although it is a relatively established notion, it is hard to define precisely. We have arrived at a definition by extracting the key principles and mechanisms involved.

- 'Gamification' is a much newer concept than game-based learning. It is about using 'elements' derived from video-game design, which are then deployed in a variety of contexts, rather than about using individual video games.

- 'Gameplay' is the treatment of topics and ideas as rules, actions, decisions and consequences, rather than as content to be communicated or assimilated.

2.1 What does this section cover?

This chapter sets out the definitions of the key terms used in this review: game-based learning, gamification and gameplay.

2.2 What literature did we consider?

We based the definitions on our review and synthesis of eight items of literature, six of which are non-empirical items, as Table 3 shows. In selecting which literature to draw on, we prioritised influential contributions, rather than the most robust studies. The definitions and concepts first introduced in this more speculative and theoretical literature have informed many empirical studies, and are frequently cited as background and inspiration.

Table 3: Extent and nature of literature considered for Chapter Two

	High	Medium
Qualitative		Salen, 2008
Quantitative		Annetta *et al.,* 2009
Review		De Freitas and Griffiths, 2008
Speculative		Bogost, 2011; Gee, 2008;Kapp, 2012; McGonigal, 2011; Shaffer, 2008

2.3 What does the literature say?

The contributions we reviewed suggested that game-based learning broadly refers to the use of video games to support teaching and learning. Different studies articulate and interpret this broad definition in different ways.

All the items reviewed in this chapter share the view that game-based learning is less about the computer game as a specific entity and more about the complex social dynamics that surround it. Game-based learning may or may not involve 'educational' video games (those with an explicit focus on learning and improving attainment) rather than 'leisure-use' video games. According to some authors, game-based learning encompasses technological developments that are blurring the lines between formats, spaces, languages and practices associated with video games, leading to 'blended' experiences, which are not just confined to the video game itself (De Freitas and Griffiths, 2008).

In terms of the social dynamics of game-based learning, a common theme is that through video games young people cultivate interests and join 'affinity groups' that operate across contexts, as part of their projects of personal development. In these groups, players engage in sophisticated forms of learning fuelled by the shared passion for gaming. They include forums where players share 'cheats'; wikis[1] that clarify elements of the game universe; and 'modding' groups who use game development skills to modify how games are played and experienced (Gee, 2008). A similar, and equally popular, theme is that video games provide virtual worlds which are effective contexts for learning, because acting in such worlds allows learners to develop social practices and take on the identities of actual professional communities. These soft learning outcomes are seen by many commentators as more useful and worthy than the 'outdated' forms of knowledge acquired through traditional schooling (Shaffer, 2008).

We also found the work of Bogost (2011) particularly useful to explore a definition of game-based learning. Bogost is concerned with understanding the distinctive properties of video games as a medium, in order to examine the implications in a range of social contexts, including education and learning. He stresses that games are first and foremost representations that simulate certain behavious and experiences, and use rulesets, role playing and reward mechanisms to motivate and engage. They offer learners a way to more fully engage with topics or ideas than they might be able to in the 'real' world. They can exercise choice and control over (virtual) reality, without incurring any real consequences. This means that a video game allows, at least in theory, learners to experience a certain school subject through interaction and simulation, rather than through the conventional materials and formats of schooling: textbooks, lessons, assignments and so forth. Bogost contends that video games treat topics and ideas not as content to be communicated or assimilated, but as rules, actions, decisions and consequences – that is, **gameplay**.

One item focused instead on '**gamification**'. Kapp describes gamification as 'the careful and considered application of game thinking to solving problems and encouraging learning using all the elements of games that are appropriate' (Kapp, 2012, p.12).

This notion seems to move away from much of the literature on game-based learning as described in this review, where there is a clear distinction between video-games on the one hand, and the learning dynamics that they may or may not enable on the other. As the word

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[1]Collaboratively developed repositories of knowledge, the most popular of which is Wikipedia (www.wikipedia.org).

suggests, gamification is more concerned with how certain situations or processes (including learning) can be turned into playful experiences that, indeed, resemble video games.

Gamification is therefore interested in 'gaming' as a set of principles, tools and techniques, which are born in video games but spill over into several other contexts, including education. This spill-over has also been described as 'adding a game layer on top of the world'[2], thus suggesting that a range of human endeavours could benefit from being viewed as games. In this 'gamified' reality, rules and principles like those used by successful game designers could make children and young people eager to engage in educational activities they used to find boring, unrewarding or too difficult. For teachers, this raises the possibility of using 'gamification' as a strategy to improve teaching, learning and assessment. At its simplest, this could mean using game-based techniques to encourage competition and self-improvement in the classroom: badges, high scores, leaderboards and so forth. Similarly, it could mean employing video game language to reframe traditional school activities – for instance, assignments could become 'missions' or 'quests'.

2.4 Moving towards a definition

Taking into account all of the reviewed literature, we could further describe game-based learning as a form of experiential engagement in which people learn by trial and error, by role-playing and by treating a certain topic not as 'content' but as a a set of rules, or a system of choices and consequences.

In curricular terms, this means translating an element of a subject (such as a law of physics or the law of supply and demand) into the mechanics of a game, which operates within a self-contained system based on choices and consequences. For instance, in the popular series of simulation games SimCity[3], players are tasked with running a virtual city, managing a number of concurrent activities and priorities to keep the population happy. According to the creator of the series (Pearce, 2002), the gameplay in SimCity reflects a specific logic (a 'model') of city-wide management. This could be likened to gardening.

> *'if you really think about playing the game, it's more like gardening. So you're kind of tilling the soil, and fertilizing it, and then things pop up and they surprise you, and occasionally you have to go in and weed the garden, and then you maybe think about expanding it, and so on'* (OP. CIT).

In SimCity, players act according to the rules determined by this internal logic, which means that each choice you make in the game has a specific effect. As such, 'learning through gameplay' in SimCity means exploring the possibilities and the limits that are offered by the underlying model: if the population is starved, then chaos and riots will ensue; if the city is to be expanded, then sources of income are needed; and so forth. All this is performed in a safe environment where failure is not only contemplated but actively encouraged. In fact,

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[2]This is the title of a talk filmed for the website TED:
http://www.ted.com/talks/seth_priebatsch_the_game_layer_on_top_of_the_world.html
[3]A SimCity 'EDU' version hasjust beenannounced. The result of a partnership between the video games company Electronic Arts and the Glass lab. See http://signup.simcityedu.org/

part of the fun is the awareness that mistakes have no lasting or real consequences, but are simply necessary to improve performance.

Complementing the definition proposed above, we suggest a number of principles and mechanisms that we have inferred from the literature considered for this chapter. These are shown in Figure 1 (below). By 'principles' we mean underlying assumptions and concepts; by 'mechanisms' we mean processes and dynamics that help us understand how video games can, in theory, assist the pursuit of educational goals. The principles and mechanisms involved in game-based learning are interdependent.

Some readers may be struck by the commonsensical nature of some of the elements considered. Arguably, this goes some way to illustrating how innovations work best when they bring into sharper relief what we know already about education and learning.

Figure 1: The principles and mechanisms of game-based learning

Principles

1. **Intrinsic motivation**. Gaming is intrinsically motivating because by and large it's a voluntary activity. Therefore, gaming for learning works best in the context of invitation and persuasion, rather than compulsion.

2. **Learning through intense enjoyment and "fun"**. Several authors suggest that games can be a vehicle for engaging students in a "flow". Flow is a state of consciousness during which an individual is in control of his actions and completely absorbed in the task at hand.

3. **Authenticity**. Authenticity means a concern for the real nature of learning, which is supposedly different from the "artificial" or decontextualised forms of learning that take place in schools. In the name of authenticity, contextual skills are prioritised over the abstract notions and facts valued in traditional instruction. Therefore, "good" gaming reflects actual learning processes, which are always grounded in specific settings and practices. These can be actual professions, but also extravagant, fantastic roles and endeavours.

4. **Self-reliance and autonomy**. Gaming encourages independent inquiry and exploration; interests and passions can branch off from the individual game, towards aspects of the "ecosystem" that surrounds it. These aspects include technical and artistic skills like programming, writing, drawing, making music; but also the desire to find out more about certain topics , e.g. about science, history or mythology.

5. **Experiential learning**. The notion of experiential learning is a very old and influential one in education, dating back to the seminal work of John Dewey. Many claim that gaming provides a cost effective alternative to learning by doing in real settings.

Mechanisms

1. **Rules**. At their most basic level, video games are sets of rules. These rules can be more or less complex depending on the choices they elicit and the related consequences. For instance, rules can be simple and binary (if/then); or multifaceted and accommodating a broad range of decision making processes.

2. **Clear but challenging goals**. The presence of clearly defined, demanding activities which, although might appear arbitrary and unnecessary, allow people to see the direct impact of their efforts.

3. **A fictional setting or "fantasy" that provides a compelling background**. This is an essential but easily misunderstood aspect of gaming. Notwithstanding the tendency to indulge in escapism and compensatory fantasies, classic studies on playing suggest that pretence can also be a deliberate and conscious strategy that assists learning. A consensual and transparent adherence to a fictional setting or role allows players to experiment with skills and identities without suffering the consequences of failure in real life.

4. **Progressive difficulty levels** , underpinned by understandable criteria for progression. Over the years game developers have devised mechanisms for progression and "levelling up" to a considerable degree of refinement. Not all of these mechanisms may be appropriate in an educational context, but they raise interesting questions for educators - not least the fact that players are allowed to tackle challenges and tests (like exams) as many times as necessary - and with no lasting consequences - in order to progress from one level to another.

5. **Interaction and high degree of student control**. This mechanism is strongly related to the notion of "agency": the feeling of being in control of one's destiny through actions and choices. Most importantly, it concerns the certainty that effort and dedication will be acknowledged and rewarded.

6. **A degree of uncertainty and unpredictability**. As long as it does not contradict point 5, a measured injection of uncertainty into tasks is consistent with many game developments tenets. For example, in the *Quest* schools students are not given assignments as such, but asked to choose between number of possible "missions". The scope and purpose of the missions become clear only when certain clues have been gathered and deciphered.

7. **Immediate and constructive feedback** . One of the most powerful mechanisms of video games is the ability to provide feedback in real time, not only as evaluation, but more often as guidance to facilitate and correct performance. This is largely in line with the idea of formative assessment in education.

8. **A social element that allows people to share experiences and build bonds**. As mentioned several times in this chapter, a game is not simply a product or tool which may or may not have a relationship with learning. The ecosystem surrounding the game is just as important. In fact, it is probably even more relevant from an education perspective, because it provides players with a range of opportunities to share, interact and pursue interests and passions.

3. Impact and potential impact of game-based learning

Key findings

- The literature was split on the extent to which video games can impact upon overall academic achievement. However, the studies consistently found that video games can impact positively on problem solving skills and knowledge acquisition.

- The majority of the studies examining the impact of video games on student motivation and engagement found positive results. However, it was unclear whether this impact could be sustained over time.

- Few studies explored whether video games can affect attitudes to learning. Of those that did, including one meta-analysis, a positive relationship was found.

- Despite the presumed link between motivation, attitude to learning and learning outcomes, the current literature on the subject of video games does not evidence this or adequately advance our knowledge and understanding of the mechanisms at play.

- While teachers are generally positive about the use of video games in the classroom, they would require very strong evidence of their impact before they replaced more traditional learning styles. Until this time, they are more likely to use video games to supplement existing practice.

- We found no studies into the impact of gamification - i.e. using video-game elements, rather than video-games - on learning and achievement.

3.1 What does this section cover?

This chapter focuses on the empirical studies included in our review list. It will draw out key methodological approaches (section 3.3), and go on to examine the type and extent of the impact of video games on learning (section 3.4) and possible independent variables on the extent and type of impact (section 3.5). In doing so, we aim to bring readers up to date on the current landscape and level of evidence available in relation to video games (section 3.6 concludes the chapter).

3.2 What literature did we consider?

Table 4: Extent of literature considered for Chapter Three

	High	Medium
Qualitative	N/A	N/A
Quantitative	Chuang and Chen, 2009; Delacruz, 2011; Huizenga *et al.,* 2009; Miller and	Annetta *et al.,* 2009; Bourgonjon *et al.,* 2010; Brom *et al.,* 2011; Fengfeng, 2008a; Kenny and McDaniel, 2011; Kolovou and Heuvel-

	High	Medium
	Robertson, 2011	Panhuizen, 2010; Liu *et al.*, 2011; Papastergiou, 2009; Schaaf, 2012; Spires *et al.*, 2011; Vos *et al.*, 2011; Ya-Ting, 2012
Mixed methods	N/A	Fengfeng, 2008b; Kebritchi *et al.*, 2010
Review and Meta-analysis	Chiu *et al.*, 2012; Vogel *et al.*, 2006	Williamson, 2009

As Table 4 suggests, this chapter synthesises 21 studies, mostly consisting of primary research into game-based learning or gamification in the classroom.

3.3 What does the most up to date review of the evidence look like?

3.3.1 What was the focus of the studies?

The studies were wide ranging in their focus and aimed to test a variety of hypotheses. Many of the studies acknowledge limitations in the current evidence base and, in designing their studies, seek to plug these gaps or test assumptions implicit in the literature and gaming theory. Most commonly, however, the studies sought to test the impact of gaming on learning outcomes as measured by academic achievement, cognitive performance, knowledge gain or skills and performance, such as capacity for problem solving or critical thinking.

A number of the studies also explored the impact of gaming on motivation and engagement in classroom activity . A few studies examined the impact of gaming on student attitudes to learning (in the wider context of school life or in relation to a specific subject).

The studies also sought in many cases to test or discuss the possible impact of a range of variables that may or may not mediate the impact of gaming in the classroom. Most commonly, these included student and/or teacher attitudes to gaming, type of game and the type of learning experience promoted by the game, and gender. Only one study explored the impact of previous gaming experience (Miller and Robertson, 2011).

It is notable that we found no studies into the impact of gamification - i.e. using video-game elements, rather than video-games - on learning and achievement. This is a clear gap in the evidence base.

3.3.2 How were studies designed?

Mathematics was the **most common subject domain** to feature in primary studies (six studies: Delacruz, 2011; Fengfeng, 2008a and b; Kebritchi *et al.*, 2010; Kolovou and Heuvel-Panhuizen, 2010; Miller and Robertson, 2011), whilst two featured science (Annetta *et al.*,

2009; Spires *et al.,* 2011). The remainder individually focused on computer science (Huizenga *et al.*, 2009), language (Vos *et al.*, 2011) and civics and society (Ya-Ting, 2012). Three of the studies did not specify subject domain. One study (Chuang and Chen, 2009) intentionally avoided curriculum subjects and instead focused on the issue of 'fire fighting' so as to limit the impact of (and possibly avoid the need to control for) prior subject knowledge or attainment levels on the study.

It was apparent that students of **secondary school age** were most likely to have been selected for studies (although some studies did not specify the age range of students involved). One study focused on first year university students, and only one study featured pupils of primary school age (Schaaf, 2012).

It is also important to note that **not all studies compared video games to traditional classroom instruction**, but instead sought to examine video games in comparison to other 'alternative learning strategies' or other 'media rich learning materials' (Brom *et al.*, 2011; Schaaf, 2012), computer based (non-game) learning tools or instruction packages (Chuang and Chen, 2009; Papastergiou, 2009) or different games played on different platforms (e.g. in Delacruz, 2011 where a game was played on the Ipod Touch as opposed to a laptop). In around four studies it was not apparent whether or not a control group had been used (Bourgonjon *et al.*, 2010*;* Fengfeng, 2008b; Kolovou and Heuvel-Panhuizen*,* 2010; Liu *et al.*, 2011).

From the information available, it was apparent that the majority of studies sought to test the impact of **games whose structure reflected one or more of the main principles of game-based learning** (for example, rules, goals, an element of fantasy, difficulty levels, and feedback; more information on the 'mechanisms' of gameplay-based learning are discussed in Chapter Two, section 2.4.1). For example, five studies (Chuang and Chen*,* 2009; Kebritchi *et al.*, 2010; Liu *et al.,* 2011; Spires *et al.,* 2011; Ya-Ting, 2012) involved games that could be defined as simulation games, therefore strongly reflecting the notion of fantasy in their design and could therefore be purported to support constructionist and experiential learning theories. These games were described variously by authors as 'supporting a narrative-centred learning environment' (Spires *et al.*, 2011), a 'microworld' (Liu *et al.*, 2011), or a '3D immersive environment'(Kebritchi *et al.,* 2010). Where named, examples include Tycoon City: New York and Sim Cities Societies (Ya-Ting, 2012), Crystal Island (built on Valve Software's Source engine, the 3D game platform for Half Life 2[4]) and Fire Department 2: Fire Captain (developed by 'Monte Cristo Games') (Chuang and Chen, 2009).

Some studies chose games which aimed to isolate one principle of gaming for specific review. For example Kolovou and Heuvel-Panhuizen (2010) used an online archery game to explore game-generated feedback to support problem solving processes, whilst Delacruz

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[4] A game engine is a software framework used to design video games. The same engine can be used to create a limitless number of games. Valve Software developed Half Life 2 in 2004 using the Source engine and made the engine available to their customers so they could modify the main game or develop new ones. See http://en.wikipedia.org/wiki/List_of_Source_engine_mods for a list of games created using this engine.

(2011) used a maths focused laptop game to explore the impact of feedback as a form of 'formative assessment'.

Some studies, which sought to measure motivation and engagement, selected games which they considered to be compatible with Keller's (1987) attention, relevance, confidence, and satisfaction (ARCS) model of motivation to facilitate children's learning (Chuang and Chen, 2009; Kebritchi *et al.*, 2010).

One study found that the engaging potential of video games could be slightly problematic, especially because students may be distracted by the entertainment elements of the game if these are not effectively meshed with the instructional component (Fengfeng, 2008a). For instance, a video game to support mathematics must strive to be integral rather than ancilliary to the specific nature of the subject matter. In such a game, subject-specific tasks work better when embedded in the fictional context and consistent with other game mechanics. For instance, players may be required to compute distances to help a likable game character jump over certain obstacles (e.g. Delacruz, 2011).

There were various common factors across games, but given the varying focus and conceptual frameworks that grounded studies, it is unsurprising that the games were often quite different in nature. The level of detail about the games involved in studies was variable; whilst most focused on the features of the games (such as content and design of the game), the literature often lacked detail about who developed the game or why and for whom. For example, it was often difficult to determine if the game had been built with the express intention of meeting educational outcomes, or whether researchers were appropriating existing games to test their possible educational impact. It was also difficult in some cases to understand what hardware or consoles were necessary to facilitate play and whether the game was multi- or single-player. Overall, therefore, this lack of information and acknowledgement of game features could be considered to have implications for the overall strength of evidence around gaming in the classroom.

In order to better illustrate the contrasts apparent in games and the varied aims of studies, we have included the following three vignettes which detail the variety of games and methodologies used to explore the impact of video games on the subject domain mathematics.

> **Study 1:** *The effects of modern mathematics computer games on mathematics achievement and class motivation,* **(**Kebritchi *et al.*, 2010**).**
>
> In this study the research treatment group used a game called DimensionM™. This game was adopted in this study because it included a) advanced three-dimensional (3-D) graphics and interfaces, b) learner centred approach and encouragement of interaction with the environment, and c) multi-player options. The game teaches algebra by involving players in completing mathematics related missions within a 3-D immersive environment designed with advanced graphics. The teachers were provided with material to support lesson delivery using the game. Quantitative data was collected through student motivation surveys, surveys to collate student and teacher demographics and through the school-district benchmark exams. In addition, a series of qualitative interviews were conducted.

Study 2: *Educational benefits of using game consoles in a primary classroom: a randomised controlled trial* **(Miller and Robertson, 2011).**

In this study an experimental class of children used a games console every day for 20 minutes: a Nintendo DS Lite, playing Dr. Kawashima's Brain Training while a control group continued with their regular classroom programme. The study was designed to test the impact of the game on students' speed and accuracy of mental computation. This was measured through a 100-item test (designed to reflect the students' current stage in the Scottish Curriculum). Questionnaires were used to measure students' 'self-perception' of their own mathematics ability and attitude to school. Previous experience of computer use at home was also recorded.

Study 3: *Online game-generated feedback as a way to support early algebraic reasoning* **(Kolovou and Heuvel-Panhuizen, 2010).**

This study tested the impact of an online game on students' problem solving processes in relation to number problems. The study featured an online archery game which directly provided students with the results of their shooting actions. No control group was used. Instead, students were given a paper and pencil test on algebra – during and after which students received no feedback. A week later students could log into an online environment and play the computer game at home (to purposely remove input from teachers). The computer game provided feedback and monitored performance. After four weeks the paper and pencil test was administered again.

3.4 The type and extent of impact

3.4.1 To what extent did gaming impact on learning outcomes?

Given the complex nature of assessment and measuring academic achievement, it is perhaps unsurprising that there was not one, definitive measure against which the studies sought to explore impact on learner performance. Instead a range of outcomes were explored across studies. For example, some studies generally sought to measure the extent of knowledge gain amongst students (Brom *et al.*, 2011; Chuang and Chen, 2009; Huizenga *et al.*, 2009; Papastergiou, 2009), while others explored the impact of gaming on specific skill sets such as problem solving or critical thinking (often positing that this was predictive of student learning, but the extent to which this link was tested was variable) (Kolovou and Heuvel-Panhuizen, 2010; Liu *et al.*, 2011; Spires *et al.*, 2011; Ya-Ting, 2012). Academic achievement was often referenced as an outcome but generally without detailing the measures explored. Although this offers important evidence about the extent of impact, it makes it somewhat difficult to fully understand the nature of the outcomes. Similarly, the method of assessment varied widely; some studies adopting standardized tests commonly used to measure traditional teaching practice while, in other cases, the researcher had

employed tests developed for the purposes of academic study or tests and measures integrated into the gaming application itself.

Overall, where studies sought to measure 'academic achievement', five calculated some degree of improvement (Chuang and Chen, 2009; Delacruz, 2011; Kebritchi *et al.*, 2010; Miller and Robertson, 2011). However, four studies found no impact on academic achievement (Annetta *et al.*, 2009; Fengfeng, 2008b; Spires *et al.*, 2011; Ya-Ting, 2012). Therefore the literature is split on the extent to which video games can impact on overall learning outcomes. One explanation for this, and perhaps some of the less positive results around academic achievement, could be a possible mismatch between traditionally measured outcomes and those (such as problem solving) facilitated by games. Furthermore, most studies were not conducted over substantial periods of time, and it could therefore be argued that learning gains were not advanced enough to be reflected in standardised achievement tests. Outcome comparisons across studies may also be aided through some level of agreement and consistency on how academic achievement should be measured in relation to video games.

Perhaps more promising were the results for problem solving and knowledge acquisition; all five studies that specifically focused on problem solving skills (Chuang and Chen, 2009; Kolovou and Heuvel-Panhuizen, 2010; Liu *et al.*, 2011; Spires *et al.*, 2011; Ya-Ting, 2012) found some degree of improvement. For example, Ya-Ting (2012) credits the simulation provided by a digital game with providing an 'authentic and relevant context for problem solving' (p. 17). Likewise, all four studies (Brom *et al.*, 2011; Chuang and Chen, 2009; Huizenga *et al.*, 2009; Papastergiou, 2009) which specifically explored knowledge acquisition also all found positive results.

> **Secondary evidence**
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> In addition to the primary evidence considered above, a meta-analysis was also pertinent to our consideration of the impact of gaming on learning outcomes. (Vogel *et al.,* 2006) observed significant cognitive gains across studies utilising games versus traditional teaching methods (although it must be acknowledged that this piece of literature makes no attempt to define 'cognitive gains' or indeed how these have been measured across studies).

3.4.2 To what extent did gaming impact on motivation and engagement?

Eight of the studies explored the impact of video games on student motivation and engagement (Annetta *et al.*, 2009; Fengfeng, 2008a; Kebritchi *et al.*, 2010; Liu *et al.*, 2011; Papastergiou, 2009; Schaaf, 2012; Vos *et al.*, 2011; Ya-Ting, 2012). This factor is identified as a key principle defining gaming for learning in Chapter Two. Studies often measured this factor through student surveys which collected self-efficacy measures or students' perceived level of focus on the activity, while some also incorporated student observations or measured 'time on task' as an indicator of engagement.

It is important to note that, again, the measures used across studies to explore this outcome varied widely. The results were generally positive, with six of the studies finding that video games increased student motivation or engagement (Annetta *et al.*, 2009; Fengfeng, 2008a;

Papastergiou, 2009; Liu *et al.*, 2011; Schaaf, 2012; Ya-Ting, 2012). The two that did not find this relationship included important caveats; in one (Kebritchi *et al.*, 2010) the authors, with hindsight, felt that the test did not adequately match the design of the experiment; while in a the second study (Vos *et al.*, 2011) the authors had compared the impact of gameplay and game construction, finding that the latter did indeed have an impact on motivation and engagement, while the former actually resulted in decreased motivation. This was the only study in our review that compared 'playing games' with 'making games'. Its findings point to interesting implications which are, however, beyond the scope of the review.

A study by Huizenga *et al.* (2009) experienced technical issues with the game used by the students. They report that this issue had an impact on some students' engagement with the game, but not all. However, this does highlight the need for games to be technically sound before they are introduced into the classroom. Further, some students in this study were found to be more engaged in the game than others, with a number of students becoming distracted by other websites.

In exploring the reasons for game-based learning having an impact on student motivation, Ya-Ting (2012) suggests that by immediately providing students with praise, encouragement and reinforcement, gaming software helps students develop confidence and motivation to continue with the task. The author also perceived the game to have elicited learner curiosity. In one of the studies (Papastergiou, 2009) a student is quoted as saying, 'it [the game] is more enjoyable and active. You never get bored as in traditional teaching because you concentrate on a goal. This helps you to retain elements in your memory easily and understand concepts that are difficult in order to advance in the game. (p.10). This perception was also reflected in Kebritchi *et al.* (2010), where teacher interviews revealed that 'when students play the game, they want to learn more and pay more attention because they liked to pass the game missions. (p. 435). The same study reported that teachers perceived the game to have 'changed students' state of mind about mathematics. The students became aware of the relationship between mathematics and real life and their mathematics phobia was diminished.' (p. 435). Furthermore, the students themselves reported that the games 'took them out of class, changed their mood, and were entertaining' and that they enjoyed the aspects of the game which included adventure, exploration and challenge. Interestingly, this was one of the few studies which explored the views of students through qualitative study, as most studies were quantitative in nature. However, this data sheds important light on some of the features that students found most engaging.

In another study, (Liu *et al.*, 2011), the authors explain that amongst students who learnt through video games, appeared to be a link between the observed increase in both the level of challenge posed by the task, and the level of skill and effort required to complete it. The authors have surmised therefore that a 'flow state' was reached amongst some students[5]. This is believed to support student engagement in learning tasks. However, despite the assumption implicit in much of the literature that motivation and engagement created by

[5]The 'flow' experience refers to an intense, sustained and focused engagement in an activity that leads to rewarding feelings of outstanding productivity. The concept was first introduced in the context of 'positive psychology' (Csíkszentmihályi,1996).

gaming directly impacts on learning outcomes, this was one of very few studies that actually examined both factors. Only this and two other studies (Papastergiou, 2009; Ya-Ting, 2012) reported both an overall improvement in motivation or engagement and skills acquisition (such as problem solving), while two other studies that measured improved motivation or engagement found no overall improvement in academic achievement measures (Annetta *et al.*, 2009; Fengfeng, 2008b). This could add further weight to the suggestion that academic achievement measures do not adequately measure the learning outcomes supported by gaming and that the intervention may need to run for longer lengths of time in order to impact on overall academic outcomes. However, further study of the motivation and learning outcomes is necessary to make more solid conclusions and to better understand the dynamic between both factors.

Despite the positive findings regarding motivation and engagement, however, the concern that motivation associated with digital gaming may be short lived and due to a 'novelty effect' also remains largely untested. Although one study (Ya-Ting, 2012) asserts that motivation was found to have been sustained, this outcome was measured over the course of a semester, and it is questionable whether this is a long enough period to be confident of continued impact.

3.4.3 To what extent did gaming impact on students' attitude to learning?

Relatively few studies explored this possible outcome. For example, Fengfeng (2008a and ; b) found that games promoted a more positive attitude to mathematics learning. Further, Fengfeng (2008b) also found that a cooperative structure (where learners worked together in the gamespace) was better than an individualistic or competitive structure at facilitating attitudes towards mathematics learning. Miller and Robertson (2011) took a slightly different focus and explored mathematics or academic self-concept, defined as the set of beliefs an individual holds about themselves as a mathematician, finding no improvement.

Secondary evidence

However, Vogel *et al's* (2006) meta-analysis found that significantly better attitudes towards learning were yielded for subjects utilising interactive games or simulations compared to those using traditional methods for instruction. This meta-analysis is also widely cited because it observed higher cognitive gains in the interactive games scenario. Given this finding was based on a number of studies, the authors conclude that this makes the finding unlikely to be due to chance. It also suggests a possible correlation between both attitudes to learning and learning outcomes. We should, however, reiterate that Vogel *et al.* make no attempt to define 'cognitive gains' or how this measure has been measured across the studies they included in their meta-analysis.

3.5 The role of independent variables

It appears possible that the impact of gaming can be mediated by the prior experience or skill levels of students, student and teacher attitude to gaming in the classroom and the type of game or learning experience promoted by the game. A few studies explored student

and/or teacher attitudes to gaming. In exploring student 'acceptance' of videogames for learning through a survey (although not the possible relationship between this and learning outcomes), Bourgonjon *et al.* (2010) reported that students' preference for using video games in the classroom was affected by their perception of: how useful the game would be in relation to learning outcomes; its ease of use; the opportunities it presents for learning; and their own personal experience of gaming outside of the classroom. Therefore, the authors argue that it cannot be assumed that outcomes for students will be consistent, given that they may commence a game-based lesson with very difference attitudes and starting points. Further to this, Williamson (2009) found that not all students automatically see the social and developmental value of the skills associated with computer games and this may subsequently impact on the extent to which they are willing to engage with the game.

Although Bourgonjon *et al.* (2010) found that male students have a more positive attitude to gaming than female students, only one study found a more positive effect of video games on outcomes for males (Brom *et al.*, 2011), while the remaining four studies which explored impact by gender (Fengfeng, 2008b; Miller and Robertson, 2011; Papastergiou, 2009; Vos *et al.*, 2011) found no difference in outcomes for males and females.

Secondary evidence

The meta-analysis carried out by Vogel *et al.* (2006) also found no significant difference between genders, suggesting that the effects of games and interactive simulations sustained across male and female participants, but also across situations (in terms of learner control, level of realism, and individual/group usage).

In terms of teacher attitudes to gaming, Kenny and McDaniel (2011) found that there is a relationship between what teachers believe and their behavioural patterns in the classroom. The study argues that teachers can be reluctant to spend efforts learning the gaming medium when they are not convinced of its impact. The authors believe that a more convincing argument needs to be constructed before teachers will change their views towards video games and integrate them into existing classroom practice. An exploratory study by Williamson (2009), found that 35 per cent of teachers (in English state primary and secondary schools) had already used computer games in their teaching and 60 per cent would consider using games in the future. The most commonly cited reason was to enhance motivation and engagement. The majority of teachers also believed that gaming could help support children's cognitive development, their ICT development, and their higher-order thinking skills. However, the results also suggested that teachers are more interested in the 'pragmatic' benefits of gaming, for example, to assist teachers in relating formal schooling to everyday lives and creating social interaction in the classroom – rather than for pursuing educational 'big ideas[6].'

There was also some evidence that the **type of game** can have an impact on outcomes. Most commonly, computer simulation games were compared to simpler drill and practice

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[6]The author cites these 'big ideas' as being: games as a persuasive medium that can affect young people's thinking; games as a constructionist technology; games as providing environments for authentic activity; and games in the context of 'media literacy'.

games. Fengfeng (2008b) found, for instance, that games are more *motivating and engaging* than drills, albeit not more *effective*.

> **Secondary evidence**
>
> A meta-analysis by Chiu *et al.* (2012) found that the type of game used has an impact on learning as far as language learning is considered. Meaningful and engaging games, in which learners are given opportunities to explore, interact and engage with a complex game world, are more *effective* than simpler games that rely on drill and practice. The meta-analysis by Vogel *et al.* (2006) found no alteration in results when controlling for the level of 'realism' in the presentation of the game.

As already mentioned, Fengfeng (2008b) found that regardless of application (gaming or drills), individualistic goal structures facilitate mathematics performance more than other goal structures (competitive and cooperative), whereas a cooperative structure was better than the other two at facilitating more positive attitudes towards mathematics learning. Similarly, Ya-Ting (2012) felt that computer games often emphasise collaborative and active learning, as their design is largely based on social constructivist principles.

As stated, studies were focused on **individual subject domains** and so it would be impossible to determine the extent to which the outcomes could be replicated in different subject domains without understanding the mechanisms behind the impact. There is little explanation in the studies as to why one subject domain has been selected for study over any other. One could assume that researchers have most commonly selected maths as the subject domain because, arguably, it is more straightforward to collect hard, measurable data about achievement for this subject when compared to, for example, humanities subjects. Alternatively, games developers or researchers may consider gaming in the classroom to better lend itself to certain subjects. Whatever the reason, it will be important that future studies take this area of inquiry a step further to explore what replicable factors, if any, exist across subject domains.

Few studies examined the possible mediating role of **previous gaming experience** on impacts in the classroom. Only two formally explored this variable (Kebritchi *et al.* 2010; Miller and Robertson, 2011) and found no difference in outcomes dependent on prior level of computer skill. This may seem surprising as, with anything, we might expect to see some advantage of having prior experience and this may be an area for further exploration in the future.

3.6 The new landscape

Overall, the results of the studies included in this review appear to demonstrate a positive relationship between gaming in the classroom, learning outcomes and motivation and engagement. However, the overall strength of the evidence has been affected by the research design or lack of information about the research design. For example, the origin and design of the game was not always clear and it was sometimes difficult to know whether or not a control group had been used. There was also some detail lacking overall about how various outcomes or variables had been measured. The findings around motivation and engagement are further called into question when we consider that only one study (Ya-Ting,

2012) sought to explicitly test the 'sustainability' of outcomes. Because the majority of studies were based on a small sample from one school or age group, there was also little scope for testing how replicable the outcomes would be in different contexts.

A number of the studies tested elements of learning theory or the impact of independent variables in isolation, which provides some interesting evidence of correlating factors and a basis for further exploration. However, the studies do not give much clarity as to whether or not it is the technology on which the game is played that adds value, or if the same results might be achieved through a lesson which is 'gamified' using more traditional resources (such as pen and paper). It may be argued that authors would have better plugged the gaps in the pre-existing literature had they further examined the mechanisms at play supporting the positive relationship that so many of the studies found.

4. Implications for future research

Key points

- It is important we develop a more analytic approach that considers how the different elements that operate within video games impact in an educational setting.
- Opening up the 'black box' of video games would enable us to focus on specific principles or mechanisms. This finer grained approach could unlock a more rewarding research agenda.
- Three research challenges have been identified:

  1. Working towards a consensus about the relationship between academic achievement and game-based learning. Efforts are needed to articulate clear relations between game elements and a range of outcomes, from a broad level (e.g. platform on which the game runs, single player, multiplayer, and so forth), gradually narrowing down to specific gameplay mechanics.
  2. Unpacking further the relationship between gaming and academic achievement in the context of educational assessment. Games seem to allow more powerful and 'always-on' forms of assessment in which all actions, interactions, successes and failures can be constantly tracked and logged. This raises a number of empirical and ethical issues.
  3. Developing research into the potential of video games that accounts for the realities of schools. In particular, more research is needed into the social, cultural and economic factors that influence attitudes towards the use of game-based learning in our increasingly diverse and multicultural schools

4.1 What does this section cover?

This chapter is a more 'future facing' section that looks at the patterns identified thus far and identifies research areas to tackle. The chapter summarises the issues noted in the review of empirical studies (section 4.3), and uses it as background to define three research challenges to inform future research (sections 4.3.1; 4.3.2; 4.3.3).

4.2 What literature did we consider?

We looked across all the literature included in our review. This section will try to interrogate the literature more thoughtfully, in order to hone in on areas that warrant further exploration. Firstly we identified the issues with the evidence base, both in terms of the quality of the evidence and gaps in its coverage.

4.3 Limitations of the reviewed evidence

- A lack of clarity about the types of games investigated, in terms of design features, scope and purposes. A game expressly built for education is likely to have some distinctive features that sets it apart from games created for entertainment purposes. Other aspects liable to influence the research process are the platform needed to run the video game for example a console or a portable device?, and the specific nature of gameplay, such as single player or multiplayer.

- The limited timescale of most studies, which might explain some of the uneven results obtained. We cannot rule out the possibility that changes in performance may require a longer and more sustained engagement with video games, or game-based design elements, than what we observed in most studies.

- One of the key assumptions we noted in the more 'speculative' literature in Chapter Two was concerned with the relationship between motivation, attitudes and learning outcomes. In this respect, the empirical studies provided some promising findings, but nothing conclusive. The main issue, which mirrors the timescale problem noted above, is that we cannot rule out the possibility that increases in motivation and engagement, with a knock-on effect on outcomes, are caused by a 'novelty effect'.

- A lack of insight about the role of individual and social characteristics. While gender was sometimes considered, and found of little significance, several equally important aspects were missing or only fleetingly accounted for. These include personality profiles, cognitive styles and previous gaming experience.

- A lack of insights about the role of subject domains other than mathematics. As noted in Chapter Three, mathematics was often the subject of choice because it lends itself to easy measurement and comparisons. We do not know whether different subject domains may require different forms of 'gameplay', thus leading to different types of learning outcomes.

- As suggested in Chapter Two, the 'gamification' trend is mostly concerned with the use of elements and mechanics *derived from* video games, rather then with actual games. However, we noted in the literature a complete lack of evidence - and a more general lack of clarity - about the impact of gamification on learning outcomes and relations between technology and video game design elements. Can such elements be detached from the technology without losing their meaning or potency? Can they be used effectively to add value to traditional teaching and learning?

Rather than addressing each evidence gap or issue individually, we used the whole list as background. We then extrapolated three specific research challenges that might inform future research efforts in game-based learning. Exploring these challenges will contribute to a more realistic, evidence-based and ultimately more effective, integration of game-based learning in education. This will be beneficial to all those interested in unlocking the educational potential of video-games: teachers, learners and the video-games industry.

4.3.1 Research challenge 1: working towards a consensus about the relationship between academic achievement and video games

It appears that empirical research may have to move beyond the search for linear relationships between video games and academic achievement. Instead, opening up the black box of video games would enable us to focus on specific principles or mechanisms that operate within them. This finer grained approach could unlock a more rewarding research agenda.

The long term objective of this agenda would be to create a taxonomy of game-based learning; an evolving and collaborative effort that will clarify relations between game elements and a range of outcomes. This taxonomy would begin from a broad level (e.g. equipment required to run the game, single player, multiplayer, and so forth), gradually narrowing down to specific gameplay mechanics.

A research question might be: what outcome measures or criteria best reflect (or correlate with) proficiency in the 'gameplay' that underpins simulation games like SimCity, in which goal-oriented actions lead to expected and unexpected consequences.

To an extent, this is what Gentile *et al.* (2009) did in order to study the relationship between video games and human behaviour; although they were focused on aggression and prosocial tendencies and not on learning. Gentile and his co-authors provided robust evidence that exposure to specific forms of content in video games has short-term, as well as long-term influences. They looked at the effects of video game content under very specific circumstances, clearly distinguishing between violent content (shooting, killing, etc.) and pro-social content in which 'players and game characters help and support each other in nonviolent ways' (p. 752). As such, the study's results point to a relationship between *specific actions* performed during gameplay and a range of psychological constructs ('priming scripts') that regulate attitudes and behaviours.

Research on the educational potential of video games could indeed learn from these efforts, and begin to analyse specific gameplay actions: what people actually do when they play video games. An important distinction will be between in-game actions, and actions performed in the social contexts that surround gameplay. Through a mix of quantitative and qualitative methods, an observer would focus on the relationships between content and design elements embedded during the development process - the 'intended' game – and the actual behaviours and interactions that unfold at specific moments and over time. The aim would be to explore whether those actions may be related to a range of benefits or outcomes. Some of these benefits and outcomes may easily overlap with official measures of formal schooling, while others will require additional efforts to be defined.

4.3.2 Research challenge 2: unpacking further the relationship between video games and academic achievement in the context of educational assessment

This research challenge follows on directly from the previous one, but is directly concerned with the complex issue of educational assessment.

Video games seem to allow more powerful and 'always-on' forms of assessment in which all actions, interactions, successes and failures can be constantly tracked and logged. This generates large amounts of data that, if correctly analysed, would allow educators to make important inferences about learners' capabilities, needs and potentials.

On the one hand, this is part of a 'data trend' in educational assessment. There is, in fact, a growing interest in the use of automated techniques to make sense of large datasets about different aspects of measurable performance. It is also safe to assume that students may benefit from a more adaptive and fast remedial action, which can be facilitated by the computer-assisted analysis of achievement and behavioural data.

Game-based learning offers the possibility of moving beyond traditional forms of standards-based assessment, to consider alternative dimensions of performance and achievement. For example, the nature of gameplay described in Chapter Two, section 2.4 highlights an important aspect: the priority of process over content. In most video games mastery is not achieved through knowledge of textbooks or manuals. Instead, what counts is the increasing familiarity with a 'proceduralised' system of choices and consequences. Some authors argue that focusing on how learners negotiate such choices could lead to fairer and more accurate forms of assessment (Schwartz and Arena, 2013). These authors suggest that the game-based assessment of choices would allow educators to evaluate more effectively learning strategies and identify 'malpractices'. For instance, when a student repeatedly makes the wrong choice when defining a sequence of actions to solve a problem.

Although these emerging research areas are promising, there are issues and risks as well. To begin with, powerful analyses of gameplay data are only applicable in digital settings. There are undoubtedly implications when important inferences are based on actions performed in fictional, digitalised contexts - not least the ethical ramifications of using forms of 'stealth' assessment of which learners are largely unaware. A digital-only approach is also incompatible with the idea of using game-derived elements, instead of actual games (i.e. gamification), in the context of otherwise 'traditional' teaching.

Moreover, if the 'choices' that learners make in games is used to formally assess them in schools, then we must consider whether they may be used to create quantitative social indicators for social decision making (for example, access to higher education). This raises a whole range of additional ethical issues, such as:

- types of choices may be tacitly imposed on learners as the 'right' ones;

- once social and educational value is attached to 'choices', they are no longer the by-product of natural behaviour. We cannot rule out the emergence of more sophisticated and hard-to-track forms of cheating and 'gaming the system'. For example, people could learn how to display artificial choice patterns, whilst teachers could, paradoxically, 'teach to the choice'.

4.3.3 Research challenge 3: developing research into the potential of video games that accounts for the realities of schools

We noticed in Chapter Three that research endeavours might be undermined at the outset by the incompatibility between video games for learning and formal instructional practices. The reviewed evidence responds to this incompatibility in different ways. Some argue that the key issue is not 'whether or not to use computer games', but 'how to better design an educational computer game', or 'how to better apply game-based classroom instructional

strategies' (Fengfeng, 2008b, p. 554). Others see the gap between school and game-based learning contexts as hard to bridge. For instance, Gee (2007) suggests that enthusiastic gameplayers share norms, values and beliefs about what counts as worthwhile knowledge, what is good and what is not in terms of performance. This is generally in contrast with the norm of schoolwork and classroom values, which makes it impossible for teachers to fully appreciate the potential of gaming.

It could be argued that this tension should be acknowledged and explored, without falling into the 'trap' of portraying schools as being too conservative. For instance, for this review we also considered literature critical of the enthusiasm with which video games are described in many educational technology circles. In particular, Buckingham (2007) argues that bringing leisure time experiences and practices into the formal educational domain may not always be possible or even desirable. He reasons: 'we need to be wary of simply *celebrating* children's informal experiences of media and technology […] there are good reasons to be cautious about the idea of simply extending those experiences into the more 'formal' context of the school' (p. 101). Indeed, Buckingham suggests that an 'anti-school' rhetoric seems to underlie many accounts of game-based learning. Instead, he articulates a defence of the distinctive role of schools, where important forms of learning take place that cannot be replicated in interest-driven, self-selecting contexts.

While it is essential to keep in mind these more critical viewpoints, they should not discourage educators and researchers from exploring ways in which video games can be beneficial to young people. In this respect, a few authors are seeking to address this contradiction without renouncing critical reflection. For instance, Young *et al.* (2012) are aware of the hype that surrounds game-based learning and gamification, but also invite more complex research questions that move beyond linear relationships between achievement and video games use.

As noted earlier on, evidence tentatively suggests that video games are motivating and support a more positive attitude to learning and school. However, these findings are not conclusive and require, most of all, a more sustained and longitudinal research effort. From a school-based perspective, this means studying the long-term motivational impact of gameplay-based approaches, when used regularly within specific curricula. School curricula are extremely diverse, with degrees of prescription and guidance changing over time and across countries - sometimes across individual schools. However, they all share the fundamentally correct assumption that meaningful learning takes place over a reasonable amount of time, generally a full academic year. As such, school curricula underpin school life and shape routines, times and priorities. Any research effort that ignores this framework is bound to be marginal, short-term and surrounded by an aura of novelty.

Acknowledging the specificity of formal learning settings also means accepting that not all students would choose to play games in their spare time, let alone at school. Enthusiastic accounts based on informal, largely self-selecting samples may in fact feed an incorrect perception that all young people engage with video games in the same, positive way. Some of the studies we reviewed suggest that not all students (and teachers) display positive attitudes and perceptions in relation to video games in education (Bourgonjon *et al.,* 2010; Kenny and McDaniel, 2011; Williamson, 2009). While resistance to using video games in the

classroom could be a threat to the uptake of game-based learning, it cannot be dismissed simply as a barrier to overcome.

More research is needed into the social, cultural and economic factors that influence attitudes towards the use of video games and 'gameplay' in our increasingly diverse and multicultural schools. A possible hypothesis to guide future research is that such factors make some individuals and groups better positioned than others to reap the benefits of technological innovations. Therefore, attention might need to shift from the search for effects of video games on learning, to how the social and economic contexts in which people live can support or undermine a positive use of technological innovations for personal or social development.

5. Implications for teachers and schools

5.1 What can teachers safely 'take home'?

This section lists the main 'messages from the review for 'teachers and other educators.

- The evidence suggests that game-based learning can improve engagement and motivation, but don't rely on games to improve attainment - there is still a lot we don't know about the impact of video games on learning.

- The best way of integrating gaming into teaching is by using it within a clear pedagogic process. In particular:
  - Place learning activities and academic content within the video game's fictional and entertainment context, maintaining a balance between 'fun' and 'learning'.
  - Make the academic content integral to the game rather than an add-on. Content-specific tasks work better when embedded in the fictional context and rules ('mechanics') of the game. For example, in a maths game, asking learners to compute distances to help a likable game character jump over obstacles will be more engaging than asking them to complete traditional maths tests in order to make a story advance.
  - Carefully plan the roles that you and your learners will take on in the game. Teachers should play roles that allow them to mediate the experience for learners: providing guidance when needed; ensuring that rules are followed; and maintaining a respectful atmosphere.

- Don't try to divorce decontextualized components of a game (such as badges, scores or leaderboards) from the fictional context and rules of the game (the 'mechanics'). Using badges and medals can work for certain simple tasks, but actual game-based learning will require using those techniques in the context of rule-sets and role-playing.

5.2 Additional points for senior leaders who wish to support the use of game-based learning in their schools

- Ensure that teachers are not left on their own when trying to enable game-based learning. Beyond the video game itself, teachers should have the time and the resources for offline activities to support learning. These include time to organise collaborative tasks, and the ability and the skills to provide timely guidance while students play the game.

- If you are trying to bring game-based learning into your school, 'buy in' from teachers is needed to ensure that video games are fully integrated. To achieve integration, you'll probably need to invest in in-depth and sustained professional development.

- Acknowledge and, if possible, address the barriers that may stop your teachers from engaging with game-based learning. These include lack of preparation time, poor technical support, outdated technologies and lack of opportunities for collaboration due to the rigid structure and time constraints of formal instruction.

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Appendix 1:
Search strategy and the review process

This appendix provides information on the:

- review parameters

- search strategies used to identify the literature that the review team considered for inclusion in the review

- review process that the team used to select the literature included in the review.

Search parameters

Publication date:	Work published from the year 2006
Geographical scope:	United Kingdom and international
Language:	Published in English
Study type:	Empirical research and/or evaluation; good practice examples; theoretical items; published literature (peer and non-peer reviewed)

Inclusion criteria

- Conforms to search parameters

- Pertinence / relevance (to research questions)

- Research quality / use of 'best evidence' approach (i.e. reliance on the best evidence available to answer any of the key research questions).

In addition, we applied the following quality criteria:

- **High**: large scale quantitative study, meta-analyses or in-depth qualitative case studies covering a range of settings and stakeholders where views are triangulated; systematic reviews have also been included in this category .

- **Medium**: quantitative or qualitative studies with smaller samples; qualitative studies not covering a range of settings or stakeholders; non-systematic reviews. We also included in this category more speculative contributions that are based on existing theories and indirect evidence.

Search strategy

This search strategy sets out the keywords used (and also their combination) with each of the bibliographic databases. All searches were limited to publication years 2006-2012

Databases

The following databases were searched.

Source	Items selected for consideration
Australian Education Index (BEI)	133
British Education Index (BEI)	88
Education Resources Information Center (ERIC)	264

Australian Education Index (AEI)
AEI is Australia's largest source of education information covering reports, books, journal articles, online resources, conference papers and book chapters.

British Education Index (BEI)
BEI provides information on research, policy and practice in education and training in the UK. Sources include over 300 journals, mostly published in the UK, plus other material including reports, series and conference papers.

Education Resources Information Center (ERIC)
The ERIC database is sponsored by the US Department of Education to provide extensive access to education-related literature.

These sources were queried using key words (used individually or in various combinations), which included:

Video Games, Gamification ,Gaming, Game design, Game mechanics, Game theory ,Game-based learning, Gameplay, Educational games, Game-based technologies, Game elements, Learning, Assessment, Best practice, Educational outcomes, Attainment, Outcomes of education, Curriculum, Engagement, Motivation, Feedback, Engage, Collaborate, Role-playing games, Online Multiplayer, Console, PC, Electronic games, Achievements.

Websites

A range of websites were also searched and included the following

List details	Number of sources
London Knowledge lab	0
OU-CRC	1
OECD Centre for Educational Research and Innovation (CERI)	0
Futurelab	0 (duplicates included in databases search results)
Becta	0

List details	Number of sources
Department for Education	0
Ofsted	0
Institute of Education	2
EPPI Centre	0
Digital Cultures Research Centre	0
Gamification.co	0
Partnership for 21st Century Skills	0
American Educational Research Association	0
Gamification Research Network	4
MacArthur Foundation	0 (duplicates included in databases searches)
ACM digital library	8
Institute of Play	37
Google scholar	17

Review process

We used a four-stage process to filter the search results, so that only the most relevant and best quality studies available were included within the review. The three stages were i) coarse-gained screening; ii) fine-grained screaning iii) appraising; and iv) synthesising. These are explained below.

i) 'Coarse grained' screening of the literature

The initial, large number of items were screened using broad criteria of relevance and quality. Items were excluded using the following broad criteria, applied to abstracts:

- wrong age group (e.g. the item focuses on post-secondary setting);

- not specific about education (e.g. the item focuses on games to develop leadership, or to support autistic children);

- about education in non-formal settings (e.g., the item focuses on game-based learning to improve performance in a nutrition course - or in a museum setting - or non-research items like practitioner guides);

- not-research based and/or too explicitly based on opinion.

This stage led to a 'Long list' of 64 items.

ii) 'Fine-grained' screening of the literature

This stage was based on a thorough analysis of the 'long list' abstracts, seeking to exclude all items that did not meet the agreed inclusion criteria. The review team then selected the most relevant and best quality items to appraise and synthesise. We selected 31 items of literature.

iii) Appraising the literature

We then appraised the full text of each selected item, using a template, to extract the key research questions(s) and findings from each study, as well as assessing the quality and relevance of each item.

iv) Synthesising the literature and making sense of patterns

Having appraised the key literature items, we synthesised the findings. This involved analysing the reviewed evidence to draw out emerging themes and key messages.

Appendix 2: the evidence base for the review

This appendix provides a brief description of all relevant items of literature included in the main body of the review, together with the table (also in Chapter One) reporting the inclusion ratings of each item.

	High	Medium
Qualitative		Marković *et al.,*2007; Salen, 2008
Quantitative	Chuang and Chen, 2009; Delacruz, 2011; Huizenga *et al.,* 2009; Miller and Robertson, 2011	Annetta *et al.,*2009; Bourgonjon *et al.,* 2010; Brom *et al.*, 2011; Fengfeng, 2008a; Kenny and McDaniel, 2011; Kolovou and Heuvel-Panhuizen*,* 2010; Liu *et al.,* 2011; Papastergiou, 2009; Schaaf, 2012; Spires *et al.,*2011; Vos *et al.,*2011; Ya-Ting, 2012
Mixed methods		Fengfeng, 2008b; Kebritchi*et al.,*2010
Review and Meta-analysis	Chiu *et al.,*2012; Vogel *et al.,* 2006; Young *et al.*, 2012	De Freitas and Griffiths, 2008; Kapp, 2012; Williamson, 2009
Speculative	N/A	Bogost, 2011; Buckingham, 2008; Gee, 2008; McGonigal, 2011; Shaffer, 2008

Full references	Brief description
Annetta, L. A., Minogue, J., Holmes, S. Y., and Cheng, M.T. (2009). 'Investigating the impact of video games on high school students' engagement and learning about genetics', *Computers and Education*, **53**, 1, 74–85.	This quasi-experimental study evaluated a teacher created videogame on genetics in terms of its affective and cognitive impact on student users.
Bogost, I. (2011). *How to Do Things with Video Games.* Minneapolis, MN: University of Minnesota Press	The book proposes some key definitions and theoretical assumptions of game-based learning and gamification. Ian Bogost is one of the most prominent authors who are shaping the emerging field of 'game studies'. He is mainly interested in applying insights from a range of disciplines, including critical social theory, politics and philosophy, to the

Full references	Brief description
	analysis of video games or game-based experiences.
Bourgonjon, J., Valcke, M., Soetaert, R., andSchellens, T. (2010). 'Students' perceptions about the use of video games in the classroom', *Computers and Education*, **54**, 4, 1145–1156.	In this study, a path model to examine and predict student acceptance of videogames is proposed, and empirically tested by involving 858 secondary school students.
Brom, C., Preuss, M., and Klement, D. (2011). 'Are educational computer micro-games engaging and effective for knowledge acquisition at high-schools? A quasi-experimental study', *Computers and Education*, **57**, 3, 1971–1988.	Curricular schooling can benefit from the usage of educational computer games, but it is difficult to integrate them in the formal schooling system. Here, the authors investigate one possible approach to this integration.
Buckingham, D. (2007). 'Playing to learn? Rethinking the educational potential of computer games.' In: Buckingham, D. *Beyond Technology: Children's Learning in the Age of Digital Culture.* Cambridge: Polity Press.	In the sixth chapter of Beyond Technology – children's learning in the age of digital culture, Buckingham (2007, p.99) examines the notion supported by many computer games advocates that more authentic kinds of learning occur through children's informal interactions with new media and technology.
Chiu, Y.H., Kao, C.W., and Reynolds, B.L. (2012). 'The relative effectiveness of digital game-based learning types in English as a foreign language setting: A meta-analysis', *British Journal of Educational Technology*, **43,** 4, 104–107.	This study synthesizes relevant studies which investigate overall effects of digital game based learning. It also refers to some meta analysis
Chuang, T.Y. and Chen W.F. (2009). 'Effect of computer-based video games on children: an experimental study', *Educational Technology and Society*, **12**, 2, 1–10.	This experimental study investigated whether computer-based video games facilitate children's cognitive learning. One hundred and eight third-graders from a middle/high socio-economic standard school district in Taiwan participated in the study
De Freitas, S. and Griffiths, M. (2008). 'The convergence of gaming practices with other media forms: what potential for learning? A review of the literature', *Learning, Media and Technology*, **33**, 1, 11–20.	This article reviews literature for evidence of these trends of convergent media forms as a starting point for a wider debate for using games technologies and practices to support learning practices.
Delacruz, G.C. (2011). *Games as Formative Assessment Environments: Examining the Impact of Explanations of Scoring and Incentives on Math Learning, Game Performance, and Help Seeking*	This report examines how different levels of detail about a game's scoring rules affect math learning and performance.

Full references	Brief description
(CRESST Report 796). Los Angeles, CA: University of California, National Center for Research on Evaluation, Standards, and Student Testing.	
Fengfeng, K. (2008a). 'A case study of computer gaming for math: engaged learning from gameplay?' *Computers and Education*, **51**, 4, 1609–1620.	This case study examined the in situ use of educational computer games in a summer math program to facilitate 4th and 5th graders' cognitive math achievement, metacognitive awareness, and positive attitudes toward math learning.
Fengfeng, K. (2008b). 'Computer games application within alternative classroom goal structures: cognitive, metacognitive, and affective evaluation', *Educational Technology Research and Development*, **56**, 5–6, 539–556.	The study found that a cooperative structure (where learners worked together in the gamespace) was better than an individualistic or competitive structure at facilitating attitudes towards maths learning
Gee, J.P. (2007). *What Video Games Have to Teach Us About Learning and Literacy.* New York, NY: Palgrave Macmillan.	This is a 'seminal' text about game-based learning that explored several theoretical and empirical issues.
Huizenga, J., Admiraal, W., Akkerman, S. and Dam, G.T. (2009). 'Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game', *Journal of Computer Assisted Learning*, **25**, 4, 332–344.	The study investigates the effects of a mobile city game .A quasi-experimental design was used with 458 pupils from 20 classes from five schools.
Kapp, K.M. (2012). *The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education*, San Francisco, CA: Pfeiffer.	This book focuses on the design opportunities of 'gamification', mainly in terms of increasing learning, retention, and productivity in the workplace.
Kebritchi, M., Hirumi, A. and Bai, H. (2010). 'The effects of modern mathematics computer games on mathematics achievement and class motivation', *Computers and Education*, **55**, 2, 427–443.	The paper reports two studies, measuring learning gains and time on task in different experimental conditions.
Kenny, R.F.K. and McDaniel, R. (2011). 'The role teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms', *British Journal of Educational Technology*, **42**, 2, 197–213.	This paper presents the results of a pilot study with a group of preservice teachers, investigating their perceptions about video games.

Full references	Brief description
Kolovou, A. and Heuvel-Panhuizen, M.V.D. (2010). 'Online game-generated feedback as a way to support early algebraic reasoning', *International Journal of Continuing Engineering Education and Life Long Learning*, **20**, 2, 224–238.	This study explores the potential of game-generated feedback to support primary school students' problem solving processes.
Liu, C.C., Cheng, Y. B. and Huang, C.W. (2011). 'The effect of simulation games on the learning of computational problem solving', *Computers and Education*, **57**, 3, 1907–1918.	This study analyzed the feedback and problem solving behaviors of 117 students in a simulation game, designed to assist them to learn computational problem solving.
Marković, F., Petrovic, O., Kittl, C. andEdegger, B. (2007). 'Pervasive learning games: A comparative study', *New Review of Hypermedia and Multimedia*, **13**, 2, 93–116.	This paper investigates how pervasive games can be used for an efficient transfer of knowledge in learning situations. The paper presents the design of a new pervasive learning game, which was compared with a conventional case-study approach in an empirical study with 100 students in respect to long-term learning results and learning efficiency.
McGonigal, J. (2011). *Why Games Make Us Better and How They Can Change the World*. London: Jonathan Cape.	This is an influential book that popularised the idea of 'gamification': the use of game design elements to aid a range of individual and social enterprises.
Miller, D.J. and Robertson, D.P. (2011). 'Educational benefits of using game consoles in a primary classroom: a randomised controlled trial', *British Journal of Educational Technology*, **42**, 5, 850–864.	Randomised Control Trial of games consoles in classroom, based on large scale quantitative study.
Papastergiou, M. (2009). 'Digital game-based Learning in high school Computer science education: impact on educational effectiveness and student motivation', *Computers and Education*, **52**, 1, 1–12.	The aim of this study was to assess the learning effectiveness and motivational appeal of a computer game for learning computer memory concepts. The sample was 88 students, who were randomly assigned to two groups.

Full references	Brief description
Salen K. (Ed.) (2008). *The Ecology of Games, Connecting Youth, Games, and Learning* (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge, MA: The MIT Press. Gee, J.P. (2008). 'Learning and games.' In: Salen, K. (Ed) *The Ecology of Games: Connecting Youth, Games, and Learning* (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge, MA: The MIT Press. Salen, K. (2008). 'Towards an ecology of gaming.' In: Salen, K. (Ed) *The Ecology of Games: Connecting Youth, Games, and Learning* (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge, MA: The MIT Press.	This volume looks at games as systems in which young users participate, as gamers, producers, and learners. It's a collection of influential views about 'game studies' including game-based learning. Specific chapters which have been reviewed more in detail are cited in full in the left column.
Schaaf, R. (2012). 'Does digital game-based learning improve student time-on-task behavior and engagement in comparison to alternative instructional strategies?' *Canadian Journal of Action Research*, **13**, 1, 50–64.	The study examined Digital Game-Based Learning activities in comparison with effective, research-based learning strategies to observe any difference in student engagement and time-on task behaviour.
Shaffer, D.W. (2006). *How Computer Games Help Children Learn*. New York, NY: Palgrave Macmillan.	Another influential book that popularised the notion of 'game-based learning'. In particular, the idea that, through role play and simulation, video games help young people think and act like actual professionals.
Spires, H.A., Rowe, J.P., Mott, B.W., and Lester, J.C. (2011). 'Problem solving and game-based learning: effects of middle grade students' hypothesis testing strategies on learning outcomes', *Journal of Educational Computing Research*, **44**, 4,453–472.	In this study, middle grade students achieved significant learning gains from gameplay interactions that required solving a science mystery based on microbiology content.
Vogel, J.J., Vogel, D.S., Cannon-Bowers, J., Bowers, C.A., Muse, K. and Wright, M. (2006). 'Computer gaming and interactive simulations for learning: a meta-analysis', *Journal of Educational Computing Research*, **34**, 3, 229–243.	A widely cited meta-analysis that examines the available evidence about the relationship between video-games, academic achievement and other learning gains.

Full references	Brief description
Vos, N., van der Meijden, H. and Denessen, E. (2011). 'Effects of constructing versus playing an educational game on student motivation and deep learning strategy use', *Computers and Education*, **56**, 1, 127–137.	In this study the effects of two different interactive learning tasks, in which simple games were described with respect to student motivation and deep strategy use.
Williamson, B. (2009) *Computer Games, Schools and Young People: a Report for Educators on Using Games for Learning*. Bristol: Futurelab [online]. Available: http://archive.futurelab.org.uk/resources/documents/project_reports/becta/Games_and_Learning_educators_report.pdf [28 February, 2013].	This report focuses on the use of games as resources to support the educational aims, objectives and planned outcomes of teachers who understand that games are an important medium in contemporary culture and young people's experiences, providing an assessment of game-based learning in UK schools.
Ya-Ting, C.Y. (2012). 'Building virtual cities, inspiring intelligent citizens: digital games for developing students' problem solving and learning motivation', *Computers and Education*, **59**, 2, 365–377.	This study investigates the effectiveness digital game-based learning (DGBL) on students' problem-solving, learning motivation, and academic achievement.
Young, M., Slota, S., Cutter, A.B. Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M. and Yukhymenko, M. (2012). 'Our princess is in another castle : a review of trends in serious gaming for education', *Review of Educational Research*, **82**, 1, 61–89..	In a review of literature, where the authors identified 300+ articles whose descriptions related to video games and academic achievement.

NFER provides evidence for excellence through its independence and insights, the breadth of its work, its connections, and a focus on outcomes.

- independent
- insights
- breadth
- connections
- outcomes