VIDEO GAMES AND LEARNING: A SCOPING STUDY OF THE DIVERSE USE OF VIDEO GAMES IN AUSTRALIAN CLASSROOMS

by Caitlin Cole

Thesis submitted in fulfilment of the requirements for the degree of Master of Research at

Western Sydney University

Submitted 4th of August, 2021

Abstract

This study investigates current uses of video games within secondary classrooms in Australia, and the ways this is impacted by teacher attitudes and experiences. First, a thorough systematic review of current literature surrounding video games in secondary classrooms was conducted. The review indicated that current research regarding video games and education is primarily concerned with short-term interventions, and often does not take into consideration the context of wider teaching activities. The review further found that research in the Australian context is limited, and primarily qualitative in nature. Second, a survey of Australian secondary teachers was conducted to explore teacher attitudes towards video game based learning, and to identify promoters and barriers to the adoption of video games. Results indicated teacher beliefs were positive regarding the ability of video games to increase student interest and engagement, and to teach real-world skills. External support for video games and the frequency of teacher video game use in their own practice significantly influenced teacher attitudes. The opportunities for building on the limited research within an Australian context means this study contributes to building a comprehensive body of research that accounts for teacher attitudes and uses of video games within Australian secondary classrooms.

Acknowledgements

Special and profound thanks go to my supervisors, Dr Roberto Parada and Dr Erin Mackenzie, for their patient and kind support, advice, and feedback throughout the duration of this project.

I would also like to thank my sister, Dr Kerri-Ann Woodbury for her proof-reading services and advice. You have supported me in so many ways through this thesis, and I appreciate all that you do.

Dedication

This thesis is dedicated to my mother, Suzanne, who taught me from my very earliest days the value of scepticism and critical thinking. You taught me to love reading and writing, but also bought me my first Gameboy and never discouraged my passion for video games. Your love and support enables all that I do.

I would also like to thank my husband, Aaron, for his ceaseless care, patience, and advice.

Further thanks must go to my housemates, Ethan and Butter, for never-ending cups of tea and pats, respectively.

Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

…… ……..

(Signature)

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

Video games hold an immutable place in our global culture. While some still see gaming as a past-time for teenage boys, in terms of revenue the video game industry now exceeds the Hollywood box office and the international music industry combined (Carter et al., 2021). In Australia, video games are played by people of all ages and genders, for a variety of reasons, including business, pleasure, education, and community (Brand et al., 2020). Video games are now part of mainstream culture, with two thirds of Australians reporting that they play video games. Forty-seven percent of people who play video games in Australia are female, and the average age of a gamer is 34 years old (Brand et al., 2020). While video gaming was once seen as a niche hobby, video games have now matured into an expressive, meaningful, and diverse cultural phenomenon. They are no longer limited to simple platform or puzzle games, and instead approach complicated concepts such as teenage friendships, bullying, and loss, as in *Life is Strange* (Dontnod Entertainment & Deck Nine, 2015). They deal with grief and the complex grey areas between acts of good and evil, as in *Last of Us II* (Naughty Dog, 2020). Players can be involved in communities of practice in myriad ways, such as player 'modding' (a shortened form of 'modification', a slang term for making changes to a commercially available game) in *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, 2011), or the community of builders in *Minecraft* (Mojang Studios, 2011). Video game competitions are broadcast to vast international audiences, with the *League of Legends* (Riot Games, 2009) Worlds Championship finals attracting viewership of 99.6 million people in 2018 (Goselin, 2018), and E-sports leagues common in high schools across the world.

The popularity and cultural impact of video games in Australia is not limited to playing for fun. An additional aspect of video game use is the growing popularity of 'serious games' – video games that are used for non-entertainment purposes. In 2016, a Senate committee conducted an inquiry into the future of Australia's video game development industry. The report from this inquiry noted that serious games are used in a variety of sectors, including health, education, defence, emergency planning, politics, engineering, urban planning, manufacturing and service delivery (Commonwealth of Australia, 2016). In Australian classrooms, the use of video games in various forms is common, with over half of Australian parents reporting that their children use video games in their curriculum and classroom learning (Brand et al., 2019). The commercial industry for educational video games is growing, and a recent report indicates that teachers are increasingly utilising video games in their classroom teaching (Commonwealth of Australia, 2016). Despite this, there is limited research that addresses the attitudes of teachers towards video games, the reality of practice surrounding video game use in Australian classrooms, and the benefits and limitations to their use.

In order to address this gap, this study sought to describe the current use of video games in Australian secondary classrooms, and the ways in which this is impacted by teacher attitudes and experiences. This study also investigated Australian teachers' perceptions of the benefits and limitations associated with the implementation of video game based learning in the classroom. This research project was designed as a scoping study employing two methodologies: a systematic review of the literature, and a survey of Australian secondary teachers. The use of two methodologies ensured a comprehensive and contextualised exploration of both contemporary research and the teacher-experience of video games in Australian secondary teaching, and the realities of teacher experiences of the same. Specifically, the research questions addressed by this investigation are:

1. According to research, how are video games currently being used in secondary classrooms?;
2. How are video games currently being used in Australian secondary classrooms?;
3. What factors influence secondary teacher uptake of video game technology within classrooms? And;
4. What are secondary teachers' perceptions of the benefits, limitations, and barriers to the implementation of video games within Australian secondary classrooms?

A systematic review of the literature was undertaken to provide a coherent and comprehensive description of both international and specifically national (Australian) research on the use of video games in secondary education. This review's aim was to identify gaps in the contemporary body of evidence, in order to inform future research direction. Subsequent to the systematic review, a scoping survey of a sample of Australian secondary teachers was undertaken to explore teacher experiences of video game use in secondary classrooms. Secondary teachers were invited to complete a survey exploring teacher's use of video games in the classroom, their perceptions of the benefits, barriers, and limitations to this, and their interest in professional development about video games in the classroom. This bi-faceted methodological approach enabled the perceptions and experiences of Australian secondary teachers to be situated within the current and historical body of evidence describing video game use in classrooms.

Video game terminology

Any discussion of the definition of video games necessitates an initial consideration of nominal definitions, and the different ways in which video games are referred to in the research field. There is significant variety in terminology used in the field of game research: what is the difference between an *electronic* game, *video* game (or videogame, video-game),

computer game, *PC* game, *mobile* game, or *digital* game? These terms (particularly video game, digital game, and computer game) are often used interchangeably, in popular use as well as in video game research, but they are not strict synonyms (Tavinor, 2009a). The terms can sometimes denote the medium on which the game is played, as in the case of computer games and PC games being played on personal computers, or mobile games being played on mobile phones, tablets, or portable consoles. Despite this, they are often used as generic terms. Similarly, the terms electronic game and digital game can be used generically, but are also used to refer to digital toys, and games outside of the visual medium. In this thesis, I will use "video game", as this is the term most commonly used in the research field, and is also the generic, non-platform specific term used to refer to a digital game within the visual medium. At times, the term digital game will be used to differentiate digital video games from traditional, non-digital games. I favour the separated term "video game", rather than the alternative combined "videogame". The merged term videogame implies a concept that is whole and somehow separate to the history of game scholarship, which is not the case: video games share significant points of similarity to traditional, non-digital games, and I believe that this is important to acknowledge in nominal usage.

Overview of the thesis

This thesis consists of six further chapters. In Chapter 2, I situate the current study within the field of game and education literature. This includes a critical review of the definitional issues of games and video games, initially in a wider context, and then specific to their use within the field of education. This review finds that current definitions of video games within education are broad and inconsistent, and not relevant to the uses of video games in the classroom. I then define video games within education for the purposes of this study, with inclusions and exclusions detailed. Additionally, Chapter 2 includes a review of existing research addressing video games within an education context, incorporating a

discussion of the impact of video games on student learning outcomes and motivation, and issues of research design in the field. This chapter further argues the critical importance of contextualising the classroom and role of the teacher in designing video game interventions, a significant gap in the current body of research.

Chapters 3 and 4 outline the methodology of the systematic review and of the survey undertaken as part of this study, providing a theoretical and procedural description of the instruments used to collect and analyse data. Chapters 5 and 6 present the results of the data analysis for the systematic review and the survey, respectively. Chapter 5 describes the demographic profile of study participants, study methodology, video-game intervention and study outcomes for all studies included in the systematic review. In addition to this, relevant themes that emerged from the systematic review are explored, including teacher professional development, and the presence of game-enhanced curricula. A separate analysis is undertaken of research identified by the systematic review and completed in the context of Australian secondary classrooms.

In Chapter 6, survey analysis methodology is described, including the use of descriptive statistics, bivariate correlation analysis, and regression analysis using bootstrap sampling. Survey results are presented, including teacher video game use within the sample for both personal and pedagogical use, teacher attitudes towards the use of video games in the classroom, external support received for the use of video games for education, and teacher perceived benefits, limitations and barriers to the use of video games.

In Chapter 7, the discussion of key findings is expanded, and the factors that influence teacher use of video games are discussed. The implications arising from this discussion, and subsequent key recommendations to inform future educational video game research are presented. Finally, the conclusions and reflective evaluation of the study are provided, and I

suggest further research agendas to address the significant knowledge gaps in this exciting field.

Chapter 2

Literature Review

This literature review chapter will focus on situating the study in the wider context of digital game scholarship, drawing from video game and education theory. Although this study primarily concerns video games in the context of secondary education, it is essential to take a wider view of video game theory to understand the cultural significance of video games, the ways in which video games are enacted in the classroom, and the grounding of literature examining the effects of video games on learning. This literature review will describe the contested scholarship of the definition of video games themselves, acknowledging that a unified definition is elusive, and subject to ongoing change and development (Arjoranta, 2018; Bateman, 2015; Stenros, 2017). Building on this, the review will focus on the ways in which video game definition is approached in the context of education, and explore the ways in which education and video game research is defined by the diverse classification of programs and technologies used within classrooms. Finally, the review will summarise the current field of digital game-based learning research.

A history of video game definition

Defining non-digital games

The question of what constitutes a game, and subsequently what constitutes a *video* game*,* is a historical and ongoing debate (Crawford, 1984; Juul, 2005; Salen & Zimmerman, 2004; Suits, 1967; Tavinor, 2009a). There are two dominant syntheses of game definitions that are accepted within video game scholarship, usually with minor criticism: Juul (2005) and Salen and Zimmerman (2004). Juul's (2005) "classic game model" describes a game as an artefact involving rules, variable and quantifiable outcomes, player effort and attachment to the outcome, and negotiable consequences. Similarly, Salen and Zimmerman summarise

and compare eight existing definitions of games, including those that are commonly referenced in game writing, to create their own definition; "A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (2004, p.11). Both papers summarise previous definitions of traditional, non-digital gaming, and combine these to create a new definition. Whilst both encompass some facets of video game definition, they are not comprehensive, and both definitions are widely challenged in the literature (Arjoranta, 2019; Bateman, 2015; Tavinor, 2009b). Despite this, game scholars commonly acknowledge these definitions with varying exceptions and additions, and they are "grudgingly accepted" (Stenros, 2017, p.500) as a basis for game definitions within the research field.

To establish the history of game definition, and understand the basis of Salen and Zimmerman (2004) and Juul's (2005) definitions, it is essential to acknowledge the influence of Wittgenstein and his concept of '*familial relationships*' (1968). The link between Wittgenstein and the definition of games is referenced widely in definitional writing about games, whether digital or traditional (Stenros, 2017). This is largely due to Wittgenstein's assertion that the concept of a 'game' is an idea that defies definition. He describes the difficulty in narrowing down a specific definition that encompasses all known uses of the term 'game', using board games, card games, ball games, Olympic games, and language games as examples. Wittgenstein proposes that, in order to define what a game is, it is necessary to consider the similarities and connections between all things that are considered a game, which he terms the '*familial relationships*' (1968). He asserts that the boundaries of definition cannot be described, as they have not been drawn (meaning that definitions are always adapting and changing for context) but that does not mean that definitions are not useful – just that they are always adapting (1968). It is important to note, though, that Wittgenstein was more concerned with the way in which language functions in relation to the

concept of games, rather than the actual definition of games themselves. Despite this, Wittgenstein has become an almost universal reference in the academic discussion of games definition, and is influential to all following definitions of the term.

Despite the definitions of Juul (2005) and Salen & Zimmerman (2004) being widely utilised, game scholars have continued to conceive of new definitions for video games. In 2017, Stenros conducted a systematic review of over 60 game definitions (both digital and non-digital) in order to explore the key differences between classifications and identify the divisive questions within the field of game scholarship. Stenros stated that, despite there being more definitions of games than ever before, this had created "more polyphony than clarity" (2017, p.500). He describes the overall corpus of game definition writing as heterogenous, encompassing formal and strict definitions, incomplete conceptualisations, and highly contextual approaches to games (Stenros, 2017). In the review, ten themes that indicate contested points of interest for game definitions and game studies were outlined: rules, purpose and function, whether games are an artifact or activity, how games are models of culture, the role of the player, (un)productivity, competition and conflict, goals and end conditions, construction of the category, and coherence (Stenros, 2017). Stenros proposes that these categories should be the basis for game scholars to develop and clarify their own contextual definition of a game, and to assist in the development of definitional precision within the game studies field (2017).

Building on the existing body of game definition writing, Arjoranta (2019) uses a Wittgensteinian lens in his approach to game definition. He initially describes a philosophical understanding of the purpose of definitions, and then builds on the concepts in order to propose ways in which to make *useful* game definitions. Following Wittgenstein, Arjoranta (2019) describes definitions as highly contextual tools, dependant on the purpose and context of the author. He asserts that there is no such thing as a perfect definition because the

usefulness of a definition is contingent on its purpose. He describes essentialist definitions as those that seek to define the 'necessary and sufficient' characteristics of what they are describing; that they seek to exclude all things that do not possess the defined characteristics. He notes that most essentialist definitions fail by either not including all of the things that are being defined, or including things that are not being defined. Arjoranta (2019) proposes that the most useful definitions are those that are concerned with solving practical problems and that they are highly contextual. In light of this, Arjoranta's means for creating useful game definitions is to ensure that any new definitions are specific to a particular use, and must consider previous published definitions. If a new definition for games is being written, it should be purposeful and say something useful about games; in the case of the present investigation, this can be made specific to educational video games. Most research that speaks about educational video games speak to the definition of just *games*, but this may need to be refined for educational research to be more effective in discussing games in education.

Defining video games

It is pertinent to note that each of the definitions outlined thus far are at least partially concerned with the definition of non-digital games. In the case of Wittgenstein (1968), writing prior to the ubiquity of video games, non-digital games are the sole focus of his definitional work. Salen & Zimmerman (2004) synthesized eight game definitions to create their own, none of which are explicitly concerned with defining digital video games. Similarly, Juul (2005) combines seven game definitions, none of which specifically define digital video games. While neither Juul (2005) nor Salen & Zimmerman's (2004) definitions *exclude* digital video games, they were not created with video games as their sole focus. In more recent research, the definitions of non-digital and digital video games are often discussed in tandem (see Arjoranta, 2019; Bateman, 2015; Stenros, 2017), with authors noting that the issue of definition is common to both, so it is useful to discuss them together.

It is possible that the amalgamation of non-digital and digital video game definitions contributes to the ongoing difficulties of game definition; Tavinor notes that the reason that the definitions of Juul (2005) and Salen & Zimmerman (2004) are commonly found insufficient for defining digital video games is because they simply do not try to do so (2009b), as they do not make the distinction between digital and non-digital games.

A notable definition that deals specifically with digital video games is that of Tavinor (2009a). Tavinor provides an alternative definition of video games by summarising and critiquing the three dominant theories within game scholarship: narratology, ludology, and interactive fiction (2009a). He asserts that the three theories in isolation are not enough to provide necessary and sufficient conditions to define video games, and encompass artefacts that are not considered video games within their definitions (Tavinor, 2009a). Narratology argues that games are a continuation of narrative structures that have previously been seen in books and movies, and describe games as *texts,* to be studied in the same way as literature (Poole, 2000). Tavinor (2009a) rejects narrative as an essential feature of games, citing games such as *Tetris* (Nintendo, 1989) and other puzzle games as examples of games that can exist without a narrative. Ludology emphasises the 'game-ness' and interactivity of video games as their essential feature, citing the way non-digital games such as *Chess* and sports games are migrated from one medium to another (physical to digital) as evidence of the essential nature of ludology to games (Aarseth, 1997). Tavinor (2009a) asserts that ludology, and interaction, are not sufficient to be the essential feature of a video game. He notes that traditional games, such as *Dungeons and Dragons* (Mearls & Crawford, 2014), can include interactivity without being considered a video game. Interactive fiction describes video games as fictional worlds within which the player asserts control and makes impactful decisions (Tavinor, 2005). Tavinor defines fictional worlds as encompassing both those that include clear fantasy elements such as the orcs and dragons of *Elder Scrolls V: Skyrim* (Bethesda Game Studios,

2011), and also the more life-like fantasy such as driving sportscars around the Nürburgring in *Gran Turismo* (Polyphony Digital, 2004). Interactive fiction is not an essential condition of video games, though, as Tavinor (2009) notes that not *all* games involve fiction (such as *Tetris* [Nintendo, 1989] and digital forms of *Sudoku* and *Chess*), and that non-video game artefacts such as pen-and-paper role playing games and childhood games of pretence all involve interactive fiction, without being considered video games.

After establishing the existing theories of narratology, ludology, and interactive fiction as individually insufficient in providing necessary and sufficient conditions to define video games, Tavinor proposes his own disjunctive definition of video games (2009a). Tavinor rejects the accepted definitions of Juul (2005) and Salen & Zimmerman (2004) as not engaging in the philosophical nature of the definition argument, as well as taking issue with their method of defining video games *vis-à-vis* traditional gaming (2009a). Treating previous theories as definitions – something that he himself admits is not their intended purpose – Tavinor (2009a) distils the necessary and sufficient conditions required to create an essentialist, disjunctive definition of video games:

> X is a video game if it is an artifact in a visual digital medium, is intended as an object of entertainment, and is intended to provide such entertainment through the employment of one of both of the following modes of engagement: rule and objective gameplay, or interactive fiction (2009a, p.26)

With the inclusion of both gameplay and interactive fiction as disjunctive requirements, this definition comes close to being inclusive of most artefacts that could be considered video games – although the specific meanings of key words within the definition (especially interactive fiction) require considerable explanation and clarification from the author to be sufficiently inclusive. The inclusion of entertainment as a requirement for classification as a

video game complicates the use of this definition within the context of video games and education; according to Tavinor's definition, games created for learning are not video games (2009a). Tavinor notes that serious games, or games for education are "clearly video games with *extended* functions" (2009a, p.31, emphasis original), highlighting the need for further definition when it comes to games within the context of education. As will be discussed further, building on Tavinor's (2009a) definition with the inclusion of further elements of context and classification for education can address this need for the definition of educational games.

In 2017, game scholar Bergonse wrote that, despite the significant impact of video games on popular culture, a multi-billion-dollar industry and a vast array of consoles and online game interactions happening all over the world, "few attempts have been made to define what a video game exactly is" (2017, p.239). This claim, which is disproven by the discussion in the preceding paragraphs, is exemplar of a reoccurring theme throughout video game research: a lack of communication between researchers, research papers, and the body of work that exists (Arjoranta, 2019). Though game definitions are a common feature of research writing, these definitions are often highly contextual, and the foundational assumptions of the authors are rarely made clear, which results in a field in which game scholars seem to "talk past each other" (Stenros, 2017, p.500). While there have been many attempts to define exactly what a video game is, the field of research remains disparate and resistant to regulation or unification, due to research that does not speak to the wider context of the field.

These disparate approaches to defining video games illustrate that a singular, essentialist definition is not only impossible, but not necessary or even desirable. The ongoing conversation about the definition of games is not a flaw in the research field, but rather an ongoing dialogue, similar to that described by Wittgenstein (1968), that will ensure

that the collective understanding of games will continue to develop and evolve as the technology does (Salen & Zimmerman, 2004). The complexity of defining video games does not indicate that it is not possible to agree on a definition, or even that the act of trying to define video games is futile, but rather emphasizes that the ongoing attempts to find a definition are a way of defining the challenges faced by the field of video game research (Tavinor, 2009b). There are also significant benefits to embracing 'fuzzy', difficult to define concepts: if definitions are static, this can limit the organic growth of the research field and inhibit meaning-making in the context of actual video game use and discovery (Stenros, 2017). Therefore, in light of the ongoing debate surrounding video game definitions, there is value in clarifying definitions in specific contexts to ensure a common language for coherence and analysis, and in adding to the ongoing debate of video games definitions without limiting the growth of the field. This is essential to consider when defining video games within the context of education.

Defining video games in education

The issue of video game definition becomes more complex within the field of education research. In the last 20 years, research concerning video games in education has dramatically increased, and has resulted in a plethora of game-based research areas. Despite the significant body of literature surrounding digital game based learning (Perotta et al., 2013; Young et al., 2012), the essential definition of video games is rarely engaged with in any meaningful way. Educational video game researchers pay scant attention to the intrinsic definition of video games and focus instead on the categorisation of games in relation to their application to education. Authors frequently reference Vygotsky (1978) and his work on games and play as a means for child imaginative development (see Young et al., 2012), or the definitional work of Prensky and his concept of 'digital natives' (2001), Juul (2005), or Salen and Zimmerman (2004). Educational researchers do not often define games within their

research, but instead identify and discuss the classification of games, or categorise the ways in which games relate to learning (Connolly et al., 2012). Classification systems are used by educational researchers to order games into various categories, such as learning outcomes, function, educational content, and genre. This preference for categorisation, rather than philosophical definition, has resulted in a field that embraces a more formulaic approach to language and classification, compared to more traditional game scholarship.

It is widely acknowledged that game based learning research lacks coherence (Ke, 2009; All et al., 2014; Girard et al., 2014) and that this is a barrier to progress in developing and understanding the impact of game based learning in education. To address this, classifications are often used in place of definition as a means to develop organisational frameworks for understanding games (Connolly et al., 2012). While the classifications themselves vary, this is generally ordering games into primary function (such as games for entertainment, games for learning, serious games), genre (action, adventure, fighting, puzzle, role-playing among others) or platform (PC, console, mobile). Classification of digital games within the research field can also be based on measurement of outcomes or learning interventions, such as skills-based learning, cognitive or affective outcomes (see Garris et al., 2002 for an example of frameworks), or motivational variables such as engagement, interest, and effort. Seminal video game education researcher James P. Gee goes as far as classifying games as 'good' or 'bad' in relation to language learning (2003). These classifications, while useful in discussing the impact and implementation of games in education, highlight a significant gap in the discussion of definition of video games within the field of education research. There is little consideration of the aesthetics of games for students (although this is acknowledged in Beavis et al., 2015), an important consideration in the cultural context of video games. The field of educational game research is broad and gamified technology use in the classroom is growing exponentially, spanning traditional card and boardgames, the use of

badges and leader boards within traditional classroom activities, digital games for classroom management, game-creation-as-learning, physical games using digital technology, augmented reality with mobile technology, and console games within the classroom. The collection of all these disparate technologies under one research field means a cohesive view of the field is almost impossible. Therefore, discussion and consensus of definition is critical to ensure research findings can be utilised.

A notable definition of games within the context of education is Whitton's (2009) proposed 'characteristics of games'. Whitton (2009) created a framework for defining games within education in order to more accurately discuss the ways games are included in education. As a summation of other game definitions, Whitton created the framework for ten defining characteristics of games: competition, challenge, exploration, fantasy, goals, interaction, outcomes, people, rules, and safety. Whitton does not claim that the ten characteristics are essential to defining what a game is within education, but rather an open list or *desirable* characteristics for definition. The more of these characteristics that an activity exhibits, the more 'game-like' it is. This framework was created with the intention of making the definition of a game as "open and inclusive as possible" (2009, p.28). While the framework is a good basis for a summary of characteristics within game-like educational activities, and a good start to discussing issues of game definition within an education context, Whitton did acknowledge that, stories, role-plays, and puzzles possess the framework's characteristics, and hence can be considered game-like, making the approach broader than may be desirable in the digital game learning research field.

A working definition of video games in education

As the previous discussion shows, definitions of video games do not account for the nuances of games used within education and are not designed for that purpose. Existing video

game definitions are often used within the context of education research to define educational video game concepts (see Backlund & Hendrix, 2013; Killingsworth et al., 2015; Young et al., 2012). Therefore, there is a current and pressing need for working definitions of video games within an education context, in order to separate video games from other educational technologies (Young et al., 2012). This is needed to define the nature of video games clearly, as opposed to simulations, learning applications, non-digital games, and student response systems, amongst others. Technology in education is a rapidly expanding area of research (Connolly et al., 2012; Stenros, 2017), and there is value in defining educational video games, and setting them apart from the huge number of other educational technologies available. While the categorisation of educational video games currently seen within the research field is a valid means of separating the impacts and uses of video games in the classroom, the philosophical discussion of definition adds depth and complexity. There is a significant gap within the literature that does not address the need for a more nuanced approach to the discussion of the combination of education and video games. There is also a need for a review of educational game literature for a synthesis of definitions of educational video games.

For the purposes of this research, and in light of the discussion of previous definitions, I propose the following definition of video games in education. This is a highly pragmatic and contextual definition specific to the needs of this study and accords with Arjoranta's definitional approach (2019). To define digital video games for this study, I have combined three dominant game definitions to create a baseline description of a digital video game (Juul, 2005; Salen & Zimmerman, 2004; Tavinor, 2009a). To make the definition specific to the context of education, Whitton's (2009) characteristics are also included, with the addition of Van Eck's (2006) educational game categorisation. The final definition is detailed below. For

the requirements of this systematic review, an artefact is defined as a video game if it meets the following criteria:

It is an artefact *exclusively* in the visual digital medium, intended as an object of entertainment or education through the following:

a. Rule-based gameplay (Tavinor, 2009; Juul, 2005; Salen & Zimmerman, 2004; Whitton, 2009) AND;

b. Variable and quantifiable outcomes, influenced by player effort (Juul, 2005; Salen & Zimmerman, 2004; Whitton, 2009)

and needs to include at least one of the following:

c. Elements of fantasy or role-playing ("that which is not real", Whitton, 2009);

d. Elements of competition or challenge (Whitton, 2009; Salen & Zimmerman, 2004);

e. Interactions with others (directly, through leader boards, collaborative or competitive; Whitton, 2009)

Additionally, interventions must include games that can be categorised into one or more of the following classifications: educational games, entertainment games for educational purposes, or learning by making games (Van Eck, 2006). As part of this definition, there are some specific sub-sections of digital gamified educational interventions that have been excluded. These will be described in detail below.

Simulation-only software

Digital simulations are a useful technology for education, and allow students to "observe and interact with representations of processes" that would otherwise be inaccessible

in a classroom setting (National Research Council, 2011, p.19). Video games and simulations share many similar characteristics, and often within educational research simulations and games are categorised together as educational technologies (Clark et al., 2009). Despite this, simulation-only software has been excluded on the basis that it does meet the definition of gameplay as outlined above. While there is clearly an element of simulation in almost all digital video games, simulation-only software differs from video games in three ways: simulations generally do not provide variable and quantifiable outcomes for the player, there is no element of interaction with others, and there is no competition or challenge involved. The rules and goals of a video game, including scoring or reward systems aimed at tracking player progress, are absent in simulation-only software (Clark et al., 2009). This is not to say that all simulations are not games; there has been a significant increase in the number of educational simulations which share game elements, such as challenges, points, or levels (see *Alien Rescue* [TEXAS Education, 2012], *Second Life* [Linden Labs, 2003], *Labster* [Labster, 2011]). Where software includes these elements, they have been included in this study as a video game, despite being labelled as 'simulations' by the developers. Where a digital artefact only involves simulated situations or phenomena, without game-like interactivity, it does not meet the requirements for video game definition, and so have been excluded from the study.

Intelligent Tutoring Systems

Software that is described as 'intelligent tutoring systems' (ITSs) or 'automated tutoring environments' have been excluded as a video game in this definition. While educational video games and ITSs share some similarities in intention (such as supporting student learning, and increasing learner engagement and motivation), the method and focus of achieving these outcomes are markedly different (Long & Aleven, 2017). There is generally no metaphor or fantasy elements to an ITS, and there is usually no social interaction,

competition, or challenge as part of student learning. The main purpose of an ITS is to provide "cost-effective yet personalised tuition" (Mills, Australia & Dalgarno, 2007, p.692) and the two different systems adopt very different approaches to learning, being grounded in "different bodies of theory" (Long & Aleven, 2017, p.2). Despite this, it is also important to note that some ITSs can include some game elements. Specifically, the ITS *iSTART-ME* was designed to address the issue of disengagement and boredom during the use of traditional ITSs (Jackson & McNamara, 2013). While the inclusion of points, levels and mini-games mean that some ITSs border on meeting the definition of a video game, the combination of ITS and gamification is a complex system that requires more thorough investigation than can be provided within the broad question of this review. Therefore, articles that use an ITS or gamified ITS intervention were excluded from this definition.

Gamification

There is significant overlap in the concepts of video games in education, digital game based learning, and gamification. The term gamification has grown in popular usage, particularly in the fields of business and education research, and is used to encompass a wide variety of parallel or overlapping concepts in relation to games, game design and gaming attributes. Despite this, it is important to note that *games* and *gamification* are not the same, even though they can sometimes be used interchangeably in insouciant common usage (Sailer & Homner, 2020). The definition of gamification is "the use of game design elements in non-game concepts" (Deterding et al., 2011, p.10), and so, by definition, video games are outside of the scope presented (see Landers et al., 2018). It is for this reason that research which solely focuses on gamification elements in education (such as avatars, badges, points, or leader boards within traditional classroom activities) were excluded within this definition.

Video games with physical or mixed-media elements

In order to be as specific to the uses of video games in education as possible, the definition of video games for this review excludes any games that are not exclusively in the digital visual medium. This includes video games that are used in combination with other media methods (such as transmedia storytelling, WebQuests, or mixed media narratives), physical elements (such as wearable technologies, step-counters or physical props), and physical environments (GPS or location dependant games). This has resulted in some artefacts that are certainly considered video games in popular usage, such as *Pokemon Go* (Nintendo, 2016) and *Just Dance* (Ubisoft, 2009), being excluded. While this may seem over-zealous, the purpose of this study is to examine uses of video games in isolation, without extraneous features. In the case of a video game that combines physical or mixed-media game interventions, it would be difficult to ascribe the impact of video games in isolation, compared to the learning impact of the other aspects of the game. There is certainly a need for the uses and impacts of these types of games to be investigated, and this has been addressed within other research (see Bower & Sturman, 2015), but it is currently out of the scope of this project. It is for this reason that only games in the digital visual medium were included within the above definition.

Video games in education: What does the research say?

The impact of video game based pedagogy

This section explores the impact of video game based pedagogy on student learning outcomes, and the strength of evidence available within the video game based education research field. With the increase of video games within the classroom (Brand et al., 2019), there has been a corresponding increase in research investigating the potential effects of games on student outcomes. While there is a considerable amount of research that indicates

evidence of positive learning outcomes from game-based learning (Clark et al., 2016; Girard et al., 2013; Young et al., 2012), there is also division within this research field (Perotta et al., 2013). Researchers within the education field are generally concerned with testing the effectiveness of video games as an educational intervention, with a focus on specific game components, measuring learning outcomes, and testing (Hanghøj & Brund, 2011). Literature in the field indicates that the large diversity in the way experimental research is conducted across the field of digital game-based research has resulted in a field that is difficult to compare, and can often be contradictory (All et al., 2016; Girard et al., 2013).

The potential impact of video games on student learning outcomes and motivation has been a focus for educational research in recent years (Backlund & Hendrix, 2013; Perotta et al., 2013; Young et al., 2012). In 2013, Perotta et al. performed a rapid review and meta-analysis of published studies in order to determine the impact of video game based learning on student engagement and knowledge attainment. The authors found that evidence for improvements in academic performance, problem solving skills and attitudes to learning as a result of game-based learning interventions was heterogenous across the 31 studies reviewed, but with some indication of positive links (Perotta et al., 2013). Similarly, Backlund & Hendrix (2013) conducted a meta-analysis of papers published between 2002 to 2012 that focused on using empirical data to assess the effectiveness of game-based learning. Across the 40 papers reviewed, the authors found that 29 reported a positive association between game-based learning and educational outcomes, providing evidence that serious games can be effective learning materials (Backlund & Hendrix, 2013). Girard et al. also conducted a meta-analysis of experimental studies designed to examine the effectiveness of video games on players' learning and motivation (2013). While the results suggested improvement in student motivation, the authors had difficulty drawing conclusions due to the significant study heterogeneity, with only nine papers having met their selection criteria (Girard et al., 2013).

Although these reviews reported that video games can have positive impacts on student learning and motivation, the results are far from conclusive. Across all reviews, researchers note that the quality and strength of current evidence in support of positive learning outcomes for video game based learning precludes any definitive conclusion.

The strength of evidence in the video game research field

Reviews of the research indicate the lack of robust evidence for impacts of video game based interventions can be related to issues of research methodology. Perotta et al. (2013) noted that studies reviewed often contained incomplete information on research design, making it difficult for the authors to draw valid conclusions on the effectiveness of game-based learning. Backlund and Hendrix (2013) also noted that 21 of the studies reviewed within their study had game developers as the main evaluators of data, highlighting a high probability of bias. A systematic review by Connelly et al. (2012) examining empirical evidence for serious games reported that the studies included in the review were significantly heterogenous in terms of the aims, theoretical frameworks and methodologies used. Connelly et al. (2012) noted that this highlighted the interdisciplinarity of the field and the divergent focus on digital games within research. Similar to the reviews conducted by Perotta et al. (2013) and Backlund and Hendrix (2013), Connelly et al. (2012) found that, while there was some empirical evidence found to support positive impacts and outcomes of video games in education, higher quality studies were needed to provide evidence of their effectiveness. Further, the authors noted the importance of considering the ways in which these interventions are integrated into student learning experience, and to develop a better understanding of the ways in which digital games integrate with learning outcomes (Connolly et al., 2012).

The importance of the context of school and classroom learning within video game based learning research was further highlighted in additional studies. In 2012, Young et al. conducted a review of over 300 articles to identify and analyse trends relating to video games and academic achievement. The authors noted that the current methodologies for researching video games within education need to extend beyond the existing parameters (such as gameplay data, and pre- and post-tests) to capture the reality of game play, stating that situated learning is more appropriate to investigate the individualized nature of video game use (Young et al., 2012). In order to focus on the complex interaction between player, game, and context, Young et al. (2012) recommended that researchers consider specific student uses of games within the context of a specific curriculum, and the ways in which this may affect the learning process, noting that the review identified no papers that investigated learning and gameplay in within the context of school or home learning in a meaningful way. This issue of school and classroom context was highlighted across other reviews of the literature as well, with Perotta et al. (2013) emphasizing the need for further research integrating the realities of schools, and the social, economic, and cultural factors that influence the use of game based learning. Further to this, Backlund & Hendrix (2013) noted a gap in the literature regarding practical pedagogical problems, including a lack of research on parent, teacher and student uptake, barriers to implementation and issues with integration between curricula and content.

In response to the heterogeneity of the game based learning research field, All et al. (2014) conducted a systematic literature review using Cochrane methodology to map the methods that empirical research used for assessing the effectiveness of video game based learning. The study found a significant variation in the way experimental research was conducted in video game based learning across participants, interventions, methods, and outcomes measured. This resulted in difficulty comparing results across studies, and concerns regarding the reliability and validity of certain methods within the field (All et al., 2014).

Reviews of the literature indicate that there is difficulty in synthesizing and comparing empirical research within video game based learning (Connolly et al, 2012; Young et al., 2012). While there is some progress towards a systematic approach to game-based research, including frameworks and methods that can be validated (see All et al., 2016), this highlights the importance of research that examines video game based learning in the context of the classroom.

The role of the teacher in video game based learning

There is limited research on teacher pedagogy in relation to video game based learning in a secondary context, despite the critical importance of the role of teachers in video game implementation. Research exploring the factors that predict teacher attitudes towards the use of video games in the classroom is even more limited. There is, however, a considerable body of research that examines teacher attitudes and willingness to use technology in the classroom, that may be a proxy for teacher likelihood to adopt video games in their pedagogy. Early research in the area of technology development and teaching found that, despite some anti-technology humanist stances in education (Davies, 1996; Goodwyn, 1992), innovative methods of using technology in education have been generally embraced by teachers (Goodwyn et al., 1997). This is supported in more recent research, with Drossel et al. (2017) confirming that teachers are generally positive towards the use of technology in the classroom. Additionally, Drossel et al. (2017) also reported that teacher positive attitudes towards technology, and more specifically their belief in their own self-efficacy in using technology, is the most significant factor influencing the frequency of teacher technology use in the classroom.

Technology use in teaching also varies according to subject area, with Science and Technology teachers reporting more positive attitudes towards technology, and a higher

frequency of technology use in teaching, compared to teachers in other subject areas (Jang & Tsai, 2013; Sezer, 2015). However, as stated, this research has focused on technology use. There are few studies that have focused on teacher attitudes and their impact specifically on video game use. This is particularly evident in the Australian context, in which, as far as the researcher is aware, there have been no recent studies focusing on teacher perceptions of video game use in Australian secondary classrooms.

In 2014, the Joan Ganz Cooney Center surveyed 694 American primary and middle school teachers on their use of video games in the classroom (Takeuchi & Vaala, 2014). The survey found that use of video games in education is wide-spread, with 78% of teacher respondents reporting that they use games to teach within their classrooms. It also indicated that games created for educational purposes, rather than commercial off-the-shelf (COTS) games, were used more commonly in the classroom. Despite this, 80% of teachers in the survey reported difficulties in finding curriculum-aligned games, and just 40% believed that a sufficient variety of such games even exist. Nousiainen et al. (2018) conducted a qualitative content analysis of case studies to identify what kind of competencies teachers need when using different video game based pedagogical approaches. The study identified that further research into teacher experiences which have fostered or hindered the development of game based pedagogy competencies is needed (Nousiainen et al., 2018). Similarly, Kangas et al. (2017) conducted a qualitative literature review studying the pedagogical activities of teachers in the game based learning process. The authors noted that many studies of game based learning provided "limited descriptions of teachers' pedagogical activities, such as the pedagogical choices and considerations that teachers make when they teach with games." (Kangas et al., 2017, p.452).

Research that specifically addresses teacher intentions to use video games within the classroom reports a number of factors that may influence video game use. Hayes and

Ohrnberger (2013) found that, in a study of American pre-service teachers, personal experience in playing video games did not influence their attitudes towards the use of video games in the classroom. Sánchez-Mena et al. (2019) examined the role of gender and age as moderating factors in higher education teachers' intention to use educational video games in teaching. The researchers found that neither gender or age influenced teacher intentions regarding the use of video games in their pedagogy, and instead found that perceived usefulness of video games was the only predicting factor for video game use (Sánchez-Mena et al., 2019). This is consistent with the findings of Bourgonjon et al. (2013), who found within a sample of 505 Belgian teachers that personal experience with video games did not influence teacher acceptance of video games in the classroom. Furthermore, Bourgonjon et al. (2013) reported that the relevance and perceived learning value of video games was the most influential factor in teacher acceptance of video games in education.

In addition to these factors, research has found that the perceptions of video game use in education from external sources, such as parents, administration, and colleagues, is a potential predictor of video game use in the classroom (Gerber & Price, 2013; Justice & Ritzhaupt, 2015). Recently, Kaimara et al. (2021) reported that a sample of 170 preservice teachers in Greece described the scepticism of teacher colleagues towards the use of video games for education as the second most commonly perceived barrier to the implementation of video games in the classroom. Similarly, Gerber and Price (2013) reported on a sample of 10 English teachers in the United States in a study of elementary, middle, and secondary English teacher perceptions of their implementation of video games in literacy teaching. The researchers reported that teachers felt that they would not be supported by school administration and colleagues in their use of video games, as they did not perceive games as a valid pedagogical experience (Gerber & Price, 2013).

In the Australian context, there is very limited research on teacher perceptions of video games in education. The *Digital Australia Report 2020* surveyed adult video game players about the potential of video games for education (Brand et al., 2019). Sixty-one percent of 3,228 respondents believed video games motivate students to learn, and 63% believed that video games were beneficial for teaching students in general. They also surveyed parents about whether and how their children had used video games at school; 52% said that their children had used video games as part of their classroom learning, and 26% said that their children had developed video games as part of their formal education. As part of the *Serious Play* project, Beavis et al. (2014) surveyed 270 Australian primary and secondary students on their attitudes towards, and the use of, video games in the classroom. The survey describes varied student experiences of in-school video game play. Student responses described opportunities for engagement, socialising, challenge, and accumulation as highly prized, but also indicated an impatience with 'boring' games, low interest levels, tediously 'educational' content, and frustrations with technological difficulties. While these studies describe the presence of video games in the classroom, and suggest the complicated reality of their use, the dearth of studies that describe Australian secondary teacher perceptions, beliefs and experiences indicates the need for data collected directly from teachers to understand the practices that underlie teacher's decision-making processes. There is a need for research that focuses on teacher attitudes and use of video games, specific to subject area and classroom context, which is not addressed by the above studies. Additionally, studies that examine the current use of video games in classrooms are required to provide contemporary, pragmatic and relevant evidence. Technology capabilities change rapidly, and the ways in which video games are perceived and used has changed since these studies were conducted.

In conclusion, the current field of video game based learning research is diverse. There is a body of evidence reporting positive impacts of video games based pedagogy on student outcomes, but this is constrained by the lack of research of high methodological quality. Both Backlund and Hendrix (2013) and Perotta et al. (2013), note there is a lack of research that examines the realities and practicalities of contemporary digital game-based learning, including the pragmatic integration of, and barriers to, implementation in the classroom. Research that considers teacher competencies (Nousiainen et al., 2018; Nousiainen et al., 2015) and pedagogical foundations (Kangas et al., 2017) further highlights the need for studies that account for the influences on teacher uptake and integration of digital game-based learning. Furthermore, beyond the work of Beavis et al. on the *Serious Play* project (2017), there is limited research on video game based learning in the Australian context. Research that investigates the specific uses and integration of digital game-based learning within Australian classrooms would address a significant gap in the current research field. Preliminary reviews of the literature outline how study design flaws impact on the strength of evidence available (Perotta et al., 2013), and the heterogeneity in experimental research approaches across the field of digital game-based learning has resulted in a body of literature that is difficult to synthesize (All et al., 2014; Girard et al., 2014). The role of the teacher and pedagogy in the implementation of digital game-based learning is a noted gap in the current body of literature (Backlund & Hendrix, 2013; Kangas et al., 2017; Nousiainen et al. 2018).

Chapter 3

Systematic Review Methodology

This chapter contextualises the broad research objectives stated in the literature review chapter and presents the rationale for the systematic review undertaken as part of this study. This chapter will also describe the methodology utilised for the systematic review. The objectives of the review are to (a) provide a broad foundational account of the current educational research in relation to video game based learning in the secondary classroom, and (b) investigate current research regarding Australian teachers' uses and attitudes toward video games in their own classrooms.

Rationale

Video games are an established part of popular culture, and the integration of digital video games and education has progressed and can no longer be considered an emerging field of research. The use of video games has become an established part of educational practice, with over half of Australian parents reporting that their children use video games in their curriculum and classroom learning (Brand et al., 2019). While there are existing systematic reviews that have explored specific aspects of motivation and engagement in game based learning (Abdul Jabbar & Felicia, 2015), positive learning impact (Connolly et al., 2012), specific curriculum subjects, or emerging technologies such as mobile devices (Chang & Hwang, 2019), and augmented reality (Pellas et al., 2018), this review will focus on digital video games use for education in the secondary classroom context.

There is a significant division in the educational digital video game research field. For example, there is conflicting evidence for the effectiveness of video games in education in relation to academic performance and student attitudes (Perotta et al., 2013), as well as significant heterogeneity in the way experimental research is conducted across the field of

game based learning (All et al., 2014; Girard et al., 2014). A broad review of the ways that games are being implemented into secondary classrooms is needed to assist in charting the direction of research and to develop the current body of knowledge. The aim of this review is to inform future video game education research practice in secondary schools and beyond, through developing recommendations for future research directions. It also aims to examine the overall influence of video games in the secondary classroom by synthesising evidence of the collective body of research in this area.

Data collection

Literature Search parameters

The following electronic databases were searched: A+ Education (Informit), Education Research Complete (EBSCO), ERIC (Proquest), Scopus, and SAGE Journals. The databases encompass a broad cross-section of education research journals, in order to capture a wide diversity of literature in the initial document pool (Alexander, 2020). All database searches were completed between the 28th to the 31st of July 2020. Search specific choices included the filters for full-text and peer-reviewed, where applicable. All searches had the years of publication specified, from 2010 to 2020.

The search was limited to the previous 10 years of research regarding video games in education. This time period was chosen with consideration for the significant increase in the use of video games for education within the last 10 years, as well as the corresponding increase in research that concerns video game use within education. Ritzhaupt et al. (2014) conducted a systematic review of digital games in education from 2000 to 2010, which indicated that manuscripts published on the topic showed a significant amplified interest growing over the years reviewed. Likewise, the ten years from 2010 have demonstrated an

increasing interest in the role of digital games in education, and a rich body of literature to review.

Supplementary to the above database searches, the reference lists of significant systematic reviews in the area of education and digital video games were searched, and any supplementary articles were added to the list for review. No grey literature was reviewed as it was beyond the scope of the present investigation.

Search terms

The research question for this systematic review focused on three areas: secondary schooling, digital video games, and the educational application of video games within a classroom context. The terms were deliberately broad, capturing all uses of video games in secondary classroom contexts. Table 3.1 details the structure of the search terms used.

Table 3.1

Systematic review search terms

Block 1: Population		Block 2: Video games		Block 3: Education
("secondary school" OR "high school" OR "middle school")	AND	("video gam*" OR gamification OR "game theory" OR "game-based" OR "educational gam*" OR edutainment OR gameplay OR online-multiplayer OR "electronic gam*" OR "digital gam*" OR "serious gam*" OR "game-based pedagog*" OR "computer gam*")	AND	(education* OR learning OR engag* OR curriculum OR assessment OR "best practice" OR classroom OR pedagog*)

Note. * asterisks serve as the Boolean truncation operator, in order to capture words that end in alternate forms (e.g. pegagog* is used to capture pedagogy, pedagogies, pedagogical)

Inclusion and exclusion criteria

This section will outline the definitions and inclusion/exclusion criteria used to select final literature for the review (see Table 3.2). These criteria were in the first instance developed in relation to the research question: 'how are video games being used in secondary classrooms?' It is therefore necessary to clearly define what is considered to be video game. Furthermore, it is essential to define the scope and context of 'secondary classrooms', so that it can be differentiated against other learning contexts, such as after-school classes, workshops, holiday programs, or laboratory-based controlled environment research.

The definition of video games

One of the most significant delimitations made in the planning of this systematic review was the definition of video games, and the inclusion and exclusion criteria that could be applied to all screened texts. The contentious scholarship of game definition and the definition of video games for this study are discussed in detail in the literature review chapter (see Chapter 2: Literature Review). Briefly, for the purposes of this review, video games are defined as:

An artefact exclusively in the visual digital medium, intended as an object of entertainment or education through (a) rule-based gameplay or (b) variable and quantifiable outcomes, influenced by player effort. In addition to this, to be defined as a video game it needs to include one of the following: (a) elements of fantasy or role-playing, (b) elements of competition or challenge, or (c) interactions with others.

Table 3.2

Systematic review inclusion and exclusion criteria

Study variables	Inclusion criteria	Exclusion criteria
Video game definition	• Studies with interventions that are games that meet the outlined video game definition	• Simulation only technology, • Intelligent Tutoring Systems, • Gamification only learning or behaviour management interventions, • Games that are combined with physical elements (GPS-based games, QR codes, step-counters), and • Games that are combined with other media elements.
Classroom context	• Studies conducted within high school or secondary classroom settings • Taught by usual classroom teacher, according to normal classroom curriculum • Intervention is at least three classroom sessions in length	• No studies that take place outside of a classroom context, e.g., workshops, after-school lessons, excursions, museum-based learning experiences • Interventions taught by researchers or other, different, teachers to everyday classroom teacher
Study design	• Includes empirical evidence from experimental studies, observational studies, or mixed-method studies • Peer reviewed journal articles	• Includes evidence from non-empirical studies, such as theory building, reviews, and reports • Grey literature
Participants	• Students, or teachers of students, that are between 11 – 18 years of age (secondary school age)	• Pre-service teachers • Age of participants not clearly specified, but undertaken in an environment outside of secondary classroom learning (e.g., university, elementary/primary school setting)
Research publication	• Published between 2010 – 2020 • English language publication	• Published prior to 2010 • Published in language other than English

This definition was used to screen articles for final inclusion, and to separate other activities and educational interventions that can be categorised under the wide umbrella of "gamified learning" such as simulations, learning applications, non-digital games, and student response systems (e.g., digital quiz applications, or physical 'clicker' devices).

Classroom setting definitions

As the primary aim of this investigation, and the focus of this review, is the way that video games are used within a secondary classroom setting, an important element of the review research question is the definition of secondary classrooms. Secondary classrooms are defined as the context in which regular secondary teaching activities would take place. To be included in the review, research needed to be conducted within conventional formal learning environments. This fits the predominant educational context in Australia where secondary education is primarily delivered within a government or non-government school classroom, with face-to-face teaching and learning activities (Australian Curriculum, Assessment and Reporting Authority, 2020). It is acknowledged that some Australian students experience secondary schooling in home-schooling or distance education contexts, though this is outside the scope of this study.

The purpose of the inclusion and exclusion criteria in relation to classroom learning was to find studies that replicated the secondary classroom ecology as close as possible. The context surrounding video game interventions can significantly shape the ways in which a student interacts with a game, and the extent to which this interaction supports learning (National Research Council, 2011). To be included in the review, studies needed to take place within a classroom, and be related to the curriculum learning of the participant group (see Table 3.2). Research interventions undertaken outside of school hours, such as summer programs or supplementary workshops were excluded under this criterion. Further to this,

studies in which the intervention takes place in a laboratory, university, or a setting otherwise outside of usual classroom practice were excluded. Studies where teaching content was unrelated to the usual teaching curriculum were excluded, as they are outside of normal teaching practice and are outside of the scope of the research question. Similarly, excursions/incursions and activities that are undertaken with normal classroom teachers, but outside of the usual class settings, are excluded as this does not reflect the typical classroom setting. Research experiments undertaken within a high school but not related to classroom learning (such as a one-hour game session to test cognitive performance) were also excluded. Games played outside of class time (e.g., for leisure) but influencing in-class understanding and learning (e.g., discussion of video games played at home for the purpose of narrative learning, or video games played as homework; see Culp et al., 2015) were included. Additionally, the use of video games in the classroom where no direct gameplay was undertaken was still accepted as a valid use of video games for education. Studies in which the intervention was administered by the researcher, or anyone other than the usual classroom teacher was excluded as being an exception to normal classroom activities. Studies where teachers were asked or recruited by researchers to implement a particular game were included, as long as the intervention was taught by the usual classroom teacher and within the usual classroom setting. As this is a possible scenario in normal teacher development and teaching, it was accepted as a valid format for research into the ways in which video games are used within a secondary classroom setting. Studies that involved preservice teachers were excluded.

The length of research interventions was also considered as part of the classroom context exclusion criteria. To be included within the review, video game classroom interventions needed to be three individual sessions or longer in time period. A ‘session’ was defined as a lesson which involved student or teacher gameplay, or teaching activities related

to gameplay. Some studies that met all other classroom setting criteria involved pre- and post- testing of students, with regular classroom learning taking place in between these tests. These studies were included within the review, but lessons in which testing was administered for research purposes were not included as a 'session', as this does not relate to regular classroom learning. Therefore, for the study purposes, a research paper that had one lesson that involved pre-testing, one video game intervention 'session', and a subsequent post-test lesson, was excluded from the review as there were not three gameplay 'sessions'. The requirement for intervention time period was included to ensure that included papers were related to standard classroom learning activities, as well as capturing the effects of game interventions that occur over time (Wouters et al. 2013). Many papers reviewed described interventions that consisted of one lesson, or significantly limited timeframes (e.g., 15-30 minutes of gameplay), and this was measured as being outside of normal classroom settings, or normal classroom learning and so was excluded from the review.

Participant age

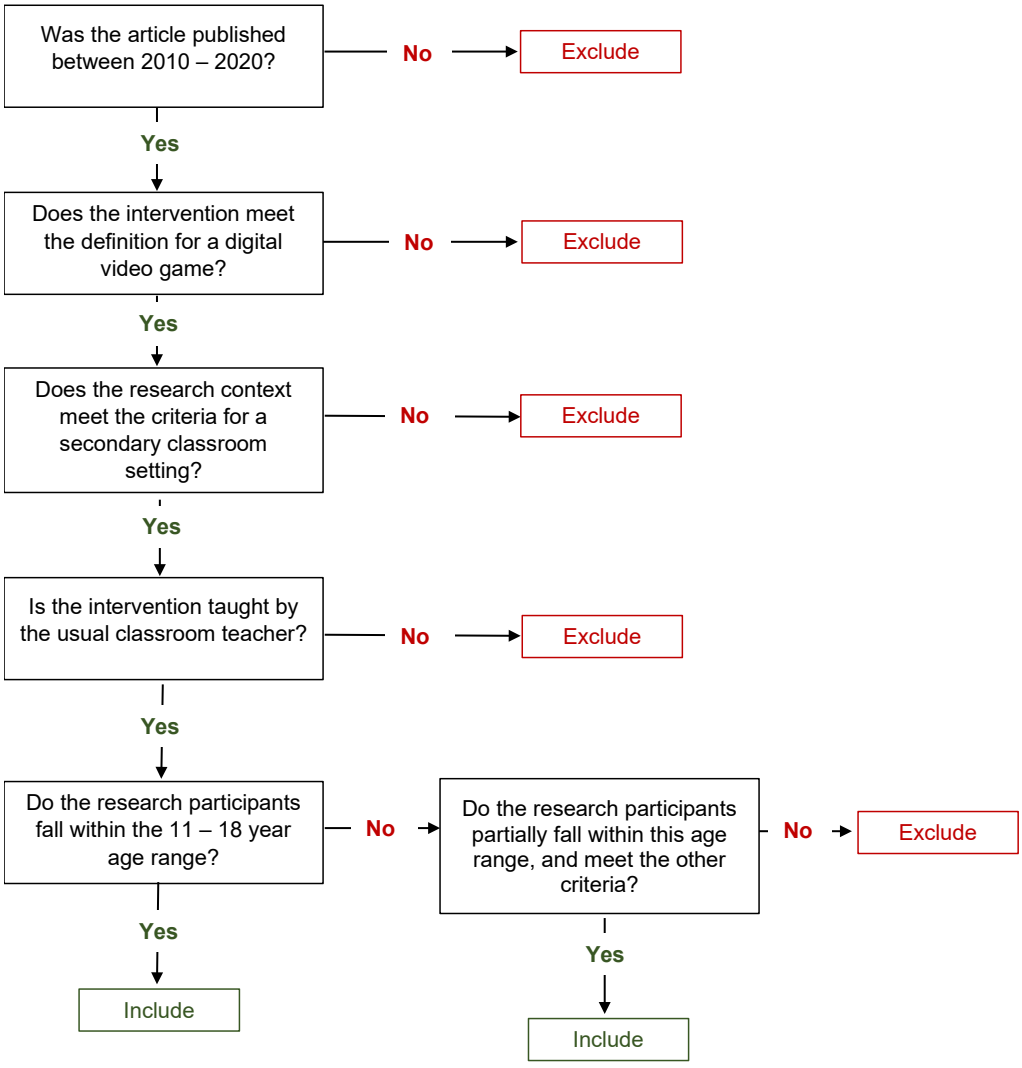
To be included in the review, the age of participants in the studies needed to be of Australian secondary school age, between 11 and 18 years old. Where participant age was not specified, studies undertaken clearly outside of a secondary school setting (e.g., university, elementary school) were excluded. Studies that described educational stages that were outside of the Australian format (e.g., middle school; gymnasium and lyceum in Greece; junior and senior high) were still included, as long as participant ages fell within the specified age range. If the participant group included a portion of students outside of the 11-to-18-year age range (e.g., 8 – 14 years old), the study was included if it met all other inclusion criteria (see Figure 3.1 for decision-making flow chart).

Other delimitations for inclusion/exclusion

Other exclusion criteria for the screening included grey literature (dissertations and theses, governmental reports or white papers, working papers, or conference proceedings), studies not published in English, and research that did not provide sufficient data to address the research question (Alexander, 2020). The following flow chart was employed in the screening process, in order to ensure that the screening process was systematically applied to all literature (Figure 3.1).

Figure 3.1

Systematic review screening decision-making flow chart



Data analysis and synthesis

Coding of papers

Following the initial search (see above) a total of 3110 possible studies were identified. After manual sorting and systematic application of the inclusion/exclusion criteria described earlier (see also Chapter 5: Systematic Review Results), a total of 85 papers were retained (for the list of papers retained, see Appendix A). The 85 papers were imported in PDF format into NVivo 12 (QSR International Pty Ltd., 2018), and subsequently analysed. Papers were assigned codes according to Key Learning Area, learning outcome, methodology, participants, game platform, research instrument, research question or hypothesis, and results (see Table 3.3). These codes were developed initially through consideration of other systematic reviews in the field of education and video games (see Connolly et al., 2012; Abdul Jabbar & Felicia, 2015), and subsequent codes were added as they emerged through analysis of the papers.

Analysis was completed by reviewing the assigned codes, and summarising the patterns and themes as they were recognised. Descriptions of the video games used within the papers were isolated and coded for analysis within NVivo. The details of the video games were categorised along the following dimensions:

1. *Developer*: papers were coded according to whether the game developed by the researchers, or not;
2. *Subject discipline*: which key learning area or knowledge domain was the game intended to improve or address; and
3. *Platform*: how the video game intervention was delivered (e.g., PC, console, online game, mobile)

Table 3.3

Code names and frequency for systematic review analysis

Name of code	Number of files where code present	Total number of code references
Participants	85	110
Research instruments	85	180
Research question or hypothesis	85	111
Results	85	244
Video game purpose		
Game for learning	49	56
Commercial off-the-shelf	22	40
Student created games	12	12
Various	7	7
Learning or research outcome		
Knowledge acquisition or content understanding	47	47
Affective or motivational	40	41
Teacher implementation or perceptions of video games	20	22
Teacher professional development	18	21
Perceptual or cognitive	15	15
Exploratory	11	12
Social skills	6	6
Behaviour change	4	5
Student perceptions of video games	2	2
Game characteristics	1	1
KLA		
Science	31	34
Social studies	15	16
Maths	13	13
Technology	10	11
English	10	10
Language	6	6
Various	6	6
Problem solving	2	2
Health education	1	1
Emotional intelligence	1	1
Visual arts	1	1
Methodology		
Quasi-experimental	34	34
Qualitative	29	29
Mixed	17	22
Survey	8	8
Randomised control trial	2	2
Game platform	41	41
Control group	28	35
Game-enriched curriculum	14	17

The included papers were also coded in terms of the following methodological criteria:

1. *Research question or hypothesis:* what the stated purpose of the research was;
2. *Sample size:* a detailed breakdown of the research sample, by provided characteristics;
3. *Method:* the design of the paper (qualitative, quantitative, or mixed), and whether the study was a RCT, quasi-experimental, survey, or qualitative design;
4. *Research instruments:* what data collection tools were used, and if it was a single method or multiple;
5. *Learning (research) outcome:* what outcomes was the research measuring (e.g., affective and motivational, behaviour change, knowledge acquisition, perceptual or cognitive, or social skills); and
6. *Results:* A short summary of the findings of the paper

The coding was performed by a single person, the author. The 85 papers retained for the results of the systematic review are summarised in Appendix B. Analysis was completed by summarising the coded papers into tables, and combining variables (e.g., KLA by study methodology, video game purpose by learning outcome) by hand. Some categories (e.g., methods) were further refined into more specific categories by the researcher within the summary tables (see tables in Chapter 5: Systematic Review Results). Each paper retained for the review was assigned an identifier that will be used to discuss individual papers in subsequent chapters.

Conclusion

This chapter expanded on the definitions of key terms used in the systematic review, as well as outlining the inclusion and exclusion criteria applied to papers within the review. The design of the review was described, as well as the analysis used to achieve the aims and

objectives of the review. The results of the systematic review follow in Chapter 5: Systematic Review Results.

Chapter 4

Survey Methodology

This chapter outlines the survey methodology undertaken as part of this study. Firstly, the rationale underlying the survey design will be described, followed by a discussion of the survey methodology, including participant recruitment details and data collection methods. This chapter will then describe the participant sample, the survey design, and the development of scales used for data analysis. Finally, the methods used to analyse the survey data will be summarised.

Rationale

An understanding of the use of video games in the classroom can inform interventions and improvements in teacher practice, at an individual, school, and government level. As teacher attitudes and familiarity with video games predicts the uptake and pedagogical use of video game based learning in the classroom (Hanghøj & Brund, 2011), this survey aimed to build an understanding of teacher attitudes towards video game based learning. This survey also aimed to examine how frequently a sample of teachers report using video games within Australian secondary classrooms. The final aim of the survey was to identify and refine the benefits and barriers to the adoption of video game based learning in order to promote the development of effective video game based pedagogy. As such, the survey was designed to address the following research questions; (a) what factors influence secondary teacher uptake of video game technology within their classrooms? And (b) what are secondary teachers' perceptions of the benefits, limitations, and barriers to the implementation of video games within the classroom?

The implementation of video games in the classroom presents rich opportunities for teachers and students across multiple curricula, with research supporting the positive impacts

of video games on student outcomes (Backlund & Hendrix, 2013; Perotta et al., 2013; Young et al., 2012). Despite this, the adoption and effectiveness of video games within the classroom is largely dependent on the pedagogy and attitudes of classroom teachers (Bourgonjon et al., 2013; Nousiainen et al., 2018). This survey aimed to address a significant gap in the current research field, particularly in Australia, by investigating the uptake, uses, and integration of video game based learning within Australian classrooms.

Teachers can be considered the true change agents within schools, with the success of technology integration being closely linked to teachers' perceptions and values (Teo, 2008). By focusing on teacher influences, experiences, professional development, and perceived benefits and limitations to the use of video games in the classroom, this survey will produce new knowledge in the area of video game based learning.

Survey design

An online survey was selected as the most appropriate data collection tool for multiple reasons. First, a survey can yield sufficient data to address the research questions without being resource intensive. Surveys can allow for the collection of both qualitative and quantitative data in an unobtrusive and simply administered tool (Fowler, 2014). Second, this project was limited by a 12-month timeframe, including the COVID-19 pandemic, meaning that a site visits and interviews were not practical. Additionally, online surveys allow data from geographically diverse populations to be collected. This is a particular advantage in Australia, which is large with a significantly dispersed population. An online survey allowed for data to be collected from teachers all over Australia.

The scoping, quantitative design of the survey was intended to purposively select "information-rich cases" (Sandelowski, 1995, p.180), describing the variation of phenomena in individual teacher experiences related to video games in education. Selection of research

participants was undertaken using a purposive sampling method, with a convenience sample. The intended sample size was not planned to be representative of the Australian secondary teaching population, but rather to encompass the '*phenomenal* variation' (Sandelowski, 1995) of teacher experiences. While this means that the sample is not representative of the larger populations, as would be permitted by a random or statistically representative sample, it is sufficient in providing rich and relevant data. This is due to survey participants being secondary teachers with a wealth of teaching experiences and an in-depth understanding of their use of video games in the classroom.

Survey methodology

Data for this study was collected from an online survey that was administered using Qualtrics (Qualtrics, 2021). The survey consisted of 60 questions, divided into five sections. The survey included 22 multiple choice questions, 31 Likert-scale questions, and five open text response boxes (see Appendix C for full survey). All scale items were rated on a five-point Likert scale (0 strongly disagree – 5 strongly agree). Demographic questions included variables such as age, gender, and geographic location, as well as teacher-related variables such as Key Learning Area (KLA), number of years teaching, and the year level of students taught. Logic flows were implemented in the survey design to ensure that participants were only presented with relevant questions, as participant answers dictated their progression through the survey. Due to the timing of the survey data collection period, a section was added at the end of the survey to gauge the impact of COVID-19 on the practices of teachers using video games in the classroom.

The questions written for the survey instrument were developed to measure personal video game use, attitudes towards video game use in the classroom, and professional development experiences in relation to video games. The survey items were adapted from a

review of the relevant literature, and similar survey instruments. For references to survey item numbers, see Appendix C. Survey item 9, which measured the types of video games played during leisure time, used the definitions of video game gameplay genres from Lee et al. (2014). Survey items 12, 13, and 16 were adapted from Justice and Ritzhaupt's (2015) validated survey instrument, which was designed to identify the barriers to games and simulations in education. Survey items 12 and 13 were modified by taking the three-point scale and amending it to a five-point scale, in order to conform with the other survey items. Survey item 13 was originally designed to measure how easy it would be for teachers to experiment with video games within one of their lessons (Justice & Ritzhaupt, 2015). The wording was altered to instead refer to the teacher's main KLA, rather than a lesson, to explore the impact of different subjects taught on teacher video game use. Survey item 16 was designed as a scale to measure teacher perceptions of video game usefulness. For this item, the mention of learning styles was removed from the original survey question, as it was not relevant to the needs of this survey.

Survey items 26 and 27 were adapted from Takeuchi and Vaala (2014), and were used to measure professional development experiences and teacher perceptions of the barriers to video game implementation. Item 26 was adapted by removing one list-item ("unsure how to integrate games"), as this was covered by other questions within the survey. Item 27 was not modified and was used as presented in Takeuchi and Vaala's survey (2014).

Teacher Video Game Use Attitudinal Scale.

The Teacher Video Game Use Attitudinal Scale was developed by adapting the scale used in An (2018). An's (2018) original scale consisted of 22 items organised into three subscales, measuring (1) educational benefits of digital games, (2) the potential of digital games to foster real world skills, and (3) teacher interest and self-efficacy. The traditional

method of estimating the internal consistency reliability of a measure is Cronbach's alpha (Cronbach & Shavelson, 2004) and is calculated by estimating the average inter-correlation between items and any set of items drawn from the same measure (Trochim, 2018). Reliability coefficients were calculated for all scales using SPSS (SPSS, 2020). Alpha can range from 0 to 1, with 0 being complete unreliability and 1 meaning complete reliability (i.e., no random error). Although there is no universal consensus about what an acceptable level of reliability is, internal consistency reliability should preferably be above .70 or .80 (George & Mallery, 2003). For the present study, coefficients greater than .90 were considered to be excellent, .80 were considered to be good and .70 acceptable (George & Mallery, 2003). The reported reliabilities in the original study for each of the subscales was .94, .91, and .82, respectively. Minor revisions were made to the original items proposed by An (2018), with the removal of one item which was not relevant to the survey participants within the context of the study (referring to procedural knowledge), and five other items that were measuring data that were collected in other sections of this study's survey (student assessment, social skills, teamwork, higher order thinking skills, and teacher confidence). Further to the original scale adapted from An (2018), a supplementary scale was developed to measure teacher perception of external support for video games use in their teaching. This was titled the External Support for Video Game Use scale. See Appendix D for full details of scale items.

Participant recruitment

After obtaining ethics approval, participant recruitment was undertaken online via email, Facebook teaching pages, Twitter, and Reddit. Email invitations were sent to professional associations (such as the Australian Association for Research in Education, the Australian Professional Teachers' Association, and other subject specific teachers' associations), describing the survey, and requesting dissemination of the survey link. In

addition to this, teachers within the research team's professional network were contacted via email and were invited to complete the survey and circulate the recruitment invitation to their networks. For full survey recruitment advertisement wording and post schedule, see Appendix E. The data collection period ran from November 30th, 2020, to May 10th, 2021. Participants were not offered any incentives or compensation for their participation in the survey, and promotion of the survey was not paid for in any way.

As the recruitment method was online, the number of individuals contacted can only be estimated. Social media algorithms impact the prioritization of posts, and it is not possible to calculate the number of people who saw these posts. As such, the number of individuals contacted was estimated according to the number of people in the social media groups where the survey link was posted. Estimate contact numbers are provided in Table 4.1. To ensure that a sufficient variety of different teacher responses were collected, survey responses were monitored as they were received, and posts were tailored to Facebook groups of subjects that were receiving low numbers of responses (e.g., PE teacher groups were targeted due to low numbers of PE teacher responses). Totals and estimated response rates were not calculated. The completion rate for collected surveys was 70%, calculated from surveys started compared to surveys completed.

Table 4.1

Survey recruitment social media distribution

Social media platform	Name of social media group	No. of group members*
Facebook groups	AARE SIG (Australian Association for Research in Education: Special Interest Group) Technology and Learning	52
	Art Teachers Australia	5000
	Aussie New Teacher Community	1800
	Aussie Teacher Support Group	3000
	Australian Early Career Teachers Association	2300
	Australian Secondary Mathematics Teachers 7-12	2700
	Australian Teacher COVID 19 Support Page	10800
	Casual Relief Teachers in Australia: Let's unite!	10600
	Cool History Teachers Australia	2500
	English Teachers Australia	2800
	Geography Teachers Online Australia	5100
	History Teachers Resources Australia	3600
	Mathematics Teachers of NSW	1900
	Melbourne Teachers	5800
	NSW Biology Teachers	3300
	NSW Casual Teachers	16800
	NSW Chemistry Teachers	2300
	NSW PDHPE Teachers	4900
	NSW Proficient Teachers maintaining Accreditation	4100
	NSW Technology Teachers	3100
	PDHPE Teachers	3000
	QLD Teachers	13500
	Queensland Senior Mathematics Teachers	1500
	Science Teachers - Advisory Group for Australia	1100
	Secondary Math Teachers South Australia	399
	Secondary Teacher Life	2400
	Secondary Teachers Ideas and Support Community (Australia)	3500
	Society and Culture Teachers Australia	2000
	TAS and HOME EC Teachers (Secondary)	2200
	Teachers in NSW - Western Suburbs	797
	Teachers in Remote Communities	3100
	Teachers of Darwin & NT	1800
	Teachers Supporting Teachers – Australia	6100
	Victorian Teachers Going Online 2020 (changed to Victorian Teachers Online Community Jan 2021)	10800
	Western Australian Teachers	2800
	WSU MTeach Secondary Alumni	601
Twitter	Research team personal Twitter accounts	
Reddit	r/AustralianTeachers	5200

Note: * data obtained from publicly available statistics on the relevant social media platform. Only estimated total numbers are publicly available.

Participants were self-identified as current (within 12 months) teachers of secondary aged students (11-18 years old) in an Australian secondary classroom setting. The requirement for teaching within the last 12 months was implemented to ensure that the survey recruited participants that were currently teaching in a secondary setting, without excluding casual or contract teachers. See Table 4.2 for inclusion and exclusion criteria.

Table 4.2

Survey inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Over 21 years old 2. A teacher accredited with an Australian teacher regulatory authority; and 3. Participants who have taught in a secondary classroom setting in Australia in at least one instance in the past 12 months.	1. Participants under 21 years old; 2. Any participants not accredited with an Australian teacher regulatory authority; 3. Participants who are accredited teachers but have not taught in a secondary classroom setting in Australia in at least one instance in the past 12 months.

Participants

The final data sample consisted of 121 completed responses and 53 partially completed responses ($N = 174$). Surveys with less than 50% completion rate were excluded from the final data analysis, resulting in a final sample of 139 responses. The average age of participants in the final sample was 35.6 ($SD = 9.74$) years old, and 61% ($n = 74$) were female. Participants' teaching experience varied from less than one year to more than 15 years, with 23% ($n = 27$) of respondents having taught for more than 15 years, and 50% ($n = 60$) of respondents having taught five years or less. The most common KLA taught by participants was Humanities and Social Sciences (31%, $n = 38$), followed by English (29%, $n = 35$), Science (23%, $n = 28$), and Technologies (23%, $n = 27$). Most respondents were from NSW (62%, $n = 75$). Table 4.3 summarizes the demographic information of participants.

Table 4.3

Survey participant demographic information

Characteristic	*n*	%
Age		
21 to 30 years	55	39.6
31 to 40 years	47	33.8
41 to 50 years	26	18.7
Over 51 years	11	7.9
Gender		
Female	74	61.2
Male	46	38
Prefer not to say	1	.8
Number of years teaching		
Less than 1 year	6	5
1 – 2 years	22	18.2
3 – 5 years	33	27.3
6 – 10 years	21	17.4
11 – 15 years	12	9.9
More than 15 years	27	22.3
Key learning area taught[a]		
Social Sciences	38	31.4
English	35	28.9
Science	28	23.1
Technologies	27	22.3
Mathematics	21	17.4
Art	8	6.6
Physical Education	8	6.6
Languages	1	.8
Geographic location		
New South Wales	75	62
Victoria	13	10.7
Western Australia	12	9.9
Queensland	12	9.9
Northern Territory	3	2.5
South Australia	3	2.5
Tasmania	2	1.7
ACT	0	0

Note: [a] percentages for key learning areas taught do not add up to 100% as multiple could be chosen

Ethical considerations

This study was approved by the Human Research Ethics Committee at Western Sydney University (approval number H14158; see Appendix F). All data collected through the survey was anonymous, which was explained to participants in the information sheet prior to starting the survey. Data generated from the survey is stored securely using secure data management software, with access restricted to only those named on the project ethics approval. Data will be destroyed after the minimum retention period of ten years.

Consent was implied by the completion of the survey, as well as a consent indicator embedded as the first question of the survey. In the participant information sheet, participants were informed of the nature of the research, the anonymity of their participation in the survey, the voluntary nature of their participation, and that the completion of the survey was considered as an indication of consent. Further to this, participants were informed that they could close the survey at any time if they chose not to proceed after commencing. Once the survey had been submitted, participants could no longer opt out of the study, as their anonymous response could not be identified for deletion from the data set. Participants were informed of this issue in the participant information sheet prior to starting survey.

Conclusion

This chapter details the methodology used for the design and implementation of the survey administered for this study. The rationale for the survey was discussed, emphasizing the importance of understanding teacher attitudes and perceptions in relation to the use of video games in the classroom, as this is essential to the successful integration of technology in schools. The survey methodology was described, including design of the survey participant recruitment methods, inclusion and exclusion criteria, and data collection methods. This chapter further described the participant sample of the survey. Ethical considerations that

were undertaken in the design of the survey were also outlined. The findings and results of this survey are presented in Chapter 6: Survey Results.

Chapter 5

Systematic Review Results

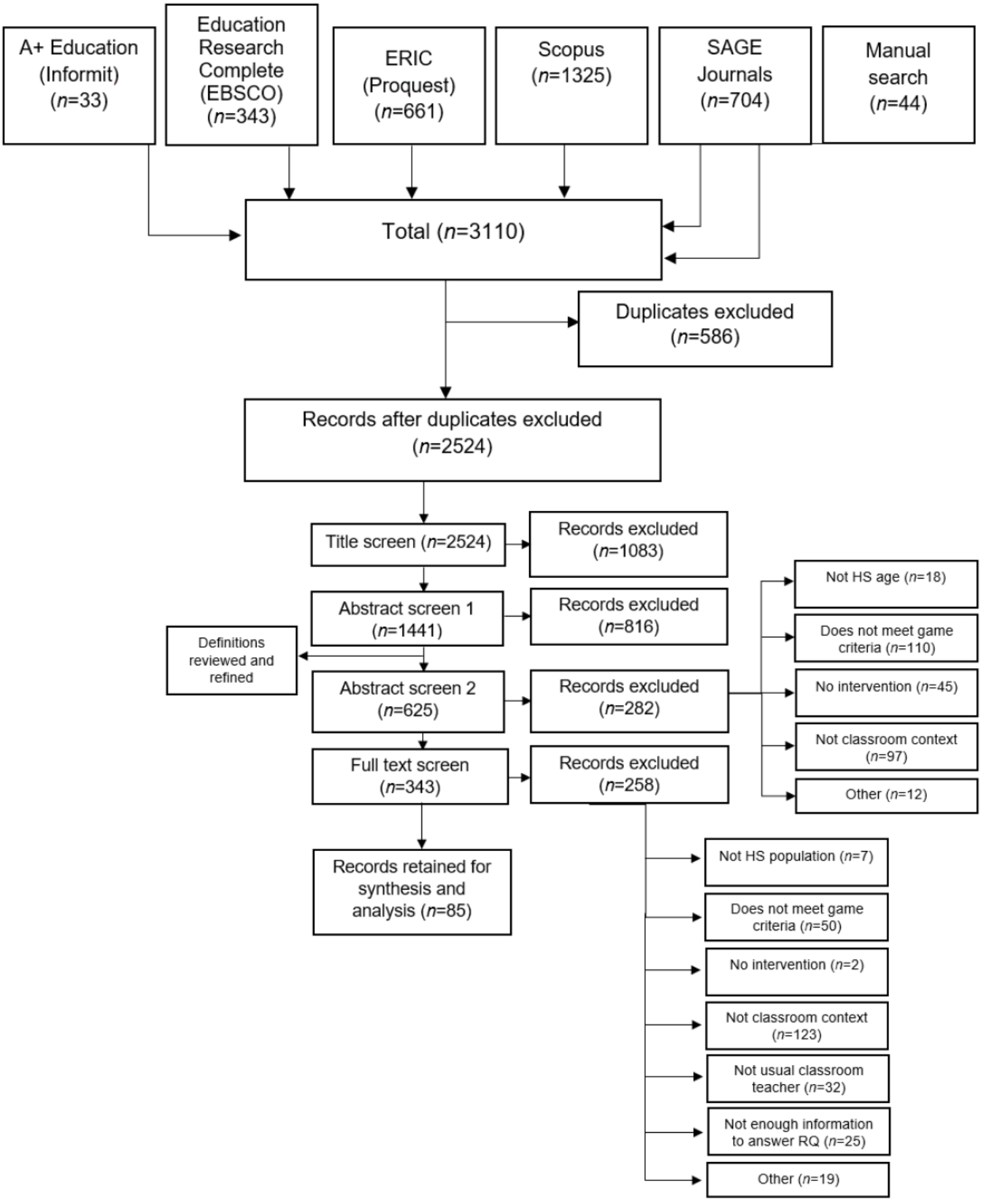
This chapter presents the results of the systematic review on the use of video games for education within secondary classrooms, the methodology of which is detailed in Chapter 3. Briefly, the papers were selected based on meeting inclusion criteria in relation to video game definition and classroom context, as well as study aim, design, and participant sample. Papers were coded according to KLA (Key Learning Area), video game platform, methodology, learning outcomes, and results. The first section of this chapter describes the studies identified by the systematic review. The second section of this chapter discusses the synthesized results of the review, including the outcomes and impacts of video games identified, the study design features, and a discussion of the ways in which video games are being used within Australian classrooms.

Papers identified by search terms

A total of 3110 papers were identified in the initial search. After the removal of duplicates, 2524 papers were retained. The screening process included a paper title screening, two abstract screens, and one full text screen, as detailed in Figure 5.1 below. After the initial abstract screen, the definitions of video games and classroom context were reviewed and refined, in order to strengthen the criteria that was being applied to papers during the screening process. After all screening was completed, as per the criteria outlined in Chapter 3: Systematic Review Methodology, a total of 85 studies were retained.

Figure 5.1

Systematic review identification flow diagram



Demographics of final studies

The 85 studies represent a total of 17,111 students and 1,056 teachers. Of the total pool of participants, 34.21% were male, 33.52% were female. No information regarding gender was available for 32.28% of the total pooled sample, with no student gender data provided by 20 of the retained studies. With the teacher demographic data available, 12.22% were male, 19.51% were female, and 68.28% was not able to be determined due to lack of data. Teacher gender data was not provided by 12 of the retained studies. Of the 77 studies that related to student data (i.e., not teacher-only studies), 41 (53.25%) provided demographic data relating to student ages, with the age range being 5 to 20 years old. Of these 77 studies, 35 provided no student age information, but provided the grades or year level of the student participants. One study provided no age-related demographic information beyond specifying high-school aged participants (Sadler et al., 2015). Total age sample information was only provided by 13 of the studies retained. The mean age of student participants for whom data was available was 14.07 (range 9 to 20 years, *SD* = 2.26). Grade level descriptions varied according to the context of the country the study was completed in, but ranged from 3rd to 12th grade. Demographic information for the study participants within the papers retained for this review was inconsistently reported, and this resulted in it being difficult to make generalisations regarding the demographic composition of the final studies.

Although the review focused on studies conducted since 2010, 59% of studies that were retained were conducted in the last five years (2015 – 2020; see Table 5.1). Papers identified were published in 19 countries, with 47% (*n* = 40) of those papers being published in the United States, 12% (*n* = 10) in Taiwan, and 7% (*n* = 6) in Australia. See Appendix A and B for full details of papers retained for the review. Within the 85 final papers retained by the review, there were 68 individual video games named.

A large number of papers (n = 3110) were identified, based on the terms used, including broad application of the term "gamification" in heath, business, and education fields. Table 5.2 presents the number of papers in each of the databases identified using the search terms, and the number of papers retained. While the largest proportion of papers was identified from the Scopus database, most of the papers that met the review inclusion criteria were from the ERIC database. All papers identified in the initial search are detailed in Appendix H, with the papers that were retained highlighted. Furthermore, the 85 papers that were retained are summarised in Appendix B and assigned an identifier (e.g., A001) that will be used to refer to individual papers within the tables in this chapter.

Table 5.1

Papers retained by year published

Year published	N	%
2010	5	6
2011	2	2
2012	7	8
2013	8	9
2014	12	14
2015	14	16
2016	5	6
2017	13	15
2018	8	9
2019	8	9
2020	3	4
Total	85	100

Table 5.2

Papers identified and number retained by database

Database	Number of papers identified in search	Number of papers meeting inclusion criteria
ERIC (Proquest)	661	55
Scopus	1325	13
Education Research Complete (EBSCO)	343	4
SAGE Journals	704	6
A+ Education (Informit)	33	2
Supplementary sources	44	5
Total	3110	85

Study design used in the papers

Table 5.3 shows the breakdown of study design used within the papers that were retained after the criteria was applied for the review. Studies retained were fairly evenly distributed between quantitative (42%, *n* = 36), qualitative (27%, *n* = 23) and mixed (31%, *n* = 26) research methods. Of the quantitative research methods, 29 (81%) used quasi-experimental designs, four (11%) used survey and two (6%) used RCT designs. Of the quantitative papers, quasi-experimental designs were by far the most common, with 29 (81%) papers using only quasi-experimental design. A further 16 papers using quasi-experimental designs in combination with another qualitative research method, such as observations, interviews, or surveys. Of the 23 papers that used a qualitative research method, 18 (78%) used a case study design, two (9%) used open-ended or qualitative survey design, and one (4%) used an interview-only design.

Table 5.3

Methodology and study design of papers within the review

Methodology	*n*	Study design	*n*	Subject design	*n*
Quantitative	36	Quasi-experimental	29	Between group design	23
				Within group design	6
		Survey	4		
		RCT	2		
Qualitative	23	Case study	18		
		Survey	2		
		Interviews	1		
		Action research	2		
Mixed	26	Quasi-experimental with qualitative supplementary data (observations, interviews, survey)	16	Between group design	8
				Within group design	8
		Survey with mixed data collection	3		
		Survey with qualitative supplementary data (observations, interviews)	7		

Table 5.4

Studies retained by Key Learning Area

Subject/Curricular area:	Study	Total: [a]
STEM [b]	A001, A003, A004, A006, A009, A011, A012, A014, A016, A017, A020, A023, A026, A027, A032, A033, A034, A035, A038, A039, A040, A041, A042, A043, A045, A046, A047, A048, A049, A051, A052, A053, A055, A057, A060, A061, A062, A063, A064, A065, A066, A068, A069, A070, A071, A072, A077, A078, A080, A082, A085	51
English Language Arts[c]	A005, A007, A021, A024, A028, A029, A036, A039, A054, A056, A064, A074, A075, A076, A081	15
Social studies[d]	A015, A018, A019, A022, A025, A034, A044, A050, A058, A064, A070, A074, A079, A083, A084	15
Other[e]	A002, A008, A010, A013, A030, A031, A037, A040, A059, A067, A073	11

Note. [a]Studies covered more than one KLA per paper, and so total adds up to more than total number of papers

[b] STEM consists of Science, Technology and Maths. There were no papers concerning the Engineering subject identified.

[c] English Language Arts consists of curricular topics surrounding the study of language, including languages other than English.

[d] Social studies includes curricular areas of History, Business and Cultural studies

[e] The 'Other' category includes the following learning areas: problem-solving, classroom management, emotional intelligence, papers that crossed multiple KLAs, and visual arts

Subject disciplines of video game implementation

Table 5.4 shows the different KLAs or subject disciplines that the games within the retained papers address. The review confirmed that video games are most commonly used to teach STEM (Science, Technology, Engineering, and Maths) subjects, with 59% (n = 50) articles using video games related to this curricular area. Specific subjects within the STEM category include Science (n = 31), Maths (n = 13), Technology (n = 10). English Language

Arts and Social Studies are used the second most commonly, with both being used by 18% (*n* = 15) of the reviewed articles. This is followed by papers that used multiple curricular areas within their design (various, *n* = 7), papers that used non-curriculum aligned topics (*n* = 3) and Visual Arts (*n* = 1).

Research methods by subject discipline

Table 5.5 shows the research methods used for each curriculum area for the articles included in the review. The mixed method category is combined quantitative and qualitative methods in one paper, and within this study, the majority (62%, 16 out of the 26 mixed method papers) of mixed methods studies also used a quasi-experimental design.

Table 5.5

Papers retained by Key Learning Area and research method used

KLA	Research method			
	Quantitative	Qualitative	Mixed	Total[a]
STEM[b]	18	12	21	51
Social studies[c]	5	3	7	15
English Language Arts[d]	5	6	4	15
Other[e]	4	4	3	11
Total	32	25	35	92

Note. [a]Studies covered more than one KLA per paper, and so total adds up to more than total number of papers

[b] STEM consists of Science, Technology and Maths. There were no papers concerning the Engineering subject identified.

[c] Social studies includes curricular areas of History, Business and Cultural studies

[d] English Language Arts consists of curricular topics surrounding the study of language, including languages other than English.

[e] The 'Other' category includes the following learning areas: problem-solving, classroom management, emotional intelligence, papers that crossed multiple KLAs, and visual arts

Primary purpose of video games

Table 5.6 shows the number of papers which focused on commercial off-the-shelf games (COTS), games for learning, and learning through making games. Within the review, 48 papers focused on games for learning, 22 researched COTS games, and 11 focused on the process of learning through making games. Six papers included games with various or not specified purposes, which were primarily research articles which explored teacher or student uses of, and attitudes towards, video games through surveys or interviews (see An et al., 2016; Beavis et al., 2014). This shows the focus of research concerning video game use in the secondary classroom primarily focuses on games made specifically for learning purposes, rather than the adaptation of commercial games, or the construction of games within the classroom. Of the 48 papers that focus on games for learning, 69% (n = 33) are written by the same people who developed the games being researched. A further five of these papers do not specify who the developers of the game were, and if those games were developed by the authors.

Table 5.6

Papers retained by video game purpose

Purpose of game	Study	Total: [a]
Game for learning	A001, A003, A004, A006, A009, A011, A012, A014, A015, A017, A018, A019, A020, A021, A022, A023, A025, A026, A027, A030, A031, A032, A033, A034, A042, A045, A046, A047, A048, A049, A051, A052, A055, A056, A057, A059, A063, A068, A069, A070, A074, A076, A077, A079, A080, A081, A082, A085	48
COTS[b]	A005, A013, A016, A024, A028, A029, A034, A036, A039, A040, A041, A044, A050, A053, A054, A058, A061, A065, A071, A075, A083, A084	22
Learning through making games	A007, A035, A038, A040, A043, A060, A062, A066, A067, A072, A078	11
Various or not specified	A002, A008, A010, A037, A064, A073	6
	Total	87

Note. [a] Studies covered more than one video game per paper, and so total adds up to more than total number of papers

[b] COTS stands for commercial off-the-shelf video games

Table 5.7 reports the purpose of the games being studied by the main KLA of the study intervention. It shows that studies with a STEM focus are more likely to use games made for learning purposes, rather than commercial games or the creation of games for learning purposes. Studies within the Social Sciences KLA also used games for learning more often than COTS games, and no studies combined the Social Sciences curricular area with game creation for learning purposes. Studies within the English Language Arts KLA used commercial games more often than games for learning, and only one study used game creation for learning purposes.

Table 5.7

Papers retained by Key Learning Area and video game purpose

KLA	COTS	Purpose of game: Game for learning	Learning through making games	Various or not specified	Total[a]
STEM[b]	9	34	9	1	53
Social Studies[c]	6	9	0	1	16
English Language Arts[d]	8	5	1	1	15
Other[e]	2	3	1	6	12
Total	25	51	11	9	96

Note. [a] Studies covered more than one KLA and video game per paper, and so total adds up to more than total number of papers

[b] STEM consists of Science, Technology and Maths. There were no papers concerning the Engineering subject identified.

[c] Social studies includes curricular areas of History, Business and Cultural studies

[d] English Language Arts consists of curricular topics surrounding the study of language, including languages other than English.

[e] The 'Other' category includes the following learning areas: problem-solving, classroom management, emotional intelligence, papers that crossed multiple KLAs, and visual arts

Outcomes of playing video games

Table 5.8 shows the number of papers that addressed the different learning outcomes of video games within the secondary classroom. The most commonly measured were knowledge acquisition or content understanding (n = 45) and affective or motivational (n = 40) outcomes. Of these papers, 27 measured both knowledge acquisition or content understanding and affective or motivational outcomes as a result of using video games in the classroom. Studies also measured teacher implementation or perceptions of video games in the classroom (n = 20), perceptual or cognitive outcomes (n = 13), were exploratory in terms of the outcomes measured (n = 8), social skill related outcomes (n = 6), and behavioural change outcomes (n = 4).

Table 5.8

Learning outcomes measured within retained papers

Outcome measured	Study	Total[a]
Knowledge acquisition or content understanding	A001, A003, A004, A006, A009, A011, A014, A015, A017, A018, A020, A021, A022, A023, A024, A025, A026, A028, A029, A033, A034, A035, A042, A043, A045, A046, A049, A050, A051, A054, A056, A057, A061, A063, A068, A069, A071, A072, A074, A077, A079, A081, A082, A083, A084	45
Affective or motivational	A001, A004, A006, A007, A010, A011, A012, A015, A017, A020, A021, A022, A023, A025, A026, A027, A028, A030, A034, A035, A037, A038, A039, A042, A045, A046, A047, A051, A054, A055, A061, A062, A063, A065, A067, A068, A074, A076, A077, A079, A083	41
Teacher implementation or perceptions of video games in the classroom	A002, A005, A009, A019, A025, A026, A032, A037, A040, A048, A050, A053, A056, A057, A059, A064, A067, A070, A073, A082	20
Perceptual or cognitive	A016, A030, A031, A036, A047, A050, A060, A078, A080, A082, A083, A084	12
Exploratory	A005, A007, A041, A043, A044, A065, A071, A075	8
Social skills	A013, A036, A039, A058, A062, A085	6
Behaviour change	A042, A052, A066, A070	4
Student perceptions of video games for education	A008, A010	2
Total		138

Note. [a] Studies covered more than one outcome per paper, and so total adds up to more than total number of papers

Study results by learning outcome

Table 5.9 outlines the outcomes of the studies retained by the systematic review. The papers were assigned a positive, negative, or mixed outcome value, as defined by a statistical or otherwise stated improvement within the study population in comparison to the baseline. Only quantitative or mixed method study outcomes with baseline measurements were included in this analysis, as qualitative study results were not appropriate for assigning a

positive or negative outcome. The overall learning outcomes reported by papers within the review as a result of using video games in the classroom were generally positive, with 68% (*n* = 67) of the papers that were assigned a value reporting positive changes to learning outcomes measured. Of the papers analysed, 26% (*n* = 26) reported a mixed outcome. Only six (6%) papers reported no change to learning outcomes measured, or a negative result. Further analysis regarding the magnitude of this effect (via a meta-analysis or similar) would be beneficial to fully examine this outcome, although this was outside of the scope of the current investigation. It should be noted that the emphasis on positive results in regard to learning outcomes measured may be the result of publication bias, and the known issue of journals tending to publish only studies which find positive results (Ferguson & Heene, 2012).

Table 5.9

Study results by outcome measured

Outcome measured[a]	Study results outcome value: Positive	Mixed	Negative	Total
Knowledge acquisition or content understanding	A001, A003, A004, A006, A011, A014, A015, A017, A018, A020, A021, A022, A023, A025, A029, A033, A035, A042, A043, A045, A046, A049, A051, A057, A061, A069, A071, A079, A081, A083, A084	A009, A024, A028, A034, A063, A077, A082	A026, A068, A072	41
Affective or motivational	A001, A004, A007, A011, A012, A015, A017, A020, A021, A022, A023, A025, A028, A035, A037, A039, A046, A047, A055, A062, A076, A083	A006, A010, A026, A027, A030, A034, A042, A061, A063, A067, A077	A045, A068	35
Teacher implementation or perceptions of video games in the classroom	A056, A070, A079	A057, A067, A082	--	6
Perceptual or cognitive	A016, A036, A038, A047, A083, A084	A030, A031, A082		9
Social skills	A036, A039, A058, A062	A013	--	4
Behaviour change	A066, A070	A052	A042	4
Total	67	26	6	99

Note. [a] Only quantitative or mixed method study outcomes with baseline measurements were included in this table. Qualitative study results were not appropriate for assigning a positive or negative outcome.

Knowledge acquisition or content understanding outcomes. The review identified a number of papers that measured the knowledge acquisition or content understanding of secondary students (n = 45). Games were used to measure knowledge acquisition over a variety of KLAs, including STEM, Social Studies, and English Language Arts. Most games used to measure knowledge acquisition were games specifically made for learning (n = 34), although ten papers also used COTS games for this learning outcome. Knowledge acquisition was most commonly measured with quantitative methods, using pre- and post-test designs (see Anderson & Barnett, 2013; Chee et al., 2013; Eseryel et al., 2011) or mixed method designs that combine a quantitative pre- post-test design in combination with an interview or observation methodology (see Foster & Shah, 2015; Hanghøj et al., 2018; Kebritchi et al., 2010). As described in Table 5.9, papers that measured knowledge acquisition or content understanding outcomes were generally positive (n = 31), finding that video games generally improved student content knowledge. Seven papers reported mixed results, and three found negative or no change to the baseline measurement of content knowledge. Further summaries of these papers are detailed in Appendix B.

Affective or motivational outcomes. Affective or motivational outcomes were the second most common focus for the papers identified in the review, with 41 papers measuring this outcome. The number of papers retained that measure this outcome indicates that video games are potentially being used to engage students in their learning, or to motivate students in the classroom. Affective or motivational outcomes refer to the subjective experiences of students while playing games, and is often used to measure engagement or motivation in relation to learning activities. These outcomes were measured by both attitudinal or motivational surveys (see Tsai et al., 2014; Yang 2012) or through qualitative case study research methods, such as interviews or focus groups (see Kim & Pavlov, 2019; Marklund & Taylor, 2016; Stieler-Hunt & Jones, 2015).

Affective student outcomes were measured across all KLAs included in the review (see Table 5.10), with STEM being the most common (n = 25). Knowledge acquisition or content understanding was often measured with affective or motivational outcomes within the same paper, with 26 papers measuring both learning outcomes. Results within the papers generally indicated that students were more engaged, enthusiastic, and motivated as a result of video game implementation in the classroom (Alfieri et al., 2015; Ault et al., 2015; Bowling et al., 2017), although some mixed results were reported (Foster & Shah, 2015; Perry & Klopfer, 2014; Tsai et al., 2014).

Table 5.10

Study learning outcomes by Key Learning Area

	Key Learning Area				
Learning Outcome	STEM	Social Studies	English Language Arts	Other	Total[a]
Knowledge acquisition or content knowledge	29	10	8	0	47
Affective or motivational	25	7	7	4	43
Perceptual or cognitive	7	3	1	2	13
Teacher implementation or perception of VG in the classroom	10	5	3	6	24
Exploratory	4	1	3	0	8
Behaviour change	4	1	0	0	5
Social skills	3	1	2	1	7
Student perception of VG	0	0	0	2	2
Total	82	28	24	15	149

Note. [a] Studies covered more than one outcome per paper, and so total adds up to more than total number of papers

Teacher implementation or perception. Teacher implementation or perception of video games in the classroom was measured by 20 papers of the total 85 included within the review. Teacher implementation or perception of video games was measured across all KLAs identified in the review (see Table 5.10), and was most commonly measured in relation to games specifically made for learning purposes (see Table 5.11). Of the 20 papers that measured teacher implementation or perceptions of video games, seven were qualitative case studies and six used quasi-experimental designs. Teacher perception of video games within education is essential for the successful implementation within the classroom, and it is significant to note that only 20 papers that were included within the review measured this as a research outcome.

Table 5.11

Study learning outcomes by game purpose

	Purpose of games				
Learning outcomes	Games for learning	COTS	Learning by making games	Various or not specified	Total[a]
Knowledge acquisition or content understanding	34	10	3	0	47
Affective or motivational	28	7	4	2	41
Perceptual or cognitive	5	5	3	0	13
Teacher implementation or perceptions of VG in the classroom	12	4	2	4	22
Exploratory	0	6	2	0	8
Behaviour change	3		1	0	4
Social skills	0	5	1	0	6
Student perceptions of VG for education	0	0	0	2	2
Total	82	37	16	8	143

Note. [a] Studies covered more than one outcome per paper, and so total adds up to more than total number of papers

Wilson et al. (2018) noted that effective implementation of video games required significant teacher skill with pedagogy, technology, and student scaffolding. Marklund and Taylor (2016) confirmed this, finding that teacher skill sets required to successfully implement video games were, involving technological know-how, gaming literacy, subject matter expertise, and a strong pedagogical foundation. Teacher belief in the usefulness of games, and their positivity about their impact, directly influences whether they will implement them in their own classrooms (Stieler-Hunt & Jones, 2015), and the success of that implementation (Proctor & Marks, 2013; Clark et al., 2018). The importance of professional development was noted, with Evans et al. (2015) reporting that training and development was essential to successful implementation of video games. Considering the importance of teacher buy-in and perception of video games to the importance of their effectiveness in the classroom, more focus on teacher implementation and practice would be a positive for the field of video game education research. This has been identified as a current gap in the papers retained within this review.

Perceptual or cognitive outcomes. Perceptual or cognitive outcomes refer to measures of student problem solving, memory, creativity, or comprehension. Of the 85 papers retained as part of this review, 12 papers used perceptual or cognitive outcomes as learning measures, and these papers were evenly spread across all KLAs (see Table 5.10). Papers within the review measured perceptual or cognitive skills with all three game purposes, with games for learning (n = 5), COTS (n = 5) and learning through making games (n = 3) all being represented (see Table 5.11). Papers included in the review focused on development of creativity and creative thinking (Checa-Romero & Pascual Gomez, 2018; Navarette, 2013; Tucker-Raymond et al., 2019), problem solving (Eseryel et al., 2014; Eseryel et al., 2011; Yang, 2015), mental effort (Khan et al., 2017; Kilic & Yildirim, 2012), and argumentation skills (Wallon et al., 2018). Papers that measured perceptual or cognitive

skills reported generally positive results (see Table 5.9) with six papers detailing positive outcomes, three reporting mixed outcomes, and no papers within the review reporting negative results.

Exploratory research. Exploratory research refers to papers that did not define the learning outcomes that were being measured before performing the research, and instead described the learning which was observed as a result of the intervention. Within the review, eight papers used exploratory methods to explore video game implementation within secondary classrooms. Of these papers, four were qualitative case studies, two were action research and two were surveys. Within the eight papers, six conducted research concerned with COTS games, and two investigated learning through making games (see Table 5.11). No papers within the review conducted exploratory research in regard to games made specifically for education. This may indicate that games made specifically for education are only being used to measure specific outcomes, and are not being researched in a broader, constructivist or open way.

Exploratory studies within the review generally found that bringing computer games into the classroom affords students rich opportunities for rewarding and innovative work that can transcend traditional classroom boundaries (Bal, 2019; Toomey & Kitson, 2017), and similarly to teacher integration findings, that the teacher is essential to the successful integration of video games into the classroom (Shah & Foster, 2014). Exploratory research also found that teachers can use video games within the classroom without having students directly play the game (Karsenti & Parent, 2020), instead using gameplay videos and related video game materials in classroom instruction. This is an area that has not been captured by other learning outcome measures or other research papers, and may not have been highlighted without the exploratory nature of Kartsenti and Parent's research (2020).

Social skill outcomes. Within papers identified by the review, six papers measured social skills as learning outcomes. Within these six papers, all KLAs were represented (see Table 5.10), and five papers were studied in relation to COTS games (see Table 5.11). Only one study was related to learning through making games, and no papers were identified that measured social skill outcomes in relation to games made for learning. Types of social skills identified and researched within the papers were emotional intelligence (Carissoli & Villani, 2019), peer interaction and classroom inclusion (Gerber et al., 2014; Hanghøj et al., 2018; Zuiker & Anderson, 2019), and student collaboration (Monjelat et al., 2017; Pellas & Peroutseas, 2016). Papers that measured social skills outcomes included a game that was designed to teach emotional intelligence, and found that the experimental group reported an improvement in the evaluation and expression of emotions (Carissoli & Villani, 2019). A qualitative case study of the impacts of commercial games based curriculum on connected learning and peer interaction found that video games promoted student experimentation, iterative learning, and student-driven experiences amongst their peers (Gerber et al., 2014). Hanghøj et al. (2018) investigated whether a commercially popular cooperative video game encouraged classroom inclusion and found that the game enabled a reframing of social participation and students' engagement with the curriculum.

Results within the papers generally indicated that video game implementation in the classroom had a positive impact on social skills (Gerber et al., 2014; Hanghøj et al., 2018; Monjelat, et al., 2017; Pellas & Peroutseas, 2016), although Carissoli and Villani (2019) found that the improvements in emotional intelligence did not persist at a three-month follow-up test.

Behaviour change outcomes. Behaviour change in relation to classroom conduct was a learning outcome that was researched in four of the papers identified within this review. Of the four papers that concerned behavioural change learning outcomes, three were in relation

to video games within STEM subjects, and one involved a game applied in both Science and History classes (Sanchez et al., 2017; see Table 5.11). Three of the papers involved games created specifically for learning, and one involved learning through making games. No papers that measured behaviour change as a learning outcome used commercial games within their research. Behavioural change that was measured in relation to video games included classroom management (Sanchez et al., 2017), technology use (Reynolds & Chiu, 2015), food and beverage intake for health (Majumdar et al., 2013), and food safety behaviours (Hsiao et al., 2020). Reynolds and Chiu (2015) found that technology engagement can be increased through video game design, and that this may lessen the impact of digital inequality influenced by student socio-economic factors. Sanchez et al. (2017) presented positive findings that described teacher experiences of increased motivation and engagement as a result of the use of a classroom management video game. Mixed results were presented by Majumdar et al., (2013) who reported significant decreases in the frequency and amount of sweetened beverages and processed snacks consumed by students compared to the control group, but no change in other behavioural change variables. In comparison to this, Hsiao et al. (2020) found that, despite positive attitudes and increased knowledge of food safety as a result of the video game intervention, there was no behavioural change observed as a result of students playing the video game.

Other identified themes

Teacher professional development

Out of the 85 papers included in the review, 18 reported that the teachers involved in the video game intervention had attended, or been provided with, professional development (PD) opportunities. Teachers had either been recruited to the research projects through their attendance at PD workshops (Ault et al., 2015; Chee et al., 2015; Wallon et al., 2018),

prepared to implement games with researcher provided PD (Chee et al., 2013; Hanghøj et al., 2018; Mills et al., 2019), or PD was part of the intervention itself (Kim & Pavlov, 2019). In the case of Ault et al. (2015), the teachers in the experimental group attended professional development, while teachers in the control group did not. This indicates that, in some cases, professional development or further teacher training is undertaken alongside the implementation of video game interventions in the classroom, and this may be an influencing factor on teacher uptake and implementation of video games for learning.

Game-enhanced curricula

Fourteen papers within the review described a video game intervention that was part of a larger curriculum being taught to the participants of the research. Learning activities within the classroom do not occur within a vacuum, and implementing video games for learning is no different. Of the papers included in this review, 14 described differing levels of video game-related curriculum and other learning activities that were implemented alongside the actual video game within the classroom. The activities surrounding the teaching of video games ranged from entire pedagogical models (Foster & Shah, 2015), game-related curricula (Perry & Klopfer, 2014; Reynolds & Chiu, 2015), researcher created teaching modules and lesson plans (Kebritchi et al., 2010) and video game related teaching activities (Karsenti & Parent, 2020). Scaffolding and surrounding learning activities were found to be essential to successful video game interventions (Johnson, 2017; Wallon et al., 2018; Wilson et al., 2018).

It therefore would appear that video game related pedagogy is connected to the learning activities that take place around the act of gameplay, and this is at times explicitly planned by researchers implementing the interventions. Game-enhanced curricula is a theme that emerged from the review and will be discussed further in the subsequent chapter.

How video games are being used in Australian classrooms

Of the 85 papers identified within the review, only six were conducted within Australian classrooms. The small number of papers retained in the review that were conducted in an Australian context resulted in limited information available to answer the second part of the proposed research question, which concerned the ways in which video games are being used in Australian secondary classrooms. Of the six papers identified that were conducted in an Australian context, three papers used COTS games within research interventions (Bacalja, 2019; Pusey & Pusey, 2015; Toomey & Kitson, 2017), one researched the impact of a game for learning (Struppert, 2010), and two papers explored attitudes towards video games in the classroom, one from the perspective of students (Beavis et al., 2014) and the other from the perspective of teachers (Stieler-Hunt & Jones, 2015).

Both Toomey and Kitson (2017) and Bacalja (2019) researched commercially popular video games in the context of curriculum texts in the English classroom. Bacalja used action research to explore the pedagogical practices of using video games to teach English to a class of eight students. The paper found that, while existing conceptual and pedagogic models of English can be adopted and adapted to suit the unique affordances of video games, issues associated with play and interactivity complicate the use of videogames in the classroom. Similarly, Toomey and Kitson (2017) used a qualitative case study to explore the use of commercial video games as texts in an English classroom, focusing on three students. The study found that bringing video games into the classroom had positive effects on student engagement, and provided students with opportunities for rewarding and innovative work that exceeded traditional classroom boundaries and notions of literacy.

Pusey and Pusey (2015) used a mixed methods survey to investigate the educational value of using a COTS video game (*MinecraftEDU*) in Science classrooms with 76 students

aged 13 to 14 years old. The comparison of student surveys indicated a clear increase in student interest in science and the use of technology in school following the program. A majority of students (84%) reported enjoying using the video game in the classroom, and 94% said they wanted to use video games in the classroom again.

Struppert (2010) conducted three case studies across Australian, American, and Swiss schools, in which an educational video game was implemented to promote intercultural competence in 76 seventh grade students. The study found that learning with video games is generally considered fun and engaging by students, although excitement can decrease over time. Students can expand their knowledge, deepen their understanding, and make valuable experiences in a variety of areas by using the video game. Findings further suggested that learning with video games requires teacher support to ensure accurate, relevant, and adequate educational outcomes.

Beavis et al. (2014) used survey methodology to explore primary and secondary students' use and attitudes towards video games in the classroom. The survey was part of the *Serious Play* project, which investigated the implications for literacy, learning, curriculum, pedagogy and assessment when digital games are introduced as part of formal learning and curriculum at school. The survey collected responses from 270 students, and found that the range of uses of video games described by students were mixed and idiosyncratic. Student experiences of in-school video game play varied, with engagement, socialising, and challenge highly prized. Students reported impatience with 'boring' games, low interest levels, tediously 'educational' content, and frustrations with technological difficulties.

Steiler-Hunt and Jones (2015) conducted interviews with 13 education professionals (eight teachers and five administrators) in order to explore why educators embrace the use of digital game-play in the classroom. Results indicated that teachers who experience their own

form of subjective ‘success’ are more likely to want to use video games again in the classroom, and that being a parent affects teachers’ attitude towards using video games. The results also indicated that the integration of learning support materials assists teachers in implementing video games.

In summary, research relating to video games in secondary classrooms within an Australian context is currently limited, and primarily qualitative in nature. Research papers that examined video game use in Australian secondary classrooms generally found that video game interventions are positive regarding student engagement, motivation, and knowledge outcomes (Pusey & Pusey, 2015; Toomey & Kitson, 2017), but that this is counter-balanced by complexities in teacher implementation (Bacalja, 2019; Steiler-Hunt & Jones, 2015; Struppert, 2010), and realities of student attitudes (Beavis et al., 2014).

Conclusion

This chapter synthesised the results of the systematic review conducted on the ways in which video games are used within secondary classrooms. The identified papers were summarised by study design, KLA and research methods used. This chapter then described and summarised the game variables and learning outcomes by the purpose of video games studied, and the outcomes of the video game interventions. Subsequently, this chapter discussed relevant themes that emerged from the systematic review, including teacher professional development, and the presence of game-enhanced curricula. Finally, the ways in which studies in an Australian context researched the use of video games in secondary classrooms.

Chapter 6

Survey Results

This chapter presents the analysis strategies for, and results of, the survey conducted with Australian secondary teachers to investigate teachers' use and perceptions of video games for education. The survey methodology is described in Chapter 4. The first section of this chapter presents the survey reliability results, and describes the data analysis strategy used. The subsequent section outlines the survey results, including the factors that are related to teacher video game use, such as demographic factors, Key Learning Area (KLA) taught, and professional development experiences. Subsequently, teacher beliefs regarding the benefits and limitations of video games will be discussed, as well as the barriers experienced by teachers regarding the use of video games in the classroom. Lastly, the impacts of the COVID-19 pandemic on teachers use of video games in the classroom will be examined.

Table 6.1

Reliability for Teacher Video Game Use Attitudinal Scale and External Support for Video Game Use Scale

Scale names	Cronbach's alpha	*N* of items	Rating
Teacher Video Game Use Attitudinal Scale total	.95	15	Excellent
Subscales			
Educational benefits of games	.92	7	Excellent
Video games and real world skills	.90	5	Excellent
Teacher interest and self-efficacy	.82	3	Good
Reliability for External Support for Video Game Use Scale	.76	4	Acceptable

Survey data analysis

Teacher Video Game Use Attitudinal Scale reliability results

As discussed in Chapter 4, the Teacher Video Game Use Attitudinal Scale was developed to measure teacher beliefs regarding the educational benefits of video games, their real world applicability, and teacher interest and self-efficacy in the use of video games in the classroom. All subscale items were combined to assess their reliability. Cronbach's alpha for the total score of the Teacher Video Game Use Attitudinal Scale was .95. Analysing items individually showed that Cronbach's alpha did not deviate below .94 if any item was deleted, showing that there is a high measure of consistency between the scale items, and as such all items were kept. Table 6.1 shows Cronbach's alpha for the subscales obtained with the current sample for this study. Responses to all three subscales of the Teacher Video Game Use Attitudinal Scale, as well as the External Support for Video Game Use Scale, were found to have acceptable levels of reliability. Further to this, the number of items in the subscales are low. Consequently, the reliability ratings for these subscales are good. For details of the scale items, see Appendix D. All mean and standard deviation data for the Teacher Video Game Use Attitudinal scale and External Support for Video Game Use scale are detailed in Appendix I.

Data analysis strategy

Data analysis was completed using IBM SPSS Statistics (Version 27.0.1.0, 2020). Data was exported from the Qualtrics survey software, cleaned, and individual ID numbers were assigned to each participant (e.g., A001). Survey items were grouped into similar thematic categories, and variable names and labels were assigned to each case for ease of analysis. Survey items that were measured with categorical variables were assigned dummy variables for analysis (see Table 6.2).

Table 6.2

Dummy variables assigned to survey items for analysis

Name of independent variable	Type of variable	Dummy variable and value
Gender	Nominal	1 = Woman 2 = Man 3 = I identify my gender as: (please specify) 4 = prefer not to say
Age	Nominal	1 = 21 to 30 2 = 31 to 40 3 = 41 to 50 4 = 51+
Number of years teaching	Nominal	1 = Less than one 2 = 1 to 2 3 = 3 to 5 4 = 6 to 10 5 = 11 to 15 6 = more than 15

Initially, descriptive statistics and frequencies were generated to conduct basic demographic analysis and explore the distribution of quantitative variables. Basic tables for descriptive statistics were generated at this point for preliminary analysis. Bivariate correlation analyses were then conducted to measure the relationships between variables in order to answer the research question, "What factors influence secondary teacher uptake of video game technology within their classrooms?"

For general analysis, correlation coefficients can range in values between -1 to 1, where 1 indicates a strong positive relationship, -1 indicates a strong negative relationship, and 0 indicates no relationship at all between variables (Akoglu, 2018). The value of the correlation coefficient indicates that for every increase (or decrease) in one variable, there is a corresponding increase (or decrease) in the other. The larger the number is, the stronger the relationship (Ellis, 2010). An estimated interpretation of the strength of correlation is that a value of .70 or higher is a very strong positive relationship, and anything below -.70 is a very

strong negative relationship (Akoglu, 2018). Zero denotes no relationship, or 'zero correlation'. For this data, correlation analyses were run to examine the relationship between the amount of time spent playing games in leisure time, and the use of games in the classroom (both occurrence of game use and frequency of use). The analysis also examined the correlation of demographic variables (age, time teaching, gender, KLA taught) and the Teacher Video Game Use Attitudinal Scale, as well as the relationship between teacher professional development experiences and the Teacher Video Game Use Attitudinal Scale.

To answer the research question "What are secondary teacher's perceptions of the benefits, limitations, and barriers to the implementation of video games within Australian secondary classrooms?" descriptive statistical analysis was completed. This included analysis of the Likert-scale responses relating to the Teacher Video Game Use Attitudinal Scale and partitioning the teachers who have previously used video games in the classroom as a subset of survey population for further descriptive analysis.

Five open response questions provided additional information in relation to video game use and teaching. Analyses of these data were performed by conducting descriptive statistics and assigning thematic codes for each of the responses. Themes were identified by reviewing all answers for common topics and assigned to each response by hand. These themes were then tallied and quantified for analysis by the researcher.

Regression analysis

Multiple regression analysis was performed to estimate which variables predicted teacher attitudes to the use of video games in the classroom. For the purposes of the regression, only participants with complete information were kept (n = 120). Participants within this sample were 38% male and 62% female. Thirty-eight percent were aged between 21 to 30, 34% were aged 31 to 40, 19% were aged 41 to 50, and 8% were aged 51 or older.

Within the sample, 23% had been teaching for two years or less, 27% had been teaching for three to five years, 18% had been teaching for six to ten years, 33% had been teaching for 11 years or longer. Twenty-nine percent of teachers in this sample taught English, 32% taught Social Sciences, 23% taught Science, 18% taught Mathematics, 22% taught Technology, 7% taught Arts, and 7% taught Health and Physical Education (percentages do not add up to 100%, as more than one subject could be selected).

Prior to conducting the multiple regression analysis, several assumptions in relation to the distribution of the data were explored. The most important assumption to investigate was whether the variables were normally distributed. Stem-and-leaf plots and box plots (see Appendix G) indicated that each of the independent variables were not normally distributed, and would violate normal distribution assumptions. This was addressed by using bootstrap analysis to correct the estimate of the confidence intervals at which the null should be rejected. Bootstrapping is useful for addressing the assumptions that are made about distribution or sample size within a particular sample (Field, 2018). When there is skew in data within the sample, the sample size is not large enough, or samples are outside of normal distribution, bootstrapping can be used to resample from the population, in order to simulate a random sample from a much larger population (Fox, 2002). Bootstrapping looks at the characteristics of the population, and creates resamples based on that. A useful analogy to describe the process of bootstrapping is "the population is to the sample as the sample is to the bootstrap samples" (Fox, 2002, p. 591).

To perform the resample of the population through bootstrapping, the bootstrap function available on SPSS 27 was implemented using 1000 samples, with a confidence interval set at 95% with bias-correction (BCa). This is one of the more robust approaches to dealing with the possibility of violating underlying distribution assumptions in regression

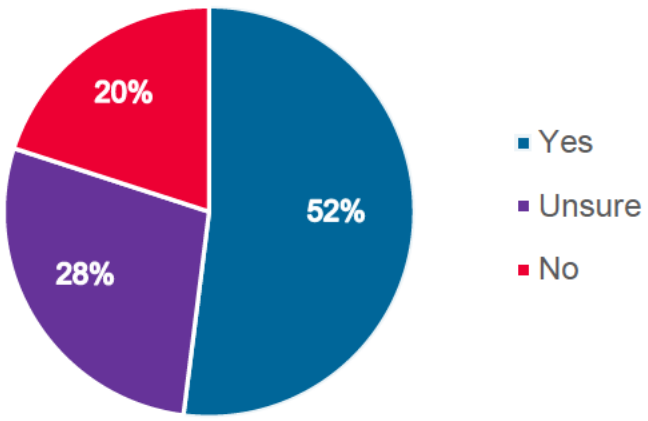
(see Field, 2018), and was undertaken to ensure the most accurate confidence level for the analysis.

Factors that influence teacher video game use

Survey responses suggested that video game use within the classroom is common, with 82% (n = 110) of teachers indicating that they have used video games as a pedagogical tool. Of the 18% (n = 25) of respondents that indicated they have not used video games within the classroom, 52% (n = 13) suggested that they would like to use games in the classroom in the future (see Figure 6.1).

Figure 6.1

Teachers who have not used video games as a pedagogical tool indicated interest in using video games in the future



Note. Calculated from the number of respondents who indicated "no" to Q15. "Have you ever used video games as a pedagogical tool in your classroom?"

Despite the high percentage of teacher video game use within the classroom, the frequency of the use of video games in teaching was reported to be low. Only 6% (n = 7) of teacher respondents that have used games in the classroom indicated that they use video games in the classroom frequently (every week), and 14% (n = 15) reported using them somewhat frequently (at least once a fortnight). The majority of respondents (68%; n = 75) that indicated that they use video games in the classroom use them occasionally, which is equivalent to five times per term, or less (see Table 6.3).

Table 6.3

Frequency of teacher video game use in the classroom

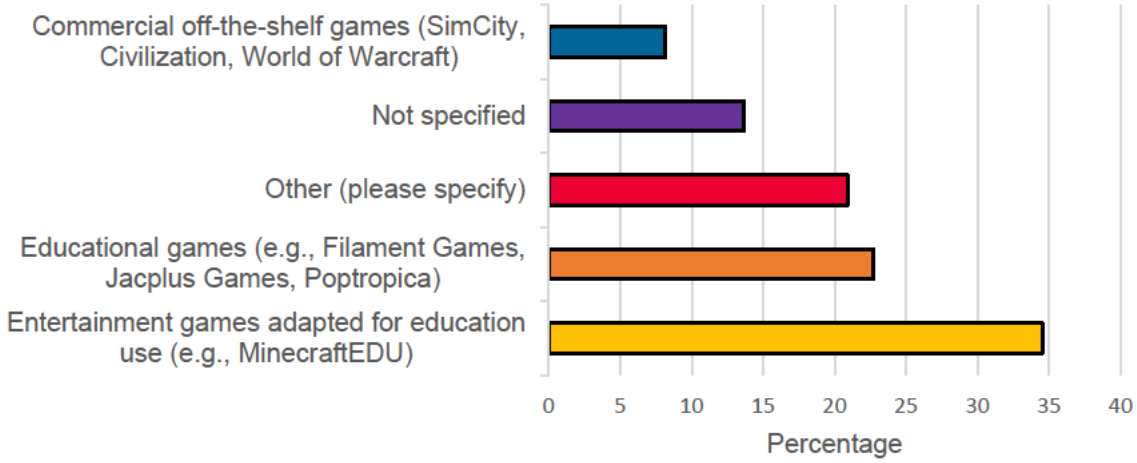
Variable	*n*	%
Very infrequently – not at all, or only once each term or less	38	34.55%
Somewhat infrequently – two or three times a term	21	19.09%
Occasionally – four or five times a term	16	14.55%
Somewhat frequently – at least once every fortnight, or multiple lessons in a fortnight	15	13.64%
Very frequently – every week of term, or multiple lessons in a week	7	6.36%
No answer provided	13	11.82%

Note. Calculated from the number of respondents who indicated "yes" to Q15: "Have you ever used video games as a pedagogical tool in your classroom?"

Teachers within the survey sample indicated that a variety of different types of games are being used for pedagogical purposes in secondary classrooms. Entertainment games that had been adapted for classroom use (such as *MinecraftEDU* or *SimCityEDU*) were most commonly used by survey respondents, with 35% (n = 38) of teachers using this type of game in the last 12 months (see Figure 6.2). Games made specifically for education were used by 23% (n = 25) of teachers who had previously used video games in the classroom, and commercial off-the-shelf (COTS) games were used by 8% (n = 5). For this survey item, the 'other' option was selected by 21% (n = 23) of teachers, and games listed in the open text box included video games that included physical elements (such as *Just Dance*), and quiz games (such as *Kahoot*). When asked to list the games that teachers use in the classroom in an open response text box, 41% of responses (n = 37) mentioned *Minecraft*. Other games listed included commercially popular games such as *Among Us*, *Assassins Creed* and *Plague Inc.*, as well as games designed for education purposes, such as *Mangahigh*, *Kahoot,* and *Arludo* games. Within this open response question, two teachers indicated they were unsure where to draw the line between educational applications and video games when reporting video games that they had used in the classroom; "*I use a variety of 'gamified' learning tools, though I'm not sure I'd consider them necessarily 'video games'. They use similar elements, though*".

Figure 6.2

Types of games used by teachers as pedagogical tools in the classroom



Personal video game experience

Survey responses indicated that personal video game use was fairly common, with 60% (n = 83) of teachers indicating that they play video games in their spare time, and 40% (n = 56) indicating that they do not. The majority of respondents who did play video games (73%; n = 61) described that they play for between 1 to 10 hours per week on average (see Table 6.4).

Table 6.4

Number of hours spent playing games for leisure

Variable	*n*	%
Less than an hour	11	13.3%
1 – 3 hours	25	30.1%
3 – 5 hours	20	24.1%
5 – 10 hours	16	19.3%
11 – 25 hours	6	7.2%
More than 25 hours	5	6.0%

Note. Calculated from number of respondents who indicated "yes" to Q7: "Do you play video games in your spare time?"

Pearson correlation coefficient were computed (see Table 6.5) to assess the relationship between personal video game use, demographics and other variables with the use of video games as a pedagogical tool in the classroom. A strong relationship was found between gender and playing video games for leisure, with female survey respondents more likely to play video games in their spare time, (r = -.492, p < .001; female = 1, male = 2). The relationship between personal video game use and use of video games in the classroom seemed to be unrelated with a weak, non-significant positive correlation between the two variables (r = .070, p = .417).

Table 6.5

Correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Educational benefits of games	--														
2. Video games and real world skills	.807**	--													
3. Teacher interest and self-efficacy	.642**	.585**	--												
4. External support for video game use	.463**	.421**	.504**	--											
5. Age	.180*	.207*	.022	-.020	--										
6. Gender	-.136	-.242**	-.323**	-.074	.010	--									
7. Number of years teaching	.258**	.217*	.131	.003	.647**	-.058	--								
8. Professional development attendance	.116	.178	.277**	.127	-.231*	-.011	-.171	--							
9. KLA[a] English	-.167*	-.142	-.106	-.083	-.119	-.125	-.142	.043	--						
10. KLA Maths	.078	.161	.039	.111	.148	-.095	.165	-.046	-.051	--					
11. KLA Science	.049	.066	.112	.047	.065	-.055	.068	.027	-.250**	.060	--				
12. KLA Social studies	-.113	-.085	.047	-.035	-.187*	-.125	-.090	.113	.323**	-.095	-.250**	--			
13. KLA Art	-.107	-.113	-.123	-.127	-.139	-.002	-.089	-.034	.129	-.072	-.108	-.091	--		
14. KLA Technology	-.124	-.135	-.269**	-.129	.155	.165	-.013	-.181*	-.311**	-.149	-.128	-.273**	-.005	--	
15. KLA PE	.180*	.183*	.219**	.137	.015	.111	.102	.049	-.112	-.121	-.146	-.112	-.089	-.155	--

Note. * = Correlation is significant at the 0.05 level (2-tailed). ** = Correlation is significant at the 0.01 level (2-tailed). [a] = Key Learning Area taught by survey respondents

Teacher experience and gender

Correlational analyses indicated that teacher age, gender, and number of years teaching are related to teacher attitudes towards the use of video games in the classroom. Teacher age was found to have a weak but significant positive correlation with the belief that video games are beneficial for education ($r = .180$, $p = .034$), as well as with the belief that video games foster real world skills ($r = .207$, $p = .015$). This finding indicated that older teachers were the more likely to believe that video games were beneficial for student motivation and engagement, and more likely to believe that video games teach problem-solving, decision-making, and communication skills (see Table 6.5 for correlation table). The longer teachers had been teaching, the more positive they were likely to be about the educational benefits of video games ($r = .258$, $p = .002$), as well as more positive about the potential of video games to teach real world skills ($r = .217$, $p = .010$).

Survey responses also indicate that gender is related to teacher video game use within the classroom. A Pearson correlation coefficient was used to assess the relationship of gender and teacher interest in the use of video games, using the Teacher Video Game Use Attitudinal Scale. Analysis found that female teachers were more likely to express that they have a positive interest and self-efficacy when it comes to implementing video games in the classroom ($r = -.242$, $p = .004$; female = 1, male = 2), although this relationship was weak. Further to this, a moderate relationship was found between gender and the video games and real world skills subscale, with female teachers also more likely to be positive about the potential of video games to foster real world skills ($r = -.323$, $p < .001$). There was a negligible, non-significant relationship found between gender and the belief that video games have educational benefits ($r = -.136$, $p = .109$; see Table 6.5).

Teacher interest and self-efficacy

Teacher interest and belief in their self-efficacy in the use of video games within the classroom was measured using the Teacher Video Game Use Attitudinal scale. The Teacher Interest and Self Efficacy subscale was developed from three survey items, as detailed in Chapter 4. The results from these survey items indicate that most survey respondents were interested in using video games in the classroom (72% somewhat agree or strongly agree; n = 100). Despite this, teachers were slightly less likely to report that they have the knowledge and skill required for using video games in the classroom (66% somewhat agree or strongly agree, n = 91; 25% somewhat disagree or strongly disagree, n = 35). Furthermore, 59% (n = 82) of teachers reported that they somewhat agree or strongly agree that they feel confident using games in the classroom, with 29% (n = 40) indicating that they somewhat disagree or strongly disagree that they were confident in video game use in the classroom (see Table 6.6).

Results indicated that teacher belief in the educational benefits of video games was strongly correlated with the belief that video games have the potential to foster real world skills, with a very strong positive relationship between these two variables found (r = .807, p < .001). Similarly, the belief in the educational benefits of video games was strongly correlated with the teacher interest and self-efficacy subscale (r = .642, p < .001), which measured teacher interest in the use of video games in the classroom, and confidence in implementing video games in their teaching practice.

Table 6.6

Teacher video game interest and self-efficacy subscale item analysis

Survey item		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I am interested in using video games in my classroom	*n*	11	12	16	41	59
	%	7.9%	8.6%	11.5%	29.5%	42.4%
I have knowledge and skills required for using video games in the classroom	*n*	8	27	13	46	45
	%	5.8%	19.4%	9.4%	33.1%	32.4%
I am confident using video games in my classroom	*n*	13	27	17	42	40
	%	9.4%	19.4%	12.2%	30.2%	28.8%

Teacher KLA and teaching practices

Teacher opinion on the compatibility of video games with their KLA and pedagogical practices were found to be mixed. Responses to the survey item measuring compatibility of video games with teacher pedagogical practices found that 38% (*n* = 53) of respondents indicated video games were mostly compatible or extremely compatible with their teaching practices. Conversely, 48% (*n* = 67) of teachers reported that video games were somewhat or not at all compatible with their teaching practices (see Figure 6.3). Teacher opinions on whether video games would be easy to experiment with in their main KLA were also mixed. Responses indicated that teachers were fairly positive about experimenting with video games in their KLA, with 63% (*n* = 87) stating they would find it somewhat or extremely easy. This is compared to 25% (*n* = 35) of responses, which indicated teachers would find it somewhat or extremely difficult to experiment with video games in their main KLA (see Figure 6.4).

Figure 6.3
Teacher opinion of the compatibility of video games with their teaching practices

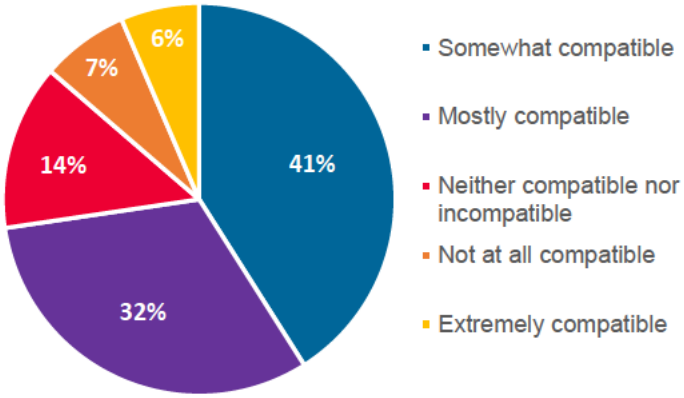
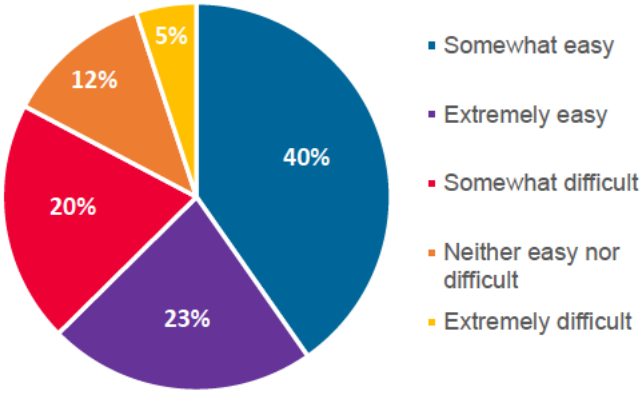


Figure 6.4
Teacher opinion of the compatibility of video games with their main KLA



In some cases, attitudes towards the use of video games in the classroom were related to the KLA taught by the survey respondents. Correlation analysis conducted on the relationship between teacher KLA and the Teacher Video Game Use Attitudinal Scale found that English teachers had weak but statistically significant negative attitudes towards the educational benefits of video games (r = -.167, p = .050). There was no statistically significant relationship between teaching other KLAs and attitudes towards the educational benefits of video games. PE teachers held more positive attitudes towards the educational benefits of video games (r = .180, p = .034), the potential for games to foster real world skills (r = .183, p = .031), and their interest and self-efficacy regarding the implementation of video games in the classroom (r = .219, p = .010). Interestingly, despite the use of video game technology within their KLA, Technology teachers were more likely to be negative regarding the subscale of Teacher Interest and Self-Efficacy towards the use of video games in the classroom, with a significant negative relationship found (r = -.269, p = .001; see Table 6.5).

Professional development

Professional development (PD) was also found to be a potential factor that is correlated to teacher video game use within the classroom. Within the survey sample, 80% (n = 97) of teachers reported that they have not attended PD in relation to video games and teaching. Of those teachers who have not attended PD, 75% (n = 73) indicated that they probably or definitely would be interested in attending a PD on this topic. The relationship between PD attendance in relation to video games, and demographic variables including age, gender, and KLA taught, were analysed along with the Teacher Video Game Use Attitudinal Scale (see Table 6.5). There was a weak but statistically significant positive correlation between video game PD attendance and the Teacher Interest and Self-Efficacy subscale (r = .277, p = .002). Teacher belief in their own self-efficacy in the use of video games, as well as their interest in the use of video games within their own teaching, appears to be associated with PD attendance. In addition to this, there is a weak but significant negative correlation between teacher age and video game PD attendance (r = -.231, p = .011), indicating that younger teachers are more likely to have attended video game related PD. There was also a significant negative correlation between teaching Technology as a subject and video game PD attendance (r = -.181, p = .002). There was no significant relationship between teaching any other KLAs and attendance to video game-related PD.

The survey also measured the ways in which teachers develop their understanding regarding the use video games in the classroom, with survey respondents most likely to learn about using video games from figuring it out themselves (58%; n = 70). Other ways teachers reported developing their understanding of video game use in the classroom included from another teacher, mentor, or supervisor (27%; n = 33), from an online resource (21%; n = 25), and from their own students or children (16%; n = 19; see Table 6.7). Only 6% (n = 7) reported learning about video games from attending PD.

Table 6.7

Ways in which teachers developed their understanding regarding the use of video games in the classroom

Variable	*n*	%
I figured it out myself	70	57.85%
From another teacher, mentor, or supervisor	33	27.27%
From an online resource	25	20.66%
From my own students, or my own children	19	15.7%
From a conference I attended	12	9.92%
Pre-service teacher education	12	9.92%
In-service professional development	7	5.79%
Other (please specify)	3	2.48%

Note. more than one option able to be chosen, percentages do not add up to 100%. Totals calculated from no. of respondents who indicated "yes" to Q15: "Have you ever used video games as a pedagogical tool in your classroom?"

Teacher beliefs about video game use in the classroom

Survey responses indicated that teacher beliefs were primarily positive regarding the use of video games in the classroom (see Table 6.8). Teacher responses indicate positive beliefs about the ability of video games to enhance students' motivation to learn (82% somewhat agree or strongly agree; $n = 114$), and enhancing interest in classroom subject matter (88% somewhat agree or strongly agree; $n = 122$). Survey responses also indicated that the majority of teachers believe that video games can help students develop problem solving skills (89% somewhat agree or strongly agree; $n = 124$) and decision making skills (89% somewhat agree or strongly agree; $n = 123$).

There was also a significant relationship between teacher belief in the educational benefit of games and the external support that teachers receive for video game use from students, parents, colleagues, and school administration ($r = .463$, $p < .001$). Confidence in receiving external support was also strongly positively correlated with teacher interest and

self-efficacy regarding using video games ($r = .504$, $p < .001$), and the belief that video games have the potential to develop real world skills ($r = .421$, $p < .001$; see Table 6.5).

Table 6.8

Teacher attitudes towards video games, who have previously used video games in their teaching practice

Survey item		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Video games are an effective way to teach students curriculum content	*n*	6	7	11	51	22
	%	6.19%	7.22%	11.34%	52.58%	22.68%
Video games are an effective way to assess students on curriculum knowledge and/or skills	*n*	7	16	17	43	14
	%	7.22%	16.49%	17.53%	44.33%	14.43%
Video games are an effective way to teach concepts	*n*	5	10	10	51	21
	%	5.15%	10.31%	10.31%	52.58%	21.65%
Video games can help students perform better on standards-aligned assessments	*n*	7	13	35	32	10
	%	7.22%	13.4%	36.08%	32.99%	10.31%
Video games are an effective way to teach social skills	*n*	8	17	21	36	15
	%	8.25%	17.53%	21.65%	37.11%	15.46%
Video games are an effective way to teach problem solving skills	*n*	5	4	11	39	38
	%	5.15%	4.12%	11.34%	40.21%	39.18%
Video games have been effective in increasing my students' engagement	*n*	4	4	4	42	43
	%	4.12%	4.12%	4.12%	43.3%	44.33%
Video games have been effective in increasing my students' motivation	*n*	2	3	12	41	39
	%	2.06%	3.09%	12.37%	42.27%	40.21%

Note. Calculated from the number of respondents who indicated "yes" to Q15. "Have you ever used video games as a pedagogical tool in your classroom?"

Teacher prior video game use and belief in the benefits of video games

The perceptions of teachers who had previously used video games within the classroom (n = 110) were measured in order to determine if the prior use of video games were related to teacher beliefs (see Table 6.8). Teacher responses indicated that teachers who had used video games in the classroom had positive perceptions about the benefits of implementing games within their teaching practices. Of the teachers who indicated that they have previously used video games within the classroom, 75% (n = 73) somewhat agreed or strongly agreed that video games are an effective way to teach curriculum content to students. Furthermore, most reported that video games have been effective in increasing their students' problem solving skills (79% somewhat agree or strongly agree; n = 77), engagement (88% somewhat agree or strongly agree; n = 85), and motivation (82% somewhat agree or strongly agree; n = 80). Additionally, more teachers reported the belief that video games are a more effective way of teaching low-level concepts or basic skills (71% somewhat agree or strongly agree; n = 99), as compared to complex content or high level skills (49% somewhat agree or strongly agree; n = 68; see Table 6.9).

When asked how video games might be useful for educational purposes, 13 teachers provided expanded responses in an open text box. Of these qualitative survey responses, four (31%) indicated that teachers believe video games can be beneficial as literary texts to teach narrative elements; "*I am interested in using video games with strong narratives, character development and world building (e.g.,* Final Fantasy *and* Horizon Zero Dawn*) to teach narrative elements in English*". Three responses noted that video games are valuable for teaching difficult concepts or technical information. Two qualitative responses indicated that video games are useful for developing positive relationship practices; "*Students need to feel safe and valued in the classroom. Games (video or otherwise) are very good for achieving this goal*".

Table 6.9

Teacher attitudes towards the use of video games for education

		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Video games can enhance students' motivation to learn	*n*	7	5	13	60	54
	%	5.0%	3.6%	9.4%	43.2%	38.8%
Video games can get students interested in the subject matter	*n*	4	7	6	64	58
	%	2.9%	5.0%	4.3%	46.0%	41.7%
Video games can be helpful for my students' learning	*n*	7	10	21	57	44
	%	5.0%	7.2%	15.1%	41.0%	31.7%
Video games are an effective way to teach low-level concepts or basic skills	*n*	5	12	23	65	34
	%	3.6%	8.6%	16.5%	46.8%	24.5%
Video games are an effective way to teach complex content and high-level skills	*n*	15	24	32	39	29
	%	10.8%	17.3%	23.0%	28.1%	20.9%
Video games can support the needs of diverse learners	*n*	3	7	22	65	42
	%	2.2%	5.0%	15.8%	46.8%	30.2%
Video games can help me provide personalised instruction	*n*	10	26	29	46	28
	%	7.2%	18.7%	20.9%	33.1%	20.1%
Video games are an effective way to teach real world skills	*n*	11	23	25	51	29
	%	7.9%	16.5%	18.0%	36.7%	20.9%
Video games can help students develop problem solving skills	*n*	7	4	4	54	70
	%	5.0%	2.9%	2.9%	38.8%	50.4%
Video games can help students develop decision making skills	*n*	8	2	6	57	66
	%	5.8%	1.4%	4.3%	41.0%	47.5%
Video games can help students develop collaboration skills	*n*	8	8	20	51	52
	%	5.8%	5.8%	14.4%	36.7%	37.4%
Video games can help students develop communication skills	*n*	11	14	19	52	43
	%	7.9%	10.1%	13.7%	37.4%	30.9%

Teacher prior video game use and belief in the limitations of video games

Teachers who have previously used video games in the classroom were asked about their beliefs regarding the limitations of video games. As discussed in the previous section, responses indicated that the majority of teacher respondents held positive beliefs about the impact of video games in the classroom. As seen in Table 6.10, few teachers who have used video games within their teaching responded negatively to the items measuring perceived benefits of video games. It should be noted, though, that approximately one quarter of these teachers indicated that they somewhat disagreed or strongly disagreed with the effectiveness of video games to teach social skills (26%; *n* = 25), standards-aligned assessments (21%; *n* = 20), and assessing curriculum knowledge and/or skills (24%; *n* = 23).

This suggests that, despite overall positive opinions regarding the use of video games in the classroom, teachers who have used video games find that there are limitations to their use for assessment, and to teach social skills. This is supported by the survey item that asked teachers who had used video games how they assess student learning or performance with games. Twenty-six percent (n = 54) of teachers reported that they use whole-class discussions to assess what their students have learned by playing video games, 21% (*n* = 44) created their own tests or quizzes to assess content, and 9% (*n* = 19) indicated that they do not assess student performance with/around video games (see Table 6.10). This suggests that teachers believe assessment around the use of video games may be a limitation of implementing video games in the classroom.

Table 6.10

Teacher assessment of learning through video game use

Survey item	*n*	%[a]
I am able to tell what students have learned through their game play in whole-class or group discussions	54	55.67%
I create my own test/quizzes to assess what students have learned by playing digital games	44	45.36%
I use the built-in assessment system that come with certain games	38	39.18%
I look at student scores in games to assess their knowledge/skills on topics we cover in other formats	37	38.14%
I do not assess student performance with/around video games	19	19.59%
Other (please specify)	13	13.4%

Note. Calculated from no. of respondents who indicated "yes" to Q15 *"Have you ever used video games as a pedagogical tool in your classroom?"*

[a] more than one option able to be chosen, percentages do not add up to 100%

Open text survey responses were collected from respondents who chose the option "video games are NOT useful for education". Five teachers indicated that they agreed with this statement, (0.6%) and four teachers provided a written answer. These four responses indicated that the potential for student distraction, and lack of focus on learning, are limitations of using video games in the classroom. One teacher noted that "*students engage with game, not the content. They do not transfer the skills/content to the real world*". Another observed that "*Students ignore instructions and only do as they want. They don't get the point of the task they are being asked to complete*". This transferability of skills from video games to other applications was a common theme in the qualitative feedback. One teacher noted that:

The current design of games is not useful for education purposes as the learning is specific for the game and students do not learn to apply it to other situations. They are "trained" to be "good at the game" and not necessarily to develop transferable skills.

Another teacher described the limitations of video games in a similar manner:

Video games are entertainment. The creative thinking, critical thinking and problem-solving skills are definitely not transferrable outside the game to any 'academic' work. I've tried, and that myth is well busted.

This view was supported by some quantitative survey responses, which indicated that teachers were less certain of the applicability of video game skills to 'real world' skills. When all survey respondents were asked if video games were an effective way to teach real world skills, 58% (n = 80) somewhat agreed or strongly agreed, but 18% (n = 25) were unsure, and 24% (n = 34) somewhat disagreed or strongly disagreed (see Table 6.9).

Table 6.11

Teacher opinions of the barriers faced to video game implementation in the classroom

	N	%
Lack of technological resources	74	61.16%
Hard to find games that fit with the curriculum	73	60.33%
Cost	66	54.55%
Insufficient time	65	53.72%
Not sure where to find quality games	60	49.59%
Emphasis on standardized test scores	44	36.36%
Unfamiliar with technology	39	32.23%
Lack of administration support	38	31.4%
Other (please specify)	22	18.18%
Lack of parental support	21	17.36%
There are no barriers	3	2.48%

Note. more than one option able to be chosen, percentages do not add up to 100%

Teacher beliefs about the barriers to video game use in the classroom

When asked to indicate the barriers experienced when implementing video games in the classroom, teacher responses were varied. The most common barriers indicated were a lack of technological resources (61%; *n* = 74), difficulties in identifying games that fit with the curriculum (60%; *n* = 73), cost (55%; *n* = 66), insufficient time (54%; *n* = 65), and not being sure where to find quality games (50%; *n* = 60; see Table 6.11). Twenty-two teachers chose the 'other (please explain)' option (13%) and provided written responses in regard to the barriers experienced. Nine of these responses reaffirmed that technological resources were a barrier to video game implementation, through inadequate student devices (in quality, consistency, and equity of access) as well as issues with school networks not being able to run games, or blocking access to video game related content. Teachers also noted that purchasing individual game licenses was complicated, and there are few options to buy commercial game licences in bulk for education use.

Six of the qualitative responses noted difficulties in implementing video games due to competing demands of the education system. One teacher described the difficulty convincing others that video games are for "real learning", and another noted that it is "*not the 'right' thing to use to teach*". Four teachers specifically mentioned the difficulty in finding games that fit with the curriculum, with one noting a "*lack of Australian specific content and syllabus aligned conten*t" was a barrier. One respondent noted that "*they [video games] don't work, they're a waste of learning time*", suggesting that there are mixed feelings about the implementation of games among the sample of teachers within the survey.

Support from school leadership, colleagues, parents, and students was generally not viewed as a barrier to the implementation of video games, with moderately high levels of support perceived from external sources. Teachers within the sample believed they would

receive strong support from students (96% somewhat agree or strongly agree; *n* = 134), school leadership (59% somewhat agree or strongly agree; *n* = 82), and other teachers (61% somewhat agree or strongly agree; *n* = 85). Teachers were less certain of support from parents, with a lower proportion (40%; *n* = 56) somewhat agreeing or strongly agreeing that parents would support the use of video games in the classroom (see Table 6.12)

Table 6.12

Teacher belief regarding the support received for video game use

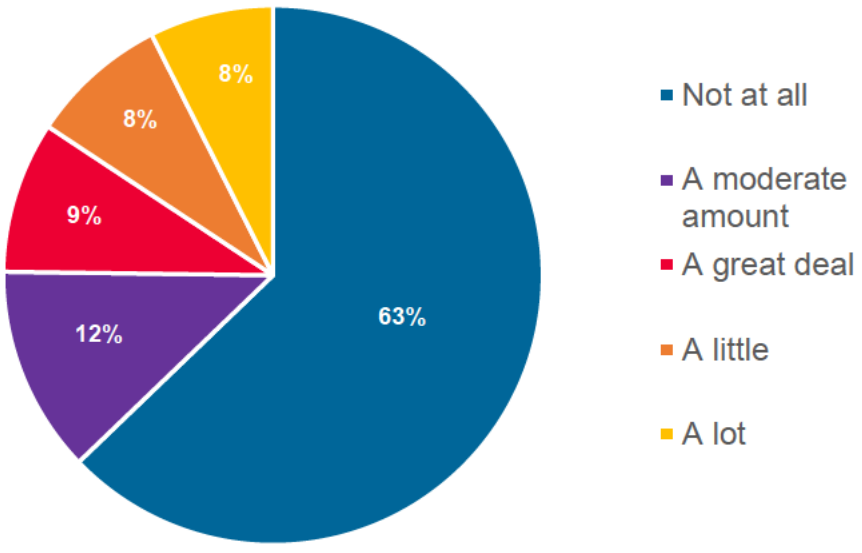
Survey item		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I believe my school leadership would support me in the use of video games in the classroom	*n*	16	23	18	51	31
	%	11.5%	16.5%	12.9%	36.7%	22.3%
I believe other teachers at my school would be supportive of me using video games in the classroom	*n*	11	24	19	63	22
	%	7.9%	17.3%	13.7%	45.3%	15.8%
I believe parents at my school would be supportive of the use of video games in the classroom	*n*	14	35	34	45	11
	%	10.1%	25.2%	24.5%	32.4%	7.9%
I believe students would be supportive of the use of video games in the classroom	*n*	1	1	3	36	98
	%	0.7%	0.7%	2.2%	25.9%	70.5%

Teacher implementation of games: COVID-19

During the time of survey data collection (November 2020 to May 2021), Australian teachers were experiencing impacts from the coronavirus pandemic. During this time, all Australian states and territories experienced interruptions in the form of school closures and the closure of non-essential services, in varying severity and time periods (Department of Health, 2021). For this reason, the survey asked teachers to indicate the extent that COVID-19 influenced their use of video games in the classroom. The majority of survey respondents (63%; $n = 76$) indicated that COVID-19 did not impact their use of video games in the classroom at all, and 21% ($n = 25$) reported being impacted "a little" or "a moderate amount" (see Figure 6.5).

Figure 6.5

Teacher experience of interruptions experienced to the use of video games as a result of COVID-19



Twenty-eight teachers provided text responses to the question "In what way has COVID-19, and the related interruptions to regular classroom teaching, influenced your use of video games in the classroom?". Seven teachers indicated that COVID-19 increased their use of video games, as online learning provided opportunities for alternative teaching and learning activities; one teacher stated that COVID-19 lockdowns "*increased my enthusiasm for the use of virtual, online multiplayer spaces as classrooms, and gamification of some learning objectives*". One teacher described using games as digital alternatives to face-to-face teaching practices: "*video games were used as form of practical when physical hands on and group work practicals were not allowed, limited or affected*". In contrast to these reports of more video game use, though, four teachers noted that COVID-19 interruptions left them with less time to implement games, as well three teachers noting issues with equal technology access for students at home being a barrier to video game implementation.

Regression analysis results

Based on the literature, seven variables were entered into a model to test their predictive use in relation to teacher positive attitudes towards video games. The model variables included: (1) whether the teacher taught STEM or not, (2) how many hours of personal video games they played per week, (3) how many years they have been teaching, (4) external support received for video games, (5) how often video games were used for teaching, (6) age, and (7) gender. These seven variables within the model accounted for 49% of the variance in teacher attitudes towards video games (Teacher Video Game Use Attitudinal Scale), $R^2 = .493$, adjusted $R^2 = .423$, $F\ (7, 51) = 7.079$, $p = < .001$. Unstandardised (B) and standardised (β) regression coefficients, and squared semi-partial (or 'part') correlations (sr^2) for each variable in the regression model are reported in Table 6.13. Partial correlations (sr^2) represent the unique amount of variance that the predictor variable brings to the model (Field, 2018). Analysis of Variance (ANOVA) was used to assess whether or not the listed variables

were a significant predictor of teacher attitudes towards video game use, as measured by the Teacher Video Game Use Attitudinal Scale. The results of the ANOVA indicated that the model was a significant predictor of teacher attitudes towards video game use, F (7, 51) = 7.079, p = <.001.

Results indicated that gender did not significantly influence teacher attitudes towards video game use (β = -.062, p = .748, bootstrap BCa CI = -.386, .272; see Table 6.13). Furthermore, it was found that STEM teaching (β = .110, p = .342, bootstrap BCa CI = -.207, .460), the number of hours of personal video game use (β = -.212, p = .084, bootstrap BCa CI = -.242, .029), age (β = -.020, p = .134, bootstrap BCa CI = -.003, .049), or number of years teaching (β = -.025, p = .791, bootstrap BCa CI = -.214, .118) did not significantly influence teacher attitudes towards video game use. The results of the regression analysis indicated that only two variables remained significant after bootstrapping was applied. External support for video game use significantly influenced teacher attitudes towards the use of video games (β = .38, p = .003, bootstrap BCa CI = .162, .530). In addition to this, how often teachers used video games in their own pedagogy (β = -.35, p = .003, bootstrap BCa CI = -.309, -.065) significantly influenced teacher attitudes towards video games use.

Table 6.13

Results of regression model predicting Teacher Video Game Use Attitudinal Scale

Variable	*B*	Bootstrap 95% BCa CI	*β*	sr^2	*t*	*p*
Teaches STEM[a]	.160	[-.207, .460]	.110	.089	.895	.342
How many hours per week personal video game use	-.114	[-.242, .029]	-.212	-.168	-1.683	.791
How many years teaching	-.025	[-.214, .118]	-.052	-.041	-.413	.791
External support subscale	.334	[.162, .530]	.382	.348	3.485	.003
How often video games used in teaching	-.190	[-.309, -.065]	-.352	-.307	-3.081	.003
Age	.020	[-.003, .049]	.270	.207	2.080	.134
Gender	-.062	[-.386, .272]	-.042	-.044	-.317	.748

Note. R^2 = .493 (N = 120, p < .001). BCa CI = bias-corrected confidence interval. Bootstrap BCa confidence intervals based 1000 bootstrap replications. *B* = unstandardised regression coefficients, *β* = standardised regression coefficients, sr^2 = squared semi-partial correlations.

[a] STEM = Science, Technology, Engineering and Maths

Conclusion

This chapter described the results of the survey of Australian secondary teachers and their perceptions and use of video games in the classroom. The results presented in this chapter included a discussion of the factors that are related to teacher use of video games for education, which were age, gender, KLA taught, and PD experiences. This chapter then detailed the ways in which teacher beliefs regarding the benefits and limitations of video games were presented in the survey data, as well as the barriers experienced by teachers regarding the use of video games in the classroom. The impacts of the COVID-19 pandemic on teachers use of video games in the classroom were examined. Lastly, the regression analysis of factors that influence teacher attitudes towards the use of video games in the classroom was described.

Chapter 7

Discussion

This chapter presents the combined findings of this thesis, and discusses the conclusions and implications of these findings. Organised by the thesis research questions, each section begins with a summary and discussion of the key results, and then explores the practical and methodological implications of the conclusions that can be drawn from the findings. The chapter then concludes with a discussion of the study limitations, followed by suggestions for further research.

Research question 1: According to research, how are video games currently being used in secondary classrooms?

The first research question explored how video games are currently being used in secondary classrooms. Data from the systematic review indicated that, internationally, video games made specifically for education are researched in classroom settings more often than commercial games or the process of learning through making games. Additionally, the systematic review suggested that video games were most often researched within STEM classroom contexts, and that learning outcomes measured by video games were most often knowledge acquisition, and affective or motivational outcomes. These findings regarding learning outcomes are generally consistent with findings of previous systematic reviews related to video games and education (Connolly et al., 2012; Boyle et al., 2016).

Despite the fact that there was over 3000 papers identified in the initial search, the systematic review overall found that research examining the use of video games within a secondary classroom context is limited. While the number of papers in the initial search indicated that there is interest in video games and education, the screening process found that

a considerable number of these papers speculated about the potential of video games and learning, or described the design or theory of educational video games, but did not include empirical evidence concerning the impact of video games on learning outcomes, and so were excluded from the review. These findings coincide with the results of Connolly et al. (2012) and Abdul Jabbar and Felicia (2015), who noted that experimental studies providing empirical evidence concerning the impact of video games on educational outcomes were a small percentage of overall studies identified within their reviews.

The systematic review also found that studies that conducted research using commercial games were more likely to be measuring learning outcomes related to social skills. Of the six papers that were retained in the review relating to social skills outcomes, five of these were studies related to commercial games. The results reported by these studies indicated that video game implementation in the classroom had a positive impact on social skills (Gerber et al., 2014; Hanghoj et al., 2018; Monjelat et al., 2017; Pellas & Peroutseas, 2016). These positive impacts are interesting considering the debate surrounding commercially popular video games and their influence on negative social tendencies (e.g., violence, anti-social behaviour; see Bavelier et al., 2011). The focus on social skills and commercial video games identified within the papers in this review may indicate that researchers may be contesting the perception of commercial video games as anti-social. Further research would be beneficial to explore this concept.

Strength of the current body of evidence

Similar to findings reported by other reviews (All et al., 2013; Boyle et al., 2012; Connolly et al., 2012; Perotta et al., 2013), the papers retained within the systematic review were diverse in terms of scope, research aims, methodologies used, sample sizes, and theoretical frameworks applied, and were representative of a significant variety of research

disciplines and fields. Hence, it is difficult to synthesise the body of research regarding video games in education, and to assess the effectiveness of video games within secondary classrooms. The overall results of the papers retained by the review regarding the impact of video games on secondary classrooms were generally positive, although a quarter of papers retained reported mixed results, indicating that the impact of video games on secondary classrooms is not conclusive with the current body of evidence. While an assessment of the quality of the research papers was outside of the scope of this study, initial observations indicate that, while there is some indication of positive outcomes between video games and learning, the body of evidence supporting the positive impact of video games in education is not strong. Only two RCTs were identified by the review (Culp et al., 2015; Wilson et al., 2017), and only half of the identified papers were quasi-experimental studies. This corresponds with the findings of Connelly et al. (2012), who reported that, while there was some evidence found to support positive impacts and outcomes, more empirical research is needed to provide strong evidence of video games' effectiveness in the classroom.

The systematic review further highlighted the issue of inconsistent reporting of study details within the current field of research. Demographic data regarding the age and gender of participant samples for both students and teachers was provided inconsistently. Additionally, information supplied on the video games being used in study interventions was often vague, with the platform, content, and design of the game often not described at all. Authors often did not provide information relating to the development of the video game, such as who had developed the game, and for what audience. Perotta et al. (2013) noted that it was often difficult to determine whether the video games being studied had been developed for educational purposes, or if the researchers were adapting an already existing game. This was consistent with the findings of the systematic review. Information provided about the context and specifics of the intervention, such as the classroom set up, instructor details, and time

played, were also often inconsistent. Both Perotta et al. (2013) and Young et al. (2012) highlighted that the lack of information regarding game details and features in reviewed studies has serious negative implications for the overall strength of evidence regarding the use of video games for learning. In summary, the results of the systematic review revealed significant inconsistencies in the reporting of study details. This is an important issue facing the current field of educational video game research, and one that is impacting the current body of evidence supporting the use of video games in the classroom.

Game developer researcher bias

Results of the systematic review also highlighted the potential for developer bias in educational video game studies. The review identified that researchers were the developers of the video games being researched in 69% of the papers that focused on games made for education purposes. This is a finding shared with Backlund and Hendrix (2013), who also noted that a number of the studies within their review included game developers as the main evaluators of data. This indicates that there is a considerable potential for conflict of interest in the research being performed, and increases the likelihood of data that is skewed towards positive publication outcomes for games being developed by research teams. It also means that video games are often being researched once, with no additional research to cross-check findings, viability and validity, or further develop and test hypotheses about particular game attributes. The systematic review results show that most research is performed on a game once (68 games named within 85 research papers), with little evidence of follow-up research, or indication of whether the video game is continued to be used in the classroom. This poses a serious threat to the generalisability of findings and the ability to make recommendations on video game use in the classroom. Research on video games should be dictated by their use in the classroom, and researchers need to consider the context in which it is being taught, in order to fully understand the implementation of the game. This would result in a body of

evidence being built around the efficacy of particular games, with more valid and rigorously tested hypotheses. This is starting to be seen in some contexts, for example amongst the research conducted in relation to *Minecraft* (Nebel et al., 2016), but there is still significant progress to be made in this respect.

Research question 2: How are video games currently being used in Australian secondary classrooms?

The second research question asked how video games are being used in Australian secondary classrooms. Data from the systematic review indicated that research in an Australian context is very limited, with only six articles meeting the review inclusion criteria. These identified articles were primarily qualitative in nature. An interesting aspect of this research was that they primarily focused on the implementation of commercial video games in the classroom, rather than games made specifically for education. This is despite the findings of Beavis et al. (2014) noting that Australian students describe educational video games as being the most commonly used within classroom teaching, and the survey results within this thesis indicating that educational games are the most often used category of games by Australian teachers. Video game interventions within an Australian context found positive results in terms of student learning outcomes and engagement, with students demonstrating innovative literacy learning (Toomey & Kitson, 2017), improved knowledge and understanding of content areas (Struppert, 2010), and increased interest in classroom learning (Bacalja, 2019; Beavis et al., 2014; Pusey & Pusey, 2015). Despite this, the complexities of teacher implementation were also noted. This included the importance of external support for teachers using video games within the classroom (Steiler-Hunt & Jones, 2015), and the importance of teacher buy-in to the success of video game implementation (Struppert, 2010).

Results from the survey indicated that video games are commonly being used in Australian secondary classrooms, with the majority of teachers in the present study having used video games as a pedagogical tool to teach curriculum content, problem-solving skills, and to increase student engagement and motivation, albeit not very frequently. Furthermore, the survey showed that personal video game use was common among Australian teachers, and that the use of video games for education is generally perceived as beneficial and valuable to student motivation and learning. Australian teachers reported that they most often use video games specifically made for education in secondary classrooms, rather than commercial games or creating video games as learning activities. These findings highlighted the discrepancy between the amount of research being conducted on the use of video games in Australian secondary classrooms, compared to the reported use of video games in the classroom by Australian secondary teachers. In addition to this, the focus of Australian research on the use of commercial video games, compared to the reports of Australian teachers using video games made for education in their teaching pedagogy is a disparity in current research. The presence of these gaps are a significant finding of this thesis.

Types of games being used in classrooms

Teachers surveyed indicated that the types of video games being used in secondary classrooms are most often video games created for educational purposes, rather than commercial games. Results from the systematic review indicated that, among the papers retained, games created for education purposes were researched most often (with Australian studies being an exception), while commercial off-the-shelf games and learning through the act of making games were researched less often. These results support the idea that games created specifically for education, such as ‘serious’ or ‘edutainment’ games, are used most commonly in secondary classrooms. Furthermore, this is also supported by the survey results, in which the respondents described the types of games being used as those that had been

adapted for education purposes, or specifically made for education. Only 6% of survey respondents reported using commercial games in the classroom.

Games created for educational purposes are more likely to be short form and simplified, with less emphasis on immersion in gameplay and story (Clark et al., 2012), whereas commercial games tend to be long form and more immersive. Findings that indicate video games made for education are used more often in the classroom are reinforced by previous studies, which indicate that teachers are not using longer-form, immersive games in the classroom, despite them performing better in studies of learning efficacy (Clark et al., 2014; Takeuchi & Vaala, 2013). Takeuchi and Vaala reported survey results that described few teachers using immersive video games that lend themselves to "deep exploration, complex decision making, and participation in the types of activities that set digital games apart from more didactic forms of instruction" (2013, p.56), with teachers more often using short-form 'mini-games' or digital repositories that have game-like lessons. Young et al. (2012), for example, found that most use of video games within classrooms prioritise curriculum coverage, individual play, and short exposure, rather than extended immersion in engaging video game play. This was supported within an Australian context, with Beavis et al.'s survey of Australian students finding that the vast majority of games described as being used in classrooms were short educational games that may not warrant the description of 'games' at all, and instead were "effectively textbooks online" (2014, p.30).

The use of short-form educational games, rather than long-form commercial games, may be explained by teacher beliefs reported in the survey, where teachers described that video games are a more effective way of teaching low-level concepts or basic skills, as compared to complex content or high level skills. Survey results further indicated that the most common barriers indicated by teachers to the use of video games in the classroom were a lack of technological resources, difficulties in identifying games that fit with the

curriculum, cost, insufficient time, and not being sure where to find quality games. Insufficient time may be the reason teachers prefer short form games, as well as these games being easier to map to curriculum standards (Richards et al., 2013; Takeuchi & Vaala, 2013). Further research on game length and immersion would be helpful to better understand the types of games being used, and whether this impacts on the learning that occurs as a result of these games being used in the classroom.

Both the systematic review and survey indicate that, despite the potential of video games to transform learning processes, they are primarily being used to directly teach content or as a motivational tool for students in the classroom. Results from the systematic review indicated that video games are being used to measure knowledge acquisition most commonly, and affective or motivational outcomes second most commonly. This finding is consistent with Connelly et al.'s systematic review (2012) and subsequent update to the review (Boyle et al., 2016), in which it was noted that, despite video games being championed as an engaging and new medium for 21st century skills, they are still being used primarily for knowledge transmission, or student reward and motivation. This is in direct contrast to the more innovative and progressive teaching activities that are often proposed when speculating about the potential of video games in education (Shaffer et al., 2005).

Research question 3: What factors influence secondary teacher uptake of video game technology within classrooms?

The third research question asked what factors influence Australian secondary teacher uptake of video game technology within their classrooms. Regression analysis of survey data indicated that personal video game use, gender, and age did not significantly influence secondary teacher attitudes towards the uptake of video game technology within their classrooms. In contrast to this, it was found that external support for video game use (from

parents, school administration, colleagues and students), and the frequency of video game use within their own pedagogy, significantly influenced teacher attitudes towards the use of video games. Survey data further indicated that teachers are rarely offered opportunities for professional development, yet the majority of teachers were interested in attending video game-related professional development.

Factors that influence teacher uptake of video games

The two factors that were found to significantly influence teacher attitudes towards the use of video games in the classroom were the level of external support for video games, and the frequency of teacher video game use in their own teaching practice. Regression analysis found that teacher video game use within their teaching practice was found to be significantly negatively related to their attitude towards the use of video games in the classroom. This means that the more often teachers used video games within their teaching, the more negative their attitudes towards the use of video games in the classroom. While there is little research related to teacher attitudes and frequency of use specific to video games, existing research concerning teacher ICT (Information and Communication Technology) use reports that positive teacher attitudes towards ICT is a predictor of more frequent use in the classroom (Drossel et al., 2017). Further research that is specific to video game use, rather than technology is needed. Research concerning the frequency of teacher video game use and teacher attitudes towards video game use in the classroom would be beneficial to explore why teachers who use video games frequently have less positive attitudes towards the use of video games in the classroom.

Regression analysis further found that gender did not significantly influence teacher attitudes to video game use. Survey results also indicated that, although not significant, female teachers were moderately more likely to express increased interest and self-efficacy in

implementing video games in their teaching, as well as being more likely to believe that video games teach real-world skills. These findings are interesting, as although almost 50% of gamers are female, culturally video games are still perceived as more aligned to masculine skills and interests (Lopez-Fernandez et al., 2019). Despite this, the indication that gender does not significantly influence teacher attitudes to video game use in the classroom is supported by research in the educational video game field. Sánchez-Mena et al. (2019) reported that teacher gender and age did not influence their attitude and behavioural intentions towards the use of educational video games in the classroom, and further suggested that teachers report different attitudes and intentions towards the use of video games for teaching material compared to their use as a leisure time activity. This is supported by the findings of the present investigation in which regression analysis found that personal video game use and age also did not significantly influence teacher attitudes towards the use of video games in the classroom. These findings indicate that teachers consider video games as valid educational resources, outside the influence of their gender, age, or personal preference for video game use. It is clear, however, that the use of video games in the classroom should be supported through training, administration, and professional development, similar to any other pedagogical intervention.

Teacher attitudes and implementation of video games in the classroom were measured by only a quarter of papers retained within the systematic review. This is significant, as teacher perception of video games within education is essential for the successful implementation within the classroom (Clark et al., 2018). Survey responses indicated that teacher interest in video game use is high, and that teachers are experimenting with video games in the classroom. Despite this, questions regarding the frequency of video game use show that teachers are not using video games regularly, possibly indicating that video games might be more of a novelty than a regular part of classroom teaching. Despite reports of

teacher interest in the use of video games in the classroom in both this survey and in wider research (An et al., 2018; Takeuchi & Vaala, 2013), successful ongoing implementation of video games requires further research in regard to teacher experiences and perceptions of video game implementation in the classroom. Considering the importance of teacher buy-in and attitudes towards video games to the importance of their effectiveness in the classroom, more focus on teacher implementation and practice would be beneficial for the field of video game education research.

Video game based curricula

An additional theme that emerged from the systematic review was the inclusion of video game based curricula in some of the studies retained. Video game based curricula was defined as the presence of teaching and learning activities outside of the video game itself, such as additional lessons, activities, or media designed to be presented to students alongside the video game intervention. Video game based curricula was described in 16% of the retained studies within the systematic review. The low number of papers that discussed the wider teaching and learning activities that surrounded video game use within the classroom may have implications for the field of research, as the broader context of gameplay impacts on the effectiveness of the implementation (Young et al., 2012). As noted by Young et al. (2012) within their systematic review, consideration of the complex interaction between player, game, and context (including the context of the video game within a specific curriculum) is essential to understanding the way in which this impacts the learning process. Researching the implementation of video games individually, without looking at the wider context of teaching and learning, does not adequately encompass the realities of the classroom.

Classroom context of video game implementation, the content and delivery methods of supplementary non-video game instruction is only described in passing by few papers retained by the review. The learning activities undertaken alongside video game interventions are often not specified within research papers, which is significant as these activities have the potential to impact the learning outcomes (Sitzmann, 2011; Wouters et al., 2013). It has also been noted in the research field that the interaction of students with informal websites or gaming communities (such as modding pages, wiki pages, or voice-chat and streaming communities) in addition to video game use in the classroom can have positive learning outcomes (Clark et al., 2014; Steinkuehler & Duncan, 2008; Gee, 2007), but these are rarely included in reviews of the research. No papers were identified within the review that addressed these learning activities surrounding the use of video games in the classroom. More research regarding the context of video game learning, including explicit discussion of the non-game instruction surrounding the implementation of games, will improve the overall understanding of this area.

Teacher professional development

The inclusion of professional development alongside video game research highlights an issue of possible bias within the field of research. Teacher professional development was a theme that emerged from the systematic review, with 21% of papers describing professional development as part of the intervention. Teachers within these papers had attended, or been provided with, professional development as part of the interventions described. Further to this, three studies recruited teachers for research through their attendance at professional development workshops (Ault et al., 2015; Chee et al., 2015; Wallon et al., 2018). Selecting research participants from teachers who have already chosen to attend video game related professional development courses will result in a sample that is already interested in, and potentially biased towards, video game based education practices. Furthermore, if research is

only conducted with teachers who have already attended professional development, the research may be reflecting practices that are not generalisable to the wider teaching profession. This is especially relevant when considered alongside the survey results regarding teacher professional development interest and experiences.

Within the survey sample, the majority of teachers indicated that they were very interested in attending professional development related to video games, with 22% of teachers who had not attended video game related professional development indicating that they would 'probably' be interested in attending, and 54% indicating they would 'definitely' be interested. Despite this, the majority (80%) of respondents reported having never attended video game related courses. Most of the surveyed teachers described having learned about using video games through figuring it out themselves, through other teachers, or using online sources. These responses indicate a gap in the provision of relevant, in-depth teacher learning programs for the use of video games for education, and the inability of teachers being able to access information about video games that is useful and meaningful in their teaching contexts. This is supported by wider research, with a literature review conducted by Meredith (2016) finding that more video game based professional development was necessary if it was to be adopted into regular classroom practice. Bourgonjon et al. (2013), for example, reported findings that indicated game based learning is not just adopted by teachers who play video games in their spare time. Rather, video game implementation requires supporting teachers in understanding the application of games to their curriculum requirements in different knowledge domains. Professional development regarding the use of video games in the classroom could address this need.

External support for video games in classrooms

Lack of support from school leadership, colleagues, parents, and students was generally not viewed as a barrier to the implementation of video games, with moderately high levels of support perceived from external sources within the survey results. In addition to this, results of the regression analysis indicated that external support for video game use significantly influenced positive teacher attitudes towards the use of video games within the classroom. These findings are noteworthy, and are supported by existing research in the field of video games and education. Negative perceptions of the use of video games in the classroom from teachers and school administration have been previously reported as an obstacle to the diffusion of educational games in schools (Justice & Ritzhaupt; 2015; Ketamo et al., 2013). Recently, Kaimara et al. (2021) reported that preservice teachers described the scepticism of teacher colleagues towards the use of video games for education as the second most commonly perceived barrier to the implementation of video games in the classroom.

Despite other studies finding lack of external support being a common experience for teachers elsewhere, becoming barriers to video game implementation in schools, the present investigation found that Australian teachers are more optimistic regarding the support received from parents, school administration, and other teachers than their international counterparts. This in turn is related to more positive attitudes in the willingness to use video games in classrooms in Australia. Beavis et al. (2014) found that teachers did not perceive parents' attitudes towards video games in the classroom as a barrier, and that they were confident in their ability to 'sell' the benefits games to others outside of their classroom. While there is limited research in the Australian context, the findings of the survey support this higher level of optimism regarding the external support for the use of video games in the classroom. This may be due to the already wide-spread adoption of technology in Australian classrooms (Vassallo & Warren, 2018), or wider support of video game use amongst

education communities in Australia. Further research regarding external support for teachers using video games for education is vital to explore and understand the impact of this on the use of video games within the classroom. Further research on the reason that Australian teachers feel that they receive positive external support for the use of video games in the classroom is essential to the field of video game and education research, and may have significant implications for supporting teachers in video game pedagogical practice internationally.

Research question 4: What are secondary teachers' perceptions of the benefits, limitations, and barriers to the implementation of video games within Australian secondary classrooms?

The fourth research question asked about secondary teacher's perceptions of the benefits, limitations, and barriers to the implementation of video games within Australian secondary classrooms. Survey results indicated that Australian teachers held strong beliefs regarding the benefits of video games in the classroom, with most teachers expressing that video games can enhance interest and engagement in the classroom, help teach real-world skills, and that they are supported by the wider community of parents, colleagues, and school leaders. Despite the strong belief in the benefits of video games, survey respondents also reported that limitations of the use of video games in the classroom included their ability to teach social skills, to assist with standards-aligned assessments, and assessing curriculum knowledge. Reported barriers to the implementation of games in the classroom included a lack of technological resources, difficulties in identifying games that fit with the curriculum, cost, insufficient time, and not being sure where to find quality games.

Teacher subject area and uptake of video game technology

A surprising finding of the survey was the interplay of the main teaching area of respondents and their attitudes towards video game use in the classroom. Results indicated that English teachers were more likely to hold negative opinions regarding the educational benefits of games, whereas Physical Education teachers held more positive opinions about their own self-efficacy, the benefits of video games, and the potential for video games to foster real world skills. The combination of video games and Physical Education is an emerging trend in the field of research, with evidence supporting the use of video games to encourage physical activity (Merino-Campos & del Castillo Fernández, 2016; Papastergiou, 2009). Young et al. (2012) found in their systematic review that video games in physical education have a "net positive effect on students' motivations toward PE and exercise" (p.77) although there is currently insufficient empirical evidence to draw causal connections between gaming and physical education.

A further finding from the survey data regarding teacher subject area and attitudes towards video games in education was that Technology teachers were more likely to hold negative opinions regarding their interest in using video games in the classroom. Technology teachers were found to hold negative opinions to close to moderate effect on the Teacher Interest and Self-Efficacy subscale, which consists of survey items relating to interest, confidence, knowledge, and skills relating to video games in the classroom. Teacher beliefs often do not align with their teaching practices, particularly in relation to technology (Chee & Tan, 2012; Ertmer et al., 2012). This could indicate that there is a complex interplay between teacher beliefs in relation to video games in the classroom, and their use of video game technology within their particular subject. Further research in that considers teacher subject area, attitudes towards the use of video games, and their use of video games in the classroom would be beneficial in this area. Further research regarding specific subjects being taught in

relation to teacher uses and attitudes towards video games would be beneficial. Research has been undertaken in this area in relation to Science teachers (An et al., 2016) but this could be extended to other subjects, specifically Technology, in order to further explore the implications of this data.

Implications and recommendations

The realm of video game based learning is incredibly complex. The interplay between game elements, learning contexts, teacher aptitudes and pedagogy, student preferences and skill-level, and classroom environment all influence the way in which a video game is implemented and received within the classroom. Research that considers video game learning in secondary classroom settings has so far been inconclusive and disjointed, being at once too specific to certain games and singular learning outcomes, and at the same time not specific enough to classroom contexts and teacher realities. It is important that future research in this area considers the different elements that operate both within video games, and within the classroom that they are being implemented in.

In their seminal review of trends in serious gaming for education, Young et al. urged researchers in the field of video game research to "stop seeking simple answers that address the wrong question" (2012, p.84). They proposed that, instead of asking whether video games enhance academic achievement, scholars in the field should focus on the interaction of player, game, and context, and ask the question; "How does a particular video game being used by a particular student in the context of a particular course curriculum affect the learning process as well as the products of school (such as test grades, course selection, retention, and interest)?" (Young et al, 2012, p.84). Nine years on from this recommendation, there is still a dearth of research that addresses this need. Few papers were identified in the systematic review that considered the wider context of video game application. Research that addresses

one or two simple variables cannot address the larger considerations of the ways in which video games are used, or how they interact with classroom contexts.

Therefore, it is a recommendation of this study that future research on the topic of video games for learning considers the social, cultural and economic factors that influence video game implementation in the classroom, and attitudes towards video games for both students and teachers. Furthermore, research that considers how certain subsections of school populations may be more likely to benefit from video game based learning than others is missing in the current field of research. It is my belief that the current state of education and video game research in Australia, and the limited amount of research currently being published in this context, is an opportunity to address the weaknesses in the larger research field.

The results of this study have key methodological implications for the field of video game and educational research. The results of the systematic review indicate that the current body of research regarding video games and education is primarily concerned with short-term interventions of specific video games, and often does not take into consideration the wider context of teacher aptitudes and implementation, classroom environment, or wider teaching activities. Games are often only researched once, and the field of research (particularly in the Australian context) does not represent the games that are currently being used in classroom practice. The research field would be improved by research that speaks to already existing reviews and research, through building on frameworks already developed (such as All et al., 2018; Clark et al., 2012), and the creation of a database of open-source educational video game software that categorises existing games for further research.

Young et al. (2012) recommend the creation of a video game database to store open-source copies of all non-commercially available researched games, so that other researchers

could cross-check validity and further develop and test hypothesis about particular game attributes. Open-source software could aid in preventing the waste of resources in game creation for specific implementation purposes, as many games (particularly related to science and mathematics) are special purpose implementations of game mechanics for specific curriculum content. While the creation of a video game database may have seemed overly optimistic at the time of Young et al.'s recommendation, the increasing support for video games in education and the proliferation of online resources may mean that this could be closer to becoming a reality. A database of this kind would go a long way towards addressing issues of validity and usefulness in the educational video game research field.

The methodological implications for educational video game research within an Australian context are considerable. Research that is conducted in an Australian context is currently limited, and primarily qualitative. There is a significant and pressing need for empirical research that considers the current uses of video games in Australian classrooms, and the teacher attitudes, perceptions, and influencing factors of video game use for education. The literature reviewed and survey results show that factors that could influence teacher include teacher age and experience, gender, and main subject area taught, but this is not settled. Research that further accounts for these factors would significantly improve our current understanding of the implications of the use of video games in secondary schools. Research should address the games that are currently being played in classrooms, rather than new games that are being developed, and should be in-depth and detailed regarding demographic information and video game characteristics, so that it is replicable and valid in its contribution to the research field.

Furthermore, there are practical implications to be taken from the findings reported in this thesis. There is considerable need for meaningful and practical professional development in relation to the use of video games in the classroom. Survey results show that teacher

beliefs regarding the educational benefits of video games are positive. It is important that teachers are supported in their interest and intent to use video games in their classrooms, and increased availability of professional development related to video games will be beneficial for both teachers and students. The interest reported in the survey regarding professional development, and the fact that teachers are "figuring it out themselves" or learning from online sources shows that there is a gap in video game use and training in the best ways to implement video games in the classroom. This is a significant gap that could be addressed by academics within the Australian educational video game field in conjunction with the Australian video game industry, through the development of professional development programs that are tailored to the needs of Australian teachers and their interest and use of video games within secondary classrooms.

Limitations and delimitations

The conduct of this research was limited by the 12-month timeframe, during which the impacts of the COVID-19 pandemic were being felt. Due to this, data collection was limited to online only methods, and recruiting teachers for survey participation was complicated by increased workloads and uncertainty due to online teaching and ongoing school closures.

For the survey, many of the limitations centre on the respondents. As survey recruitment was conducted online through social media, it can be assumed that teacher respondents have a familiarity with, and are comfortable using technology. This may have resulted in a sample in which more technologically literate teachers are oversampled. With the current study, it is uncertain the direction of this bias, as it was found that Technology teachers held more negative views towards the use of video games in the classroom. This

means that the survey results may well underestimate the magnitude of teacher positive attitudes towards video games, although this cannot be known for certain.

The age range of participants may have skewed survey results, as 40% of respondents were aged between 21 and 30 years old. The method of social media recruitment may have resulted in oversampling of early career teachers. A further limitation of survey participants was the geographic location of the sample, which greatly favoured New South Wales and Victoria. This was despite attempts to promote the survey in other geographic social media pages.

The systematic review was limited by the search terms used, the databases included and the time period of the review. A further limitation was that the demographic information provided in articles retained for the review was inconsistent and made generalisation difficult, which is something that needs to be addressed by future researchers. Comparison of control group conditions was outside of the scope of this study, but would be beneficial to understanding the field of research. Control group conditions varied amongst the studies retained by the systematic review, from pen and paper conditions to different games played, to the same game with enhanced features, to no educational intervention at all. This is an area for further investigation.

While the survey conducted in this study produced interesting preliminary results, further survey research with a larger sample size would enable greater generalisability of the findings. In addition to this, research that uses interview or focus group methods to gather deeper contextual data to pair with the survey results would be beneficial to the overall field of video game based pedagogy within an Australian secondary context, in order to gain a more thorough and contextualised understanding of the experiences and attitudes of Australian teachers.

Conclusion

This thesis makes a novel contribution to the area of video games and education, particularly in the Australian context. Overall, the findings indicate that video games are used by the majority of Australian teachers in their classroom pedagogy, but the current field of research concerning video games and education does not reflect this practice. The data generated by this thesis, and the analysis conducted, has highlighted the importance of understanding teacher use of video games within secondary classrooms, and the benefits, limitations, and barriers experienced by teachers when using video games in their pedagogy. The findings of this thesis have also identified many areas of further research, particularly in the ongoing construction of the body of research surrounding games that are currently being used in the classroom. Finally, this thesis has identified opportunities for building on the limited research within an Australian context, which means this scoping study can contribute to building a comprehensive body of research that accounts for teacher attitudes and uses of video games within Australian secondary classrooms.

References

Aarseth, E. (1997). *Cybertext: Perspectives on ergodic literature.* Johns Hopkins University Press.

Abdul Jabbar, A. I., & Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. *Review of Educational Research*, *85*(4), 740–779. https://doi.org/10.3102/0034654315577210

Akoglu H. (2018). User's guide to correlation coefficients. *Turkish journal of emergency medicine*, *18*(3), 91–93. https://doi.org/10.1016/j.tjem.2018.08.001

Alexander, P. A. (2020). Methodological guidance paper: The art and science of quality systematic reviews. *Review of Educational Research*, *90*(1), 6–23. doi: 10.3102/0034654319854352

Alfieri, L., Higashi, R., Shoop, R., & Schunn, C. D. (2015). Case studies of a robot-based game to shape interests and hone proportional reasoning skills. *International Journal of STEM Education*, *2*(2015), 1–13. Social Science Premium Collection. https://doi.org/10.1186/s40594-015-0017-9

All, A., Nunez Castellar, E., & Van Looy, J. (2014). Measuring effectiveness in digital game-based learning: A methodological review. *International Journal of Serious Games*, *1*(2), 236–244. doi:10.17083/ijsg.v1i2.18

All, A., Nuñez Castellar, E., & Van Looy, J. (2016). Assessing the effectiveness of digital game-based learning: Best practices. *Computers & Education*, *92-93*(2016), 90–103. doi: 10.1016/j.compedu.2015.10.007

An, Y-J. (2018). The effects of an online professional development course on teachers' perceptions, attitudes, self-efficacy, and behavioral intentions regarding digital game-based learning. *Educational Technology Research and Development: A Bi-Monthly*

Publication of the Association for Educational Communications & Technology, *66*(6), 1505–1527. doi:10.1007/s11423-018-9620-z

An, Y-J., Haynes, L., D'Alba, A., & Chumney, F. (2016). Using educational computer games in the classroom: Science teachers' experiences, attitudes, perceptions, concerns, and support needs. *Contemporary Issues in Technology and Teacher Education, 16*(4), 415–433.

Anderson, J. L., & Barnett, M. (2013). Learning physics with digital game simulations in middle school science. *Journal of Science Education and Technology*, *22*(6), 914–926. https://doi.org/10.1007/s10956-013-9438-8

Arjoranta, J. (2019). How to define games and why we need to. *The Computer Games Journal*, 8(3), 109–120.

Ault, M., Craig-Hare, J., Frey, B., Ellis, J. D., & Bulgren, J. (2015). The effectiveness of reason racer, a game designed to engage middle school students in scientific argumentation. *Journal of Research on Technology in Education*, *47*(1), 21–40. https://doi.org/10.1080/15391523.2015.967542

Australian Curriculum, Assessment and Reporting Authority. (2020). *National report on schooling in Australia, thirtieth edition.* https://www.acara.edu.au/docs/default-source/default-document-library/national-report-on-schooling-in-australia-2018.pdf?sfvrsn=e3cc7007_0

Bacalja, A. (2019). What videogames have to teach us (still) about subject English. *English in Australia*, *53*(3), 51–63.

Backlund, P., & Hendrix, M. (2013). Educational games - Are they worth the effort? A literature survey of the effectiveness of serious games. *2013 5th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)*, (1-

8). https://ieeexplore-ieee-org.ezproxy.uws.edu.au/stamp/stamp.jsp?tp=&arnumber=6624226

Bal, M. (2019). Use of digital games in writing education: An action research on gamification. *Contemporary Educational Technology*, *10*(3), 246–271. https://doi.org/10.30935/cet.590005

Bateman, C. (2015). Implicit game aesthetics. *Games and Culture*, *10*(4), 389–411. doi:10.1177/1555412014560607

Bavelier, D., Green, C., Han, D., Renshaw, P. F., Merzenich, M. M., & Gentile, D. A. (2011). Brains on video games. *Nature Reviews Neuroscience*, *12*(12), 763–768.

Beavis, C. Dezuanni, M., & O'Mara, J. (2017). *Serious play: Literacy, learning and digital games*. Taylor & Francis.

Beavis, C., Griffith, L. R., Dezuanni, M., Mcgillivra, C., O'Mara, J., Prestridge, S., Stieler-Hunt, C., Thompson, R., & Zagami, J. (2014). Teachers' beliefs about the possibilities and limitations of digital games in classrooms. *E-Learning and Digital Media*, *11*(6), 569–579. doi:10.2304/elea.2014.11.6.569

Beavis, C., Muspratt, S., & Thompson, R. (2014). 'Computer games can get your brain working': Student experience and perceptions of digital games in the classroom. *Learning, Media and Technology*, *40*(1), 21–42. doi:10.1080/17439884.2014.904339

Bergonse, R. (2017). Fifty years on, what exactly is a videogame? An essentialistic definitional approach. *The Computer Games Journal*, *6*(4), 239–255. https://doi-org.ezproxy.uws.edu.au/10.1007/s40869-017-0045-4.

Bethesda Game Studios. (2011). The Elder Scrolls V: Skyrim. Bethesda Softworks.

Bourgonjon, J., De Grove, F., De Smet, C., Van Looy, J., Soetaert, R., & Valcke, M. (2013).

Acceptance of game-based learning by secondary school teachers. *Computers & Education*, *67*(2013), 21–35.

Bower, M., & Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers and Education*, *88*, 343–353. https://doi.org/10.1016/j.compedu.2015.07.013

Bowling, K. G., Miller, L. M., Patel, R., & Bass, K. M. (2017). Impacts of virtual clinical trials simulations on science knowledge and attitudes. *Electronic Journal of Science Education*, *21*(7), 1–19.

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Lim, T., Ninaus, M., Ribeiro, C., Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, *94*(2016), 178–192. doi:10.1016/j.compedu.2015.11.003

Brand, J. E., Jervis, J., Huggins, P. M., & Wilson, T. W. (2019). *Digital Australia 2020*. IGEA. https://www.igea.net/wp-content/uploads/2015/07/Digital-Australia-2016-DA16-Final.pdf

Carissoli, C., & Villani, D. (2019). Can videogames be used to promote emotional intelligence in teenagers? Results from EmotivaMente, a school program. *Games for Health Journal*, *8*(6), 407–413. https://doi.org/10.1089/g4h.2018.0148

Carter, L., Robinson, L., Gartry, L., & Palmer, A. (2021, May 3). Hooked. *Australian Broadcasting Corporation*. https://www.abc.net.au/news/2021-05-03/video-games-you-play-are-using-sneaky-tactics-four-corners/100098826

Chang, C. Y., & Hwang, G. J. (2019). Trends in digital game-based learning in the mobile era: a systematic review of journal publications from 2007 to 2016. *International*

Journal of Mobile Learning and Organisation, *13*(1), 68–78. doi:10.1504/IJMLO.2019.096468

Checa-Romero, M., & Pascual Gómez, I. (2018). Minecraft and machinima in action: Development of creativity in the classroom. *Technology, Pedagogy and Education*, *27*(5), 625–637. https://doi.org/10.1080/1475939X.2018.1537933

Chee, Y. S., Mehrotra, S., & Liu, Q. (2013). Effective game based citizenship education in the age of new media. *Electronic Journal of E-Learning*, *11*(1), 16–28.

Chee, Y. S., Mehrotra, S., & Ong, J. C. (2015). Authentic game-based learning and teachers' dilemmas in reconstructing professional practice. *Learning, Media and Technology*, *40*(4), 514–535. https://doi.org/10.1080/17439884.2014.953958

Clark, D. B., Tanner-Smith, E., Hostetler, A., Fradkin, A., & Polikov, V. (2018). Substantial integration of typical educational games into extended curricula. *Journal of the Learning Sciences*, *27*(2), 265–318.

Clark, D., Nelson, B., Sengupta, P., & D'Angelo, C. (2009, October). *Rethinking science learning through digital games and simulations: Genres, examples, and evidence*. Paper presented at the Learning science: Computer games, simulations, and education workshop sponsored by the National Academy of Sciences, Washington, DC.

Clark, D., Tanner-Smith, E., & Killingsworth, S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, *86*(1), 79–122. doi: 10.3102/0034654315582065

Clark, D., Tanner-Smith, E., Killingsworth, S. (2014). *Digital games, design and learning: a systematic review and meta-analysis (Executive summary).* SRI International.

Commonwealth of Australia. (2016). *Game on: More than playing around. The future of Australia's video game development industry.* Senate Standing Committees on

Environment and Communications. https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Video_game_industry/Report

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers and Education*, 59(2), 661–686.

Crawford, C. (1983). *The art of computer game design*. Osborne/McGraw-Hill.

Cronbach, L. J., & Shavelson, R. J. (2004). My current thoughts on coefficient alpha and successor procedures. *Educational and Psychological Measurement*, *64*(3), 391–418. https://doi.org/10.1177/0013164404266386

Culp, K. M., Martin, W., Clements, M., & Presser, A. (2015). Testing the impact of a pre-instructional digital game on middle-grade students' understanding of photosynthesis. *Technology, Knowledge and Learning*, *20*(1), 5–26. https://doi.org/10.1007/s10758-014-9233-5

Davies, C. (1996). *What is English teaching?* Open University Press.

Department of Health. (2021, June). *Coronavirus (COVID-19) at a glance infographic collection*. Commonwealth of Australia. https://www.health.gov.au/resources/collections/coronavirus-covid-19-at-a-glance-infographic-collection

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." In A. Lugmayr, H. Franssila, C. Safran, & I. Hammouda (Eds.), *MindTrek 2011* (pp. 9–15). doi: 10.1145/2181037.2181040

Dontnod Entertainment & Deck Nine. (2015). Life is Strange [PC video game]. Square Enix.

Drossel, K., Eickelmann, B., & Gerick, J. (2017). Predictors of teachers' use of ICT in school – the relevance of school characteristics, teachers' attitudes and teacher collaboration. *Education and Information Technologies*, *22*(2017), 551–573.

Ellis, P. (2010). *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results*. Cambridge University Press.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, *59*(2), 423–435.

Eseryel, D., Ge, X., Ifenthaler, D., & Law, V. (2011). Dynamic modeling as a cognitive regulation scaffold for developing complex problem-solving skills in an educational massively multiplayer online game environment. *Journal of Educational Computing Research*, *45*(3), 265–286.

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., & Miller, R. (2014). An investigation of the interrelationships between motivation, engagement, and complex problem solving in game-based learning. *Educational Technology & Society*, *17*(1), 42–53.

Evans, M. A., Nino, M., Deater-Deckard, K., & Chang, M. (2015). School-wide adoption of a mathematics learning game in a middle school setting: Using the TPACK framework to analyze effects on practice. *Asia-Pacific Education Researcher*, *24*(3), 495–504. https://doi.org/10.1007/s40299-014-0225-y

Ferguson, C. J., & Heene, M. (2012). A vast graveyard of undead theories: Publication bias and psychological science's aversion to the null. *Perspectives on Psychological Science*, *7*(6), 555–561.

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage Publications.

Foster, A., & Shah, M. (2015). The play curricular activity reflection discussion model for

game-based learning. *Journal of Research on Technology in Education*, *47*(2), 71–88. https://doi.org/10.1080/15391523.2015.967551

Fowler, F. J. (2014). *Survey research methods (5th ed.)*. Sage Publications.

Fox, J. (2002). *Applied regression analysis and generalized linear models* (3rd ed.). Sage Publications.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation and Gaming*, *33*(4) 441–467. doi: 10.1177/1046878102238607

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave Macmillan.

Gee, J. P. (2007). Good video games and good learning. *Phi Kappa Phi Forum*, *85*(2), 33–41.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference.* (11.0 update; 4th ed.). Allyn & Bacon.

Gerber, H. R., & Price, D. P. (2013). Fighting baddies and collecting bananas: Teachers' perceptions of games-based literacy learning. *Educational Media International*, *50*(1), 51–62.

Gerber, H. R., Abrams, S. S., Onwuegbuzie, A. J., & Benge, C. L. (2014). From Mario to FIFA: What qualitative case study research suggests about games-based learning in a US classroom. *Educational Media International*, *51*(1), 16–34. https://doi.org/10.1080/09523987.2014.889402

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted*

Learning, *29*(3), 207–219. doi:10.1111/j.1365-2729.2012.00489.x

Goodwyn, A. (1992). English teachers and the Cox models, *English in Education*, *28*(3), 4–10.

Goselin, A. (2018, December 11). *The 2018 League of Legends World Finals had nearly 100 million viewers*. Rift Herald. https://www.riftherald.com/2018/12/11/18136237/riot-2018-league-of-legends-world-finals-viewers-prize-pool

Hanghøj, T., & Brund, C. E. (2011). Teacher roles and positioning in relation to educational games. In S. Egenfeldt-Nielson, B. Meyer, & B. H. Sorenson (Eds.), *Serious Games in Education*. (pp. 125–136). Aarhus University Press.

Hanghøj, T., Lieberoth, A., & Misfeldt, M. (2018). Can cooperative video games encourage social and motivational inclusion of at-risk students? *British Journal of Educational Technology*, *49*(4), 775–799. https://doi.org/10.1111/bjet.12642

Hayes, E., & Ohrnberger, M. (2013). The gamer generation teaches school: The gaming practices and attitudes towards technology of pre-service teachers. *Journal of Technology and Teacher Education*, *21*(2), 154–177.

Hsiao, H.-S., Tsai, F.-H., & Hsu, I.-Y. (2020). Development and evaluation of a computer detective game for microbial food safety education. *Journal of Educational Computing Research*, *58*(6), 1144–1160. https://doi.org/10.1177/0735633120924924

Jackson, G. T., & McNamara, D. S. (2013). Motivation and performance in a game-based intelligent tutoring system. *Journal of Educational Psychology*, *105*(4), 1036–1049. https://doi.org/10.1037/a0032580

Jang, S.-J. & Tsai, M.-F. (2013). Exploring the TPACK of Taiwanese secondary school science teachers using a new contextualized TPACK model. *Australasian Journal of Educational Technology*, *29*(4). https://doi.org/10.14742/ajet.282

Johnson, C. (2017). Learning basic programming concepts with game maker. *International Journal of Computer Science Education in Schools*, *1*(2), 1–20.

Justice, L. J., & Ritzhaupt, A. D. (2015). Identifying the barriers to games and simulations in education: Creating a valid and reliable survey. *Journal of Educational Technology Systems*, *44*(1), 86–125. doi:10.1177/0047239515588161

Juul, J. (2005). *Half-Real: Video games between real rules and fictional worlds*. MIT Press.

Kaimara, P., Fokides, E., Oikonomou, A., & Deliyannis, I. (2021). Potential barriers to the implementation of digital game-based learning in the classroom: Pre-service teachers' views. *Technology, Knowledge and Learning*, 1–20. Advance online publication. https://doi.org/10.1007/s10758-021-09512-7

Kangas, M., Koskinen, A., & Krokfors, L. (2017). A qualitative literature review of educational games in the classroom: the teacher's pedagogical activities. *Teachers and Teaching*, *23*(4), 451–470. doi: 10.1080/13540602.2016.1206523

Karsenti, T., & Parent, S. (2020). Teaching history with the video game Assassin's Creed: Effective teaching practices and reported learning. *Review of Science Mathematics & ICT Education*, *14*(1), 27–45.

Ke, F. (2009). A qualitative meta-analysis of computer games as learning tools. In R.E. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (pp. 1–31). IGI Global.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers and Education*, *55*(2), 427–443. https://doi.org/10.1016/j.compedu.2010.02.007

Ketamo, H., Kiili, K., Arnab, S., & Dunwell, I. (2013). Integrating games into the classroom: Towards new teachership. In S. Freitas, M. Ott, M. M. Popescu, & I. Stanescu (Eds.),

New pedagogical approaches in game enhanced learning: Curriculum interaction (pp. 114–135). IGI Global. doi:10.4018/978-1-4666-3950-8.ch007

Khan, A., Ahmad, F. H., & Malik, M. M. (2017). Use of digital game based learning and gamification in secondary school science: The effect on student engagement, learning and gender difference. *Education and Information Technologies*, *22*(6), 2767–2804. https://doi.org/10.1007/s10639-017-9622-1

Kilic, E., & Yildirim, Z. (2012). Cognitive load and goal based scenario centred 3D multimedia learning environment: Learners' motivation, satisfaction and mental effort. *Journal of Educational Computing Research*, *47*(3), 329–349. https://doi.org/10.2190/EC.47.3.e

Killingsworth, S. S., Clark, D. B., & Adams, D. M. (2015) Self-explanation and explanatory feedback in games: Individual differences, gameplay, and learning. *International Journal of Education in Mathematics, Science and Technology*, *3*(3), 162–186.

Kim, Y. J., & Pavlov, O. (2019). Game-based structural debriefing: How can teachers design game-based curricula for systems thinking? *Information and Learning Science*, *120*(9–10), 567–588. https://doi.org/10.1108/ILS-05-2019-0039

Koops, M., & Hoevenaar, M. (2013). Conceptual change during a serious game: Using a lemniscate model to compare strategies in a physics game. *Simulation and Gaming*, *44*(4), 544–561. https://doi.org/10.1177/1046878112459261

Landers, R. N., Auer, E. M., Collmus, A. B., & Armstrong, M. B. (2018). Gamification science, its history and future: definitions and a research agenda. *Simulation & Gaming*, *49*(3), 315–337. https://doi.org/10.1177/1046878118774385

Lee, J. H., Karlova, N., Clarke, R. I., Thornton, K., & Perti, A. (2014). Facet analysis of video game genres. *iConference 2014 Proceedings*, 125–139. https://doi.org/10.9776/14057

Linden Lab. (2003). Second Life [PC video game]. Linden Lab.

Long, Y., & Aleven, V. (2017). Educational game and intelligent tutoring system. *ACM Transactions on Computer-Human Interaction*, *24*(3), 1–27.

Lopez-Fernandez, O., Williams, A. J., Griffiths, M. D., & Kuss, D. J. (2019). Female gaming, gaming addiction, and the role of women within gaming culture: A narrative literature review. *Frontiers in Psychiatry*, *10*(454). doi:10.3389/fpsyt.2019.00454

Majumdar, D., Koch, P. A., Lee, H., Contento, I. R., Islas-Ramos, A. D. L., & Fu, D. (2013). 'Creature-101': A serious game to promote energy balance-related behaviors among middle school adolescents. *Games for Health Journal*, *2*(5), 280–290. https://doi.org/10.1089/g4h.2013.0045

Marklund, B. B., & Taylor, A.-S. A. (2016). Educational games in practice: The challenges involved in conducting a game-based curriculum. *Electronic Journal of E-Learning*, *14*(2), 122–135.

Mearls, M., & Crawford, J. (2014). *Dungeons & dragons player's handbook*. Renton, WA: Wizards of the Coast.

Meredith, T. R. (2016). Game-based learning in professional development for practicing educators: A review of the literature. *TechTrends*, *60*(5), 496–502. doi:10.1007/s11528-016-0107-7

Merino-Campos, C., del Castillo Fernández, H. (2016). The benefits of active video games for educational and physical activity approaches: A systematic review. *Journal of New Approaches in Educational Research*, *5*(2), 115–122.

Mills, C., Australia, F., & Dalgarno, B. (2007). A conceptual model for game based intelligent tutoring systems. *ASCILITE 2007 - The Australasian Society for Computers in Learning in Tertiary Education*, 692–702.

Mills, K., Ketelhut, D., & Gong, X. (2019). Change of teacher beliefs, but not practices, following integration of immersive virtual environment in the classroom. *Journal of Educational Computing Research*, *57*(7), 1786–1811. https://doi.org/10.1177/0735633119854034

Mojang Studios. (2011). Minecraft [video game]. Microsoft Studios.

Monjelat, N., Méndez, L., & Lacasa, P. (2017). Becoming a tutor: Student scaffolding in a game-based classroom. *Technology, Pedagogy and Education*, *26*(3), 265–282. https://doi.org/10.1080/1475939X.2016.1210538

National Research Council. (2011*). Learning science through computer games and simulations* (Committee on Science Learning: Computer Games, Simulations, and Education, M. A. Honey, & M. L. Hilton, Eds.). National Academies Press, Board on Science Education, Division of Behavioral and Social Sciences and Education. https://doi.org/10.17226/13078.

Naughty Dog. (2020). Last of Us II [video game]. Sony Interactive Entertainment.

Navarrete, C. C. (2013). Creative thinking in digital game design and development: A case study. *Computers and Education*, *69*, 320–331. https://doi.org/10.1016/j.compedu.2013.07.025

Nebel, S., Schneider, S., & Rey, G. D. (2016). Mining learning and crafting scientific experiments: A literature review on the use of Minecraft in education and research. *Educational Technology & Society*, *19*(2), 355–366.

Nintendo. (1989). Tetris. [video game]. Nintendo of America.

Nintendo. (2016). Pokémon Go [Mobile video game]. Niantic.

Nousiainen, T., Kangas, M., Rikala, J., & Vesisenaho, M. (2018). Teacher competencies in game-based pedagogy. *Teaching and Teacher Education*, *74*, 85–97. doi:

10.1016/j.tate.2018.04.012

Nousiainen, T., Vesisenaho, M., & Eskelinen, P. (2015). "Let's do this together and see what we can come up with!": Teachers' views on applying game-based pedagogy in meaningful ways. *eLearning Papers*, *2015*(44), 74–84. https://openeducationeuropa.eu/sites/default/files/old/The-Teacher's-Role%20in-Educational-Innovation_Issue_44.pdf

Papastergiou, M. (2009). Exploring the potential of computer and video games for health and physical education: A literature review. *Computers and Education*, *53*(3), 603–622.

Pellas, N., & Peroutseas, E. (2016). Gaming in Second Life via Scratch4SL: Engaging high school students in programming courses. *Journal of Educational Computing Research*, *54*(1), 108–143. https://doi.org/10.1177/0735633115612785

Pellas, N., Fotaris, P., Kazanidis, I., & Wells, D. (2018). Augmenting the learning experience in primary and secondary school education: a systematic review of recent trends in augmented reality game-based learning. *Virtual Reality*, *2019*(23), 329–346. doi:10.1007/s10055-018-0347-2

Perrotta, C., Featherstone, G., Aston, H. & Houghton, E. (2013). *Game-based learning: Latest evidence and future directions.* National Foundation for Educational Research. https://www.nfer.ac.uk/nfer/publications/GAME01/GAME01.pdf

Perry, J., & Klopfer, E. (2014). UbiqBio: Adoptions and outcomes of mobile biology games in the ecology of school. *Computers in the Schools*, *31*(1–2), 43–64. https://doi.org/10.1080/07380569.2014.879771

Polyphony Digital. (2004). Gran Turismo 4 [video game]. Sony Interactive Entertainment.

Poole, (2000). *Trigger happy: The inner life of video games.* Fourth Estate.

Prensky, M. (2001). *Digital game-based learning*. McGraw Hill.

Proctor, M. D., & Marks, Y. (2013). A survey of exemplar teachers' perceptions, use, and access of computer-based games and technology for classroom instruction. *Computers & Education*, *62*, 171–180. https://doi.org/10.1016/j.compedu.2012.10.022

Pusey, M., & Pusey, G. (2015). Using Minecraft in the science classroom. *International Journal of Innovation in Science and Mathematics Education*, *23*(3), 22–34.

QSR International Pty Ltd. (2018). NVivo Version 12 [PC software]. https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home

Reynolds, R., & Chiu, M. M. (2015). Reducing digital divide effects through student engagement in coordinated game design, online resource use, and social computing activities in school. *Journal of the Association for Information Science and Technology*, *67*(8), 1822–1835. https://doi.org/10.1002/asi.23504

Richards, J., Stebbins, L., & Moellering, K. (2013). Games for a digital age: K-12 market map and investment analysis. *In Joan Ganz Cooney Center at Sesame Workshop, New York*.

Riot Games. (2009). League of Legends [video game]. Riot Games and Garena.

Ritzhaupt, A., Poling, N., Frey, C. & Johnson, M. (2014). A synthesis on digital games in education: What the research literature says from 2000 to 2010. *Journal of Interactive Learning Research*, *25*(2), 261–280.

Sadler, T. D., Romine, W. L., Menon, D., Ferdig, R. E., & Annetta, L. (2015). Learning biology through innovative curricula: A comparison of game- and nongame-based approaches. *Science Education*, *99*(4), 696–720. https://doi.org/10.1002/sce.21171

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, *32*(1), 77–112. doi: 10.1007/s10648-019-09498-w

Salen, K., & Zimmerman, E. (2004). *Rules of play*. MIT Press.

Sanchez, E., Young, S., & Jouneau-Sion, C. (2017). Classcraft: From gamification to ludicization of classroom management. *Education and Information Technologies*, *22*(2), 497–513. https://doi.org/10.1007/s10639-016-9489-6

Sánchez-Mena, A., Martí-Parreño, J., & Aldás-Manzano, J. (2019). Teachers' intention to use educational video games: The moderating role of gender and age, *Innovations in Education and Teaching International*, *56*(3), 318–329, doi:10.1080/14703297.2018.1433547

Sandelowski, M. (1995). Sample size in qualitative research. *Research in Nursing & Health*, *18*(3), 179–188.

Sezer, B. (2015) Examining technopedagogical knowledge competencies of teachers in terms of some variables. *Procedia-Social and Behavioral Sciences*, *174*(2015), 208–215. https://doi.org/10.1016/j.sbspro.2015.01.648

Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, *87*(2), 104–111. https://doi.org/10.1177/003172170508700205

Shah, M., & Foster, A. (2014). Undertaking an ecological approach to advance game-based learning: A case study. *Educational Technology & Society*, *17*(1), 29–41.

Stenros, J. (2017). The game definition game: A review. *Games and Culture*, *12*(6), 1–22. https://doi-org.ezproxy.uws.edu.au/10.1177/1555412016655679

Stieler-Hunt, C., & Jones, C. M. (2015). Educators who believe: Understanding the enthusiasm of teachers who use digital games in the classroom. *Research in Learning Technology*, *23*, 1–14. https://doi.org/10.3402/rlt.v23.26155

Struppert, A. (2010). 'It's a whole new fun different way to learn.' Students' perceptions of

learning with an electronic simulation: Selected results from three case studies in an Australian, an American and a Swiss middle school. *International Journal of Learning*, *17*(9), 363–375.

Suits, B. (1967). What is a game? *Philosophy of Science*, *34*(2), 148–156.

Takeuchi, L M., & Vaala, S. (2014). Level up learning: A national survey on teaching with digital games. http://www.joanganzcooneycenter.org/wp-content/uploads/2014/10/jgcc_leveluplearning_final.pdf

Tavinor, G. (2005). Video games and interactive fiction. *Philosophy and Literature*, *29*(1), 24–40.

Tavinor, G. (2009a). *The art of videogames*. Wiley-Blackwell.

Tavinor, G. (2009b). The definition of videogames revisited. *The Philosophy of Computer Games Conference, Oslo 2009,* (2009), 1–11. https://bit.ly/3nDCkSE

Teo, T. (2008). Pre-service teachers attitudes towards computer use: a Singapore survey. *Australasian Journal of Educational Technology*, *24*(4).

TEXAS Education. (2012). Alien Rescue [PC video game]. The University of Texas at Austin.

Toomey, M., & Kitson, M. (2017). Engaging the enemy: Computer games in the English classroom. *Literacy Learning: The Middle Years*, *25*(3), 38–49.

Trochim, W. (2018). *Web center for social research methods: Types of reliability*. http://www.socialresearchmethods.net/kb/reltypes.php

Tsai, F.-H., Tsai, C.-C., & Lin, K.-Y. (2015). The evaluation of different gaming modes and feedback types on game-based formative assessment in an online learning environment. *Computers and Education*, *81*, 259–269.

https://doi.org/10.1016/j.compedu.2014.10.013

Tucker-Raymond, E., Puttick, G., Cassidy, M., Harteveld, C., & Troiano, G. M. (2019). “I broke your game!”: Critique among middle schoolers designing computer games about climate change. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-019-0194-z

Ubisoft. (2009) Just Dance [Wii video game]. Ubisoft.

Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE Review*, *41*(2), 1–16.

Vassallo, S. and Warren, D. (2018). Use of technology in the classroom. In D. Warren & G. Daraganova (Eds.), *Growing Up in Australia – The Longitudinal Study of Australian Children, Annual Statistical Report 2017*. Australian Institute of Family Studies. https://growingupinaustralia.gov.au/sites

Vygotsky, L. S. (1978). *Mind in society*. Harvard University Press.

Wallon, R. C., Jasti, C., Lauren, H. Z., & Hug, B. (2018). Implementation of a curriculum-integrated computer game for introducing scientific argumentation. *Journal of Science Education and Technology*, *27*(3), 236–247.

Whitton, N. (2009). *Learning with digital games: A practical guide to engaging students in higher education*. Routledge.

Wilson, C. D., Reichsman, F., Mutch-Jones, K., Gardner, A., Marchi, L., Kowalski, S., Lord, T., & Dorsey, C. (2018). Teacher implementation and the impact of game-based science curriculum materials. *Journal of Science Education and Technology*, *27*(4), 285–305. https://doi.org/10.1007/s10956-017-9724-y

Wilson, S. N., Engler, C. E., Black, J. E., Yager-Elorriaga, D. K., Thompson, W. M., McConnell, A., Cecena, J. E., Ralston, R., & Terry, R. A. (2017). Game-based

learning and information literacy: a randomized controlled trial to determine the efficacy of two information literacy learning experiences. *International Journal of Game-Based Learning*, *7*(4), 1–21. https://doi.org/10.4018/IJGBL.2017100101

Wittgenstein, L. (1968). *Philosophical investigations: The German text, with a revised English translation* (3rd ed.). Blackwell.

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, *105*(2), 249–265. https://doi.org/10.1037/a0031311.

Yang, Y.-T. C. (2012). Building virtual cities, inspiring intelligent citizens: Digital games for developing students' problem solving and learning motivation. *Computers & Education*, *59*(2), 365–377. https://doi.org/10.1016/j.compedu.2012.01.012

Yang, Y.-T. C. (2015). Virtual CEOs: A blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students. *Computers and Education*, *81*, 281–295. https://doi.org/10.1016/j.compedu.2014.10.004

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M. & 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. doi: 10.3102/0034654312436980

Zuiker, S. J., & Anderson, K. T. (2019). Fostering peer dialogic engagement in science classrooms with an educational videogame. *Research in Science Education*. 1–24. https://doi.org/10.1007/s11165-019-9842-z

Appendix A

Articles Retained for Systematic Review

Alfieri, L., Higashi, R., Shoop, R., & Schunn, C. D. (2015). Case studies of a robot-based game to shape interests and hone proportional reasoning skills. *International Journal of STEM Education*, *2*(2015), 1–13. Social Science Premium Collection. https://doi.org/10.1186/s40594-015-0017-9

An, Y-J., Haynes, L., D'Alba, A., & Chumney, F. (2016). Using educational computer games in the classroom: Science teachers' experiences, attitudes, perceptions, concerns, and support needs. *Contemporary Issues in Technology and Teacher Education, 16*(4), 415–433.

Anderson, J. L., & Barnett, M. (2013). Learning physics with digital game simulations in middle school science. *Journal of Science Education and Technology*, *22*(6), 914–926. https://doi.org/10.1007/s10956-013-9438-8

Ault, M., Craig-Hare, J., Frey, B., Ellis, J. D., & Bulgren, J. (2015). The effectiveness of reason racer, a game designed to engage middle school students in scientific argumentation. *Journal of Research on Technology in Education*, *47*(1), 21–40. https://doi.org/10.1080/15391523.2015.967542

Bacalja, A. (2019). What videogames have to teach us (still) about subject English. *English in Australia*, *53*(3), 51–63.

Bai, H., Pan, W., Hirumi, A., & Kebritchi, M. (2012). Assessing the effectiveness of a 3-D instructional game on improving mathematics achievement and motivation of middle school students. *British Journal of Educational Technology*, *43*(6), 993–1003. https://doi.org/10.1111/j.1467-8535.2011.01269.x

Bal, M. (2019). Use of digital games in writing education: An action research on

gamification. *Contemporary Educational Technology*, *10*(3), 246–271. https://doi.org/10.30935/cet.590005

Beavis, C., Muspratt, S., & Thompson, R. (2014). 'Computer games can get your brain working': Student experience and perceptions of digital games in the classroom. *Learning, Media and Technology*, *40*(1), 21-42. doi:10.1080/17439884.2014.904339

Bell, A., & Gresalfi, M. (2017). Teaching with videogames: How experience impacts classroom integration. *Technology, Knowledge and Learning*, *22*(3), 513–526. https://doi.org/10.1007/s10758-017-9306-3

Bourgonjon, J., Valcke, M., Soetaert, R., & Schellens, T. (2010). Students' perceptions about the use of video games in the classroom. *Computers and Education*, *54*(4), 1145–1156. https://doi.org/10.1016/j.compedu.2009.10.022

Bowling, K. G., Miller, L. M., Patel, R., & Bass, K. M. (2017). Impacts of virtual clinical trials simulations on science knowledge and attitudes. *Electronic Journal of Science Education*, *21*(7), 1–19.

Buteau, C., & Muller, E. (2018). Case study of an epistemic mathematics computer game. *International Journal of Game-Based Learning*, *8*(3), 34–55. https://doi.org/10.4018/IJGBL.2018070103

Carissoli, C., & Villani, D. (2019). Can videogames be used to promote emotional intelligence in teenagers? Results from EmotivaMente, a school program. *Games for Health Journal*, *8*(6), 407–413. https://doi.org/10.1089/g4h.2018.0148

Chang, M., Evans, M. A., Kim, S., Norton, A., & Samur, Y. (2015). Differential effects of learning games on mathematics proficiency. *Educational Media International*, *52*(1), 47–57. https://doi.org/10.1080/09523987.2015.1005427

Chartofili, A., & Fokides, E. (2019). Teaching local history, culture, traditions, and customs using digital games: Preliminary results from a case study in the island of Nisyros.

Open Journal for Educational Research, *3*(2), 81–94.

Checa-Romero, M., & Pascual Gómez, I. (2018). Minecraft and machinima in action: Development of creativity in the classroom. *Technology, Pedagogy and Education*, *27*(5), 625–637. https://doi.org/10.1080/1475939X.2018.1537933

Chee, Y. S., & Tan, K. C. D. (2012). Becoming chemists through game-based inquiry learning: The case of 'Legends of Alkhimia'. *Electronic Journal of E-Learning*, *10*(2), 185–198.

Chee, Y. S., Mehrotra, S., & Liu, Q. (2013). Effective game based citizenship education in the age of new media. *Electronic Journal of E-Learning*, *11*(1), 16–28.

Chee, Y. S., Mehrotra, S., & Ong, J. C. (2015). Authentic game-based learning and teachers' dilemmas in reconstructing professional practice. *Learning, Media and Technology*, *40*(4), 514–535. https://doi.org/10.1080/17439884.2014.953958

Chen, C.-H. (2019). The impacts of peer competition-based science gameplay on conceptual knowledge, intrinsic motivation, and learning behavioral patterns. *Educational Technology Research and Development*, *67*(1), 179–198. https://doi.org/10.1007/s11423-018-9635-5

Chen, H.-R., & Lin, Y.-S. (2016). An examination of digital game-based situated learning applied to Chinese language poetry education. *Technology, Pedagogy and Education*, *25*(2), 171–186. https://doi.org/10.1080/1475939X.2015.1007077

Chen, H.-P., Lien, C.-J., Annetta, L., & Lu, Y.-L. (2010). The influence of an educational computer game on children's cultural identities. *Educational Technology & Society*, *13*(1), 94–105.

Chen, M.-P., Wong, Y.-T., & Wang, L.-C. (2014). Effects of type of exploratory strategy and prior knowledge on middle school students' learning of chemical formulas from a 3D role-playing game. *Educational Technology Research and Development*, *62*(2), 163–

185. https://doi.org/10.1007/s11423-013-9324-3

Cipollone, M., Schifter, C. C., & Moffat, R. A. (2014). Minecraft as a creative tool: A case study. *International Journal of Game-Based Learning*, *4*(2), 1–14. https://doi.org/10.4018/ijgbl.2014040101

Clark, D. B., Tanner-Smith, E., Hostetler, A., Fradkin, A., & Polikov, V. (2018). Substantial integration of typical educational games into extended curricula. *Journal of the Learning Sciences*, *27*(2), 265–318.

Culp, K. M., Martin, W., Clements, M., & Presser, A. (2015). Testing the impact of a pre-instructional digital game on middle-grade students' understanding of photosynthesis. *Technology, Knowledge and Learning*, *20*(1), 5–26. https://doi.org/10.1007/s10758-014-9233-5

Deater-Deckard, K., El Mallah, S., Chang, M., Evans, M. A., & Norton, A. (2014). Student behavioural engagement during mathematics educational video game instruction with 11 – 14 year olds. *International Journal of Child-Computer Interaction*, *2*(2014), 101–108.

Ebrahimzadeh, M. (2017). Readers, players, and watchers: EFL students' vocabulary acquisition through digital video games. *English Language Teaching*, *10*(2), 1–18.

Ebrahimzadeh, M., & Alavi, S. (2017). Digital video games: E-learning enjoyment as a predictor of vocabulary learning. *Electronic Journal of Foreign Language Teaching*, *14*(2), 145–158.

Eseryel, D., Ge, X., Ifenthaler, D., & Law, V. (2011). Dynamic modeling as a cognitive regulation scaffold for developing complex problem-solving skills in an educational massively multiplayer online game environment. *Journal of Educational Computing Research*, *45*(3), 265–286.

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., & Miller, R. (2014). An investigation of the

interrelationships between motivation, engagement, and complex problem solving in game-based learning. *Educational Technology & Society*, *17*(1), 42–53.

Evans, M. A., Nino, M., Deater-Deckard, K., & Chang, M. (2015). School-wide adoption of a mathematics learning game in a middle school setting: Using the TPACK framework to analyze effects on practice. *Asia-Pacific Education Researcher*, *24*(3), 495–504. https://doi.org/10.1007/s40299-014-0225-y

Fan, K.-K., Xiao, P., & Su, C.-H. (2015). The effects of learning styles and meaningful learning on the learning achievement of gamification health education curriculum. *EURASIA Journal of Mathematics, Science & Technology Education*, *11*(5), 1211–1229.

Foster, A., & Shah, M. (2015). The play curricular activity reflection discussion model for game-based learning. *Journal of Research on Technology in Education*, *47*(2), 71–88. https://doi.org/10.1080/15391523.2015.967551

Garneli, V., & Chorianopoulos, K. (2018). Programming video games and simulations in science education: Exploring computational thinking through code analysis. *Interactive Learning Environments*, *26*(3), 386–401.

Gerber, H. R., Abrams, S. S., Onwuegbuzie, A. J., & Benge, C. L. (2014). From Mario to FIFA: What qualitative case study research suggests about games-based learning in a US classroom. *Educational Media International*, *51*(1), 16–34. https://doi.org/10.1080/09523987.2014.889402

Groff, J. S., Howells, C., & Cranmer, S. (2012). Console game-based pedagogy: A study of primary and secondary classroom learning through console video games. *International Journal of Game-Based Learning*, *2*(2), 35–54. https://doi.org/10.4018/ijgbl.2012040103

Gunbatar, M. S., & Karalar, H. (2018). Gender differences in middle school students'

attitudes and self-efficacy perceptions towards mBlock programming. *European Journal of Educational Research*, *7*(4), 925–933.

Hanghøj, T., Lieberoth, A., & Misfeldt, M. (2018). Can cooperative video games encourage social and motivational inclusion of at-risk students? *British Journal of Educational Technology*, *49*(4), 775–799. https://doi.org/10.1111/bjet.12642

Herro, D. C. (2015). Implementing game design in school: A worked example. *Canadian Journal of Learning and Technology*, *41*(2), 1–26. https://doi.org/10.21432/T26G7B.

Hewett, K. J. E., Zeng, G., & Pletcher, B. C. (2020). The acquisition of 21st-century skills through video games: Minecraft design process models and their web of class roles. *Simulation and Gaming*, *51*(3), 336–364. https://doi.org/10.1177/1046878120904976

Hsiao, H.-S., Tsai, F.-H., & Hsu, I.-Y. (2020). Development and evaluation of a computer detective game for microbial food safety education. *Journal of Educational Computing Research*, *58*(6), 1144–1160. https://doi.org/10.1177/0735633120924924

Johnson, C. (2017). Learning basic programming concepts with game maker. *International Journal of Computer Science Education in Schools*, *1*(2), 1–20.

Karsenti, T., & Parent, S. (2020). Teaching history with the video game Assassin's Creed: Effective teaching practices and reported learning. *Review of Science Mathematics & ICT Education*, *14*(1), 27–45.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers and Education*, *55*(2), 427–443. https://doi.org/10.1016/j.compedu.2010.02.007

Khan, A., Ahmad, F. H., & Malik, M. M. (2017). Use of digital game based learning and gamification in secondary school science: The effect on student engagement, learning and gender difference. *Education and Information Technologies*, *22*(6), 2767–2804. https://doi.org/10.1007/s10639-017-9622-1

Kilic, E., & Yildirim, Z. (2012). Cognitive load and goal based scenario centered 3d multimedia learning environment: Learners' motivation, satisfaction and mental effort. *Journal of Educational Computing Research*, *47*(3), 329–349. https://doi.org/10.2190/EC.47.3.e

Kim, Y. J., & Pavlov, O. (2019). Game-based structural debriefing: How can teachers design game-based curricula for systems thinking? *Information and Learning Science*, *120*(9–10), 567–588. https://doi.org/10.1108/ILS-05-2019-0039

Koops, M., & Hoevenaar, M. (2013). Conceptual change during a serious game: Using a lemniscate model to compare strategies in a physics game. *Simulation and Gaming*, *44*(4), 544–561. https://doi.org/10.1177/1046878112459261

Lee, J. K., & Probert, J. (2010). Civilization III and whole-class play in high school social studies. *Journal of Social Studies Research*, *34*(1), 1–28.

Liu, M., Rosenblum, J. A., Horton, L., & Kang, J. (2014). Designing science learning with game-based approaches. *Computers in the Schools*, *31*(1–2), 84–102. https://doi.org/10.1080/07380569.2014.879776

Majumdar, D., Koch, P. A., Lee, H., Contento, I. R., Islas-Ramos, A. D. L., & Fu, D. (2013). 'Creature-101': A serious game to promote energy balance-related behaviors among middle school adolescents. *Games for Health Journal*, *2*(5), 280–290. https://doi.org/10.1089/g4h.2013.0045

Marklund, B. B., & Taylor, A.-S. A. (2016). Educational games in practice: The challenges involved in conducting a game-based curriculum. *Electronic Journal of E-Learning*, *14*(2), 122–135.

Marlatt, R. (2018). Literary analysis using Minecraft: An Asian American youth crafts her literacy identity. *Journal of Adolescent & Adult Literacy*, *62*(1), 55–66. https://doi.org/10.1002/jaal.747

Metcalf, S., Chen, J., Kamarainen, A., Frumin, K., Vickrey, T., Grotzer, T., & Dede, C. (2014). Shifts in student motivation during usage of a multi-user virtual environment for ecosystem science. *International Journal of Virtual and Personal Learning Environments*, *5*(4), 1–15.

Mifsud, C. L., Vella, R., & Camilleri, L. (2013). Attitudes towards and effects of the use of video games in classroom learning with specific reference to literacy attainment. *Research in Education*, *90*, 32–52. https://doi.org/10.7227/RIE.90.1.3

Mills, K., Ketelhut, D., & Gong, X. (2019). Change of teacher beliefs, but not practices, following integration of immersive virtual environment in the classroom. *Journal of Educational Computing Research*, *57*(7), 1786–1811. https://doi.org/10.1177/0735633119854034

Monjelat, N., Méndez, L., & Lacasa, P. (2017). Becoming a tutor: Student scaffolding in a game-based classroom. *Technology, Pedagogy and Education*, *26*(3), 265–282. https://doi.org/10.1080/1475939X.2016.1210538

Nadolny, L., Alaswad, Z., Culver, D., & Wang, W. (2017). Designing with game-based learning: Game mechanics from middle school to higher education. *Simulation and Gaming*, *48*(6), 814–831. https://doi.org/10.1177/1046878117736893

Navarrete, C. C. (2013). Creative thinking in digital game design and development: A case study. *Computers and Education*, *69*, 320–331. https://doi.org/10.1016/j.compedu.2013.07.025

Panoutsopoulos, H., & Sampson, D. G. (2012). A study on exploiting commercial digital games into school context. *Educational Technology & Society*, *15*(1), 15–27.

Pellas, N., & Peroutseas, E. (2016). Gaming in Second Life via Scratch4SL: Engaging high school students in programming courses. *Journal of Educational Computing Research*, *54*(1), 108–143. https://doi.org/10.1177/0735633115612785

Perry, J., & Klopfer, E. (2014). UbiqBio: Adoptions and outcomes of mobile biology games in the ecology of school. *Computers in the Schools*, *31*(1–2), 43–64. https://doi.org/10.1080/07380569.2014.879771

Proctor, M. D., & Marks, Y. (2013). A survey of exemplar teachers' perceptions, use, and access of computer-based games and technology for classroom instruction. *Computers & Education*, *62*, 171–180. https://doi.org/10.1016/j.compedu.2012.10.022

Pusey, M., & Pusey, G. (2015). Using Minecraft in the science classroom. *International Journal of Innovation in Science and Mathematics Education*, *23*(3), 22–34.

Reynolds, R., & Chiu, M. M. (2015). Reducing digital divide effects through student engagement in coordinated game design, online resource use, and social computing activities in school. *Journal of the Association for Information Science and Technology*, *67*(8), 1822–1835. https://doi.org/10.1002/asi.23504

Robertson, J. (2013). The influence of a game-making project on male and female learners' attitudes to computing. *Computer Science Education*, *23*(1), 58–83. https://doi.org/10.1080/08993408.2013.774155

Sadler, T. D., Romine, W. L., Menon, D., Ferdig, R. E., & Annetta, L. (2015). Learning biology through innovative curricula: A comparison of game- and nongame-based approaches. *Science Education*, *99*(4), 696–720. https://doi.org/10.1002/sce.21171

Sadler, T. D., Romine, W. L., Stuart, P. E., & Merle-Johnson, D. (2013). Game-based curricula in biology classes: Differential effects among varying academic levels. *Journal of Research in Science Teaching*, *50*(4), 479–499. https://doi.org/10.1002/tea.21085

Sanchez, E., Young, S., & Jouneau-Sion, C. (2017). Classcraft: From gamification to ludicization of classroom management. *Education and Information Technologies*, *22*(2), 497–513. https://doi.org/10.1007/s10639-016-9489-6

Shah, M., & Foster, A. (2014). Undertaking an ecological approach to advance game-based learning: A case study. *Educational Technology & Society*, *17*(1), 29–41.

Siko, J., Barbour, M., & Toker, S. (2011). Beyond jeopardy and lectures: Using 'Microsoft Powerpoint' as a game design tool to teach science. *Journal of Computers in Mathematics and Science Teaching*, *30*(3), 303–320.

Stieler-Hunt, C., & Jones, C. M. (2015). Educators who believe: Understanding the enthusiasm of teachers who use digital games in the classroom. *Research in Learning Technology*, *23*, 1–14. https://doi.org/10.3402/rlt.v23.26155

Struppert, A. (2010). 'It's a whole new fun different way to learn.' Students' perceptions of learning with an electronic simulation: Selected results from three case studies in an Australian, an American and a Swiss middle school. *International Journal of Learning*, *17*(9), 363–375.

Toomey, M., & Kitson, M. (2017). Engaging the enemy: Computer games in the English classroom. *Literacy Learning: The Middle Years*, *25*(3), 38–49.

Tsai, C.-H., Cheng, C.-H., Yeh, D.-Y., & Lin, S.-Y. (2017). Satisfaction of high school students with a mobile game-based English learning system. *International Journal of Mobile Learning and Organisation*, *11*(2), 131–154. https://doi.org/10.1504/IJMLO.2017.084276

Tsai, F.-H., Tsai, C.-C., & Lin, K.-Y. (2015). The evaluation of different gaming modes and feedback types on game-based formative assessment in an online learning environment. *Computers and Education*, *81*, 259–269. https://doi.org/10.1016/j.compedu.2014.10.013

Tucker-Raymond, E., Puttick, G., Cassidy, M., Harteveld, C., & Troiano, G. M. (2019). "I broke your game!": Critique among middle schoolers designing computer games about climate change. *International Journal of STEM Education*, *6*(1).

https://doi.org/10.1186/s40594-019-0194-z

Turan, Z., & Meral, E. (2018). Game-based versus to non-game-based: The impact of student response systems on students' achievements, engagements and test anxieties. *Informatics in Education*, *17*(1), 105–116.

Wallon, R. C., Jasti, C., Lauren, H. Z., & Hug, B. (2018). Implementation of a curriculum-integrated computer game for introducing scientific argumentation. *Journal of Science Education and Technology*, *27*(3), 236–247.

Wilson, S. N., Engler, C. E., Black, J. E., Yager-Elorriaga, D. K., Thompson, W. M., McConnell, A., Cecena, J. E., Ralston, R., & Terry, R. A. (2017). Game-based learning and information literacy: a randomized controlled trial to determine the efficacy of two information literacy learning experiences. *International Journal of Game-Based Learning*, *7*(4), 1–21. https://doi.org/10.4018/IJGBL.2017100101

Wilson, C. D., Reichsman, F., Mutch-Jones, K., Gardner, A., Marchi, L., Kowalski, S., Lord, T., & Dorsey, C. (2018). Teacher implementation and the impact of game-based science curriculum materials. *Journal of Science Education and Technology*, *27*(4), 285–305. https://doi.org/10.1007/s10956-017-9724-y

Yang, Y.-T. C. (2012). Building virtual cities, inspiring intelligent citizens: Digital games for developing students' problem solving and learning motivation. *Computers & Education*, *59*(2), 365–377. https://doi.org/10.1016/j.compedu.2012.01.012

Yang, Y.-T. C. (2015). Virtual CEOs: A blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students. *Computers and Education*, *81*, 281–295. https://doi.org/10.1016/j.compedu.2014.10.004

Zuiker, S. J., & Anderson, K. T. (2019). Fostering peer dialogic engagement in science classrooms with an educational videogame. *Research in Science Education*. 1–24.

https://doi.org/10.1007/s11165-019-9842-z

Appendix B

Summary of Articles Retained in Systematic Review

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A001	Alfieri, Higashi, Shoop & Schunn (2015) USA	To determine whether a VG increases test scores and students' interests and values pertaining to mathematics	Knowledge acquisition AND Affective or motivational	Expedition Atlantis	Game for learning	Maths	Unknown	Mixed Case study	116 students (6 – 8th grade; age and gender not specified), 3 teachers (gender not specified)	5 days	Students' proportional reasoning skills increased from pre- to post-test (particularly at school A), as well as their interest in robotics (all three schools) and their value of mathematics for use within robotics (particularly at schools B and C) as inferred from within-participant comparisons.
A002	An, Haynes, D'Alba & Chumney (2016) USA	To investigate science teachers' experiences, attitudes, perceptions, concerns, and support needs related to the use of educational computer games	Teacher implementation or perception of VG	Various	Various	Various	N/A	Quant Survey	111 science teachers (middle and high school; 40 male and 71 female)	N/A	The results showed that 73% of participants had used computer games in teaching. MS teachers were more confident and reported a higher level of perceived benefits than HS teachers. The major barriers to VG in the classroom included lack of computers, lack of time, time needed for preparation for school and national high-stakes testing, and lack of knowledge about science games.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A003	Anderson & Barnett (2013) USA	To explore the impact of a VG on students' understanding of electromagnetic concepts	Knowledge acquisition	Supercharged!	Game for learning	Science	Unknown	Mixed method QE	90 students (8th grade; age not specified; 52 boys and 38 girls)	7 class periods	VG resulted in an increase in test scores from pre- to post-assessment and the student interviews. This study also suggests that digital games can support science instruction and learning when they are appropriately designed and implemented within the classroom, but they do not take the place of science instruction.
A004	Ault et al. (2015) USA	To determine if a science VG can improve students' knowledge, confidence, and motivation to engage in science.	Knowledge acquisition AND Affective or motivational	Reason Racer	Game for learning	Science	No	Quant QE	906 students (6 – 8th grade; age not specified; 485 boys and 421 girls) and 8 teachers (gender not specified)	6 weeks	Experimental group improved in every aspect of argumentation skill and judgment. Students who played the game also reported an increase in confidence and motivation to engage in science compared to students who did not play the game.
A005	Bacalja (2019) Australia	To explore the pedagogical issues and practices of using video games to teach English, and how this affects learning and teaching.	Teacher implementation or perception of VG AND Exploratory	Bully, Dungeon Siege 3, Fable 2, Forza 4, Marvel Ultimate Alliance 2, Halo 3	COTS	English	No	Qual Action research	6 students (10th grade; 15 – 16 years; 3 boys and 3 girls) and 1 teacher (male)	5 weeks	This study found that while existing conceptual and pedagogic models of subject English can be adopted and adapted to suit the unique affordances of video games, issues associated with play and interactivity complicate the use of videogames in the classroom.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A006	Bai, Pan, Hirumi & Kebritchi (2012) USA	To assess the effectiveness of a VG on mathematical knowledge and student motivation to learn	Knowledge acquisition AND Affective or motivational	Dimension M	Game for learning	Maths	Yes	Quant QE	437 students (8th grade; age not specified; 201 boys, 236 girls)	18 weeks	Results indicated that the game increased mathematical knowledge acquisition in algebra and maintained student motivation to learn.
A007	Bal (2019) Turkey	To determine the contribution of gamification to writing skills of middle school students.	Affective or motivational AND Exploratory	Storium	Learning through making games	English	No	Qual Action research	12 students (7th grade; age not specified; 5 boys and 7 girls)	12 weeks	Results found all participants were actively involved in the implementation process. VG use increased the interest of students towards the course, facilitated classroom management, supported collaborative work, and developed creativity.
A008	Beavis, Muspratt & Thompson (2014) Australia	To explore students' use and attitudes towards games in the classroom.	Student perceptions of VG	Various	Various	Various	N/A	Mixed survey	270 students (4 – 9th grade; 9 – 14 years; 168 boys, 102 girls)	N/A	The range of uses of VG described were mixed and idiosyncratic. Student experiences of in-school VG play varied, with engagement, socialising, and challenge highly prized. Student showed impatience with 'boring' games, low interest levels, tediously 'educational' content, and frustrations with technological difficulties.
A009	Bell & Gresalfi (2017) USA	To explore how teacher experience impacts on the implementation of video games within the classroom.	Teacher implementation or perception of VG AND Knowledge acquisition	Boone's Meadow	Game for learning	Maths	Yes	Mixed QE	61 students (7th grade; age and gender not specified) and 1 teacher (female)	4 days, once a year for 2 years	Results found teacher's pedagogy changed between the 2 years, with year 2 involving more student gameplay and narrative immersion. Despite this, pre- to post-test gain was greater in year 1 than year 2. Further, the teacher, and the teacher's familiarity with the game, clearly plays an important role in what students learn.
A010	Bourgonjon et al. (2010) Belgium	To propose and test a model to predict student acceptance of, and immersion in, video games.	Student perceptions of VG AND Affective or motivational	Various	Various	Various	N/A	Quant Survey	858 students (12 – 20 years; 445 boys and 413 girls)	N/A	The results show that students' preference for using video games in the classroom is affected directly by a number of factors: the perceptions of students regarding the usefulness, ease of use, learning opportunities, and personal experience with video games in general.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A011	Bowling, Miller, Patel & Bass (2017) USA	To report the effectiveness of VGs in improving science knowledge, science careers, and scientific possible selves in HS science students.	Knowledge acquisition AND Affective or motivational	Virtual Clinical Trials	Game for learning	Science	Yes	Quant QE	525 students (11 - 12th grade; 161 boys 364 girls) and 9 teachers (gender not specified)	3 or 4 game play sessions	Results show all students increased their knowledge and attitudes toward clinical trials, with students completing two simulations having the greatest shifts. The results demonstrate that knowledge gain, attitude change, and the promotion of science identity are achievable through exposure to simulations, while shifts in career interest are not as consistently realized.
A012	Buteau & Muller (2018) Canada	An empirical study of students' experience playing an educational VG as part of a mathematics data management course.	Affective or motivational	E-Brock Bugs	Game for learning	Maths	Yes	Qual Case study	61 students (16 years; 36 boys, 25 girls)	3 weeks	Results suggest that VG players may experience a mathematical in-game identity (MI), thereby providing preliminary empirical evidence towards the epistemic character of the VG. Most players engaged in the mathematics in the game. Results found that 76% of the students would like to use video games in their mathematics classes. Similarly, 80% view the VG as a useful activity for probability learning.
A013	Carissoli & Villani (2019) Italy	To investigate the effectiveness of emotional intelligence (EI) training using VG to increase EI abilities in adolescents.	Social or soft skills	Emotiva-mente curriculum (various games)	COTS	Emotional intelligence	No	Qual QE	121 students (14 – 16 years; 19 boys, 102 girls)	Eight 1.5 hour sessions	Experimental group reported an improvement in the evaluation and expression of emotions in relation to the self (own emotions) compared with the control group, immediately after the training, but this difference did not persist at the follow-up (3 months later). The intervention helped adolescents to improve emotional skills.
A014	Chang et al. (2015) USA	To examine the effects of a VG on the mathematics proficiency of middle school students.	Knowledge acquisition	[The Math App]	Game for learning	Maths	Yes	Quant QE	306 students (6th grade; age not specified; gender not specified)	20mins a day, for 18 days, over 9 weeks	Overall, students in experimental group showed an increase in mathematics scores from pre-test to post-test. Students in the lower-ability group classes demonstrated the greatest increase in mathematics performance. Students in the control group showed a decrease in scores in the lower ability and regular proficiency groups.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A015	Chartofili & Fokides (2019) Greece	To examine whether digital games have an impact on teenagers' cultural identity formation.	Knowledge acquisition AND Affective or motivational	Three unnamed games	Game for learning	Social studies	Yes	Quant QE	40 students (13 – 16 years; gender not specified)	Three 2 hour gaming sessions	Digital games produced better learning outcomes when compared with both the other teaching tools (board game and printed material). Participants enjoyed their teaching more when they played the digital games, considered them more effective in terms of knowledge acquisition, and were more motivated to learn.
A016	Checa-Romero & Pascual Gomez (2018) Spain	To examine the development of creativity through the use of VG in the classroom.	Perceptual or cognitive	Minecraft EDU	COTS	Technology	No	Mixed QE	85 students (13 years avg. age; 47 boys, 35 girls; 3 unspecified)	8 weeks	Results show a significant increase in creativity and high scores for creativity in student artefacts. VG produced opportunity to develop innovative educational contexts and encourage creative processes.
A017	Chee & Tan (2012) Singapore	To examine student knowledge and self-identity toward science inquiry through a VG-based learning program.	Knowledge acquisition AND Affective or motivational	Legends of Alkhimia	Game for learning	Science	Yes	Quant QE	78 students (13 years avg. age; 40 boys, 38 girls)	Twice a week for 4 weeks	The experimental group significantly outperformed the control students in knowledge and conceptual understanding of chemistry. In the attitudinal survey, students in the experimental group felt like scientists, and felt their teachers perceived them as such.
A018	Chee, Mehrotra & Liu (2013) Singapore	To examine the comparative learning outcomes of students who participated in a VG curriculum with those from a control class.	Knowledge acquisition	StatecraftX	Game for learning	Social studies	Yes	Mixed QE	84 students (15 years avg. age; 46 boys, 38 girls)	3 weeks	Results show that students from the experimental group outperformed those in the control group. Experimental group students conveyed a strong sense of personal voice, and awareness about current global and local issues. In contrast, essays of control group students showed a tendency to reproduce what was contained in the social studies textbook on the topic being studied.
A019	Chee, Mehrotra & Ong (2015) Singapore	To explore the issues teachers encounter when attempting to reconstruct professional practice in the classroom when enacting a VG curriculum.	Teacher implementation or perception of VG	StatecraftX	Game for learning	Social studies	Yes	Qual Case study	9 teachers (6 female, 3 male)	3 weeks	Results showed evidence of resistance to, and discomfort with, a new mode of teaching and learning, on the part of students as well as teachers. Teachers reported experiencing pressure to ensure students score high marks on standard assessments, and tensions that arise from weak alignment between mandated and innovation-based forms of assessment.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A020	Chen (2019) Taiwan	To investigate how the different modes of game-design triggers learning outcomes, focusing on peer learning and intergroup competition.	Knowledge acquisition AND Affective or motivational	Summon of Magic Crystal	Game for learning	Science	Yes	Mixed QE	110 students (7th grade; age not specified; 60 boys and 50 girls)	2 weeks	The peer-competition and peer-no-competition groups outperformed those in the individual-competition and individual-no-competition groups in terms of conceptual knowledge. Additionally, peer-competition groups exhibited higher interest and value and lower tension than those in the individual gameplay groups.
A021	Chen & Lin (2016) Taiwan	To determine whether the implementation of a VG impacts on learner acceptance and learning effects of learning Chinese poetry	Knowledge acquisition AND Affective or motivational	Gourd Tang Dynasty	Game for learning	English	Yes	Quant QE	105 students (8th grade; age not specified; 57 boys and 48 girls)	2 classes a week for 4 weeks	Students who used the VG had significantly better learning achievements than students who underwent traditional narrative instruction. Perceived usefulness was a key factor in the students' positive attitudes towards the digital game-based situated learning system. There were no significant differences with respect to individual characteristics.
A022	Chen, Lien, Annetta & Lu (2010) Taiwan	To explore the influences that an educational computer game might have on children's cultural identities.	Knowledge acquisition AND Affective or motivational	FORmosa Hope	Game for learning	Social studies	Yes	Quant QE	130 students (7th grade; 11 – 12 years; 71 boys and 59 girls)	6 weeks	The experimental group significantly strengthened their cultural identities compared to the control group. This implies that educational games can have an impact on children's cultural identities through their educational contexts.
A023	Chen, Wong, & Wang (2014) Taiwan	To examine students' performance and motivation in learning chemical formulas via a 3D role-playing game	Knowledge acquisition AND Affective or motivational	The Alchemists Fort	Game for learning	Science	Yes	Quant QE	115 students (8th grade; age not specified; 59 boys, 56 girls)	3 weeks	Learners showed mild positive motivation toward learning chemistry via a VG. Higher prior-knowledge learners outperformed their lower prior-knowledge peers on performance and motivation measures.
A024	Cipollone, Schifter & Moffat (2014) USA	To explore the use of VG in a high school literature class in three student-made machinima	Knowledge acquisition	Minecraft	COTS	English	No	Qual Case study	20 students (9th and 10th grade; age 13 – 16; gender not specified)	5 class periods	Findings indicate the VG offers a unique opportunity for students to display their creativity and understanding of concepts in ways that are more feasible than if they were attempted in the "real" world. VG is constructionist in its nature, which implicates a different style of instruction than is typically employed in the classroom.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A025	Clark et al. (2018) USA	To examine teacher integration of a variety of different VGs developed for education into a curriculum of Jacksonian democracy.	Teacher implementation or perception of VG AND Knowledge acquisition AND Affective or motivational	55 games developed for research project	Game for learning	Social studies	No	Mixed QE	848 students (6th, 10th, and 8th grade; age and gender not specified) and 15 teachers (gender not specified)	3 weeks	Results showed significantly higher gains for the experimental group in terms of multiple-choice factual outcomes, open-response factual outcomes, evidentiary depth, and student engagement outcomes. The role of teacher experience and student engagement were significant in the efficacy of the game condition.
A026	Culp, Martin, Clements & Presser (2015) USA	To test the impact of a VG on middle grade students' understanding of the process of photosynthesis.	Teacher implementation or perception of VG AND Knowledge acquisition AND Affective or motivational	The Ruby Realm	Game for learning	Science	Yes	Quant RCT	914 students (12 years avg. age; 452 boys and 462 girls) and 41 teachers (gender not specified)	One unit (time not specified)	The intervention did not have a significant impact on student understanding of photosynthesis. The interaction of treatment teachers' observation scores and students' average assessment scores approached significance. This study suggests that when digital games are used as a step in the process of learning difficult conceptual material, teachers may need support and guidance to make productive connections between in-game experiences and the target concepts.
A027	Deater-Deckard et al. (2014) USA	To examine student behavioural engagement during mathematics instruction using a mathematics VG.	Affective or motivational	The Candy Factory	Game for learning	Maths	Unknown	Mixed QE	97 students (6 – 8th grade;11 – 14 years; 45 boys and 52 girls)	8 weeks	Students were highly engaged, but engagement was lower for students who had the most prior gaming experience. Observed engagement was associated with better performance on knowledge assessment. Prior gaming experience and method of assessing engagement are important modulators of student response to VG instruction.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A028	Ebrahimzadeh & Alavi (2017) Iran	To examine learning enjoyment through a VG to see if it could predict high school students' vocabulary learning.	Knowledge acquisition AND Affective or motivational	Warcraft III: The Frozen Throne	COTS	Language	No	Quant QE	136 students (12 – 18 years, 14.81 SD; 136 boys)	5 weeks	Results showed no significant difference between watcher and player group in terms of enjoyment. Autonomy and knowledge improvement positively correlated with the vocabulary post-test scores. Concentration, goal clarity, feedback, and social interaction did not reach statistical significance. Results indicate that enjoyment is associated with vocabulary learning
A029	Ebrahimzadeh (2017) Iran	To investigate vocabulary acquisition through a commercial VG compared to a traditional pencil-and-paper treatment.	Knowledge acquisition	Warcraft III: The Frozen Throne	COTS	Language	No	Mixed QE	241 students (12 – 18 years; 241 boys)	5 weeks	Results indicate that both watchers and players of the VG outperformed the reader group in vocabulary acquisition. Findings indicate that VGs seem to offer potential for inclusion in educational settings.
A030	Eseryel et al. (2014) USA	To examine the interplay between learners' motivation, engagement, and problem-solving outcomes during VG learning.	Affective or motivational AND Perceptual or cognitive	McLarin's Adventures	Game for learning	Problem solving	Yes	Quant QE	88 students (9th grade; avg. age 14.6 years; 38 boys, 50 girls)	1 year	Results suggest that learners' motivation determines their engagement during gameplay, which in turn determines their development of complex problem-solving competencies. Findings also suggest that learner's motivation, engagement, and problem-solving performance are greatly impacted by the nature and the design of game tasks.
A031	Eseryel, Ge, Ifenthaler & Law (2011) USA	To explore how a VG learning environment can facilitate problem-solving skill acquisition through 2 empirical studies	Perceptual or cognitive	McLarin's Adventures	Game for learning	Problem solving	Yes	Quant QE	531 students across 2 studies: Study 1: 251 students (9th grade; 118 boys, 133 girls) Study 2: 280 students (9th grade; gender not specified)	16 weeks	**Study 1**: Results suggest that the knowledge of students in experimental group did not improve. Results indicate VG may not lead to improved conceptual learning and problem-solving performance. **Study 2**: Results suggest that students in the modelling-only group exhibited significantly higher positive gains in their problem solving. In contrast, students in the modelling + game group exhibited a slight decline. However, when compared with Study 1, students in both groups in Study 2 showed significant improvement in all the six measures.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A032	Evans, Nino, Deater-Deckard & Chang (2015) USA	To use TPACK framework to explore how teachers implement VG to teach pre-algebraic concepts.	Teacher implementation or perception of VG	The Candy Factory	Game for learning	Maths	Unknown	Qual Case study	9 teachers (gender not specified)	N/A	Results indicate the need for training and professional development when implementing a learning VG. Results show the overall change for these teachers was switching from didactic lectures and assessments to collaborative workshops and a digitally-based learning environment.
A033	Fan, Xiao & Su (2015) Taiwan	To examine the learning outcomes and achievements of students using a VG within the classroom, and the effects of instructional strategies related to this.	Knowledge acquisition	Mobile Meaningful Blood Circulation Learning System	Game for learning	Science	Yes	Quant QE	46 students (7 – 9th grade; age not specified; 25 boys and 21 girls)	10 weeks	Findings show student gender presented no significant difference in learning achievement. Students with different learning styles revealed differences in learning achievement; and students in the experimental group had a higher learning achievement than the students in the control group, with notable differences.
A034	Foster & Shah (2015) USA	To explain the process of game-based learning in classrooms through the use of the Play Curricular activity Reflection Discussion (PCaRD) model.	Knowledge acquisition AND Affective or motivational	Dimension M, Physicus, and Rollercoaster Tycoon 3	Game for learning AND COTS	Maths, Science AND Social studies	No	Mixed QE	21 students (9th grade; age and gender not specified) and 3 teachers (male)	1 year	Results indicate that PCaRD aids in student learning, motivation to learn, and identification with content. There were mixed quantitative results for student knowledge gain with only statistical significant gains for mathematics. Results also found that PCaRD provided teachers with an adaptive structure for integrating games in an existing and new curriculum.
A035	Garneli & Chorianopoulos (2018) Greece	To examine if computational thinking (CT) is supported by simulation or VG construction, and if student motivation and learning is impacted.	Knowledge acquisition AND Affective or motivational	Scratch	Learning through making games	Technology AND science	No	Quant QE	34 students (3rd grade; 15 years; 13 boys and 21 girls)	Five 2-hour sessions	VG construction, rather than simulation construction, resulted in projects with higher CT skills and more primitives, as measured through projects' code analysis. Moreover, the VG context seems to better motivate students for future engagement with computing activities

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A036	Gerber, Abrams, Onwuegbuzie & Benge (2014) USA	To explore the impact of using COTS VGs on transforming students' literacy learning in-school.	Social skills AND Perceptual or cognitive	Various	COTS	English	No	Qual Case study	2 students as focus in class of 27 students (10^{th} grade; 16 years; 15 boys and 12 girls)	18 weeks	Findings indicated that the games-based curriculum created through a connected learning frame enabled students to engage in a constellation of connections among digital media, traditional texts, peers, and guiding teachers.
A037	Groff, Howells & Cranmer (2012) Scotland	To identify the benefits of console game-based learning in primary and secondary schools, and to understand how the benefits of VGs transfer to other settings.	Teacher implementation or perception of VG AND Affective or motivational	Various	Various	Various	No	Qual Case study	19 school leaders, 48 teachers, 150 students (5 – 16 years; gender not specified)	N/A	School leaders viewed VG projects as successful, and were enthusiastic about their impact. Reports of enthused, engaged and highly motivated pupils were common. In the majority of schools visited, any changes in learning and teaching were attributed to the development of active and interdisciplinary learning rather than GBL per se.
A038	Gunbatar & Karalar (2018) Turkey	To assess the effects of teaching programming with VGs on self-efficacy perceptions and attitudes, with a focus on gender.	Affective or motivational	mBlock	Learning through making games	Technology	No	Quant QE	82 students (6^{th} grade; 13 years; 43 boys and 39 girls)	12 weeks	It was found that programming with VG significantly increased students' self-efficacy perceptions and attitudes towards programming, with no difference in this by gender. As a result, teaching programming with VGs can provide similar possibilities for both genders in self-efficacy perceptions and attitudes regarding programming.
A039	Hanghøj, Lieberoth & Misfeldt (2018) Denmark	To investigate if challenges encountered in cooperative VGs can encourage classroom inclusion, and whether this experience can be translated into engagement.	Social or soft skills AND Affective or motivational	Torchlight II	COTS	Language and Maths	No	Mixed QE	190 students (3 – 6^{th} grade; 9 – 12 years; 92 boys, 98 girls)	3 weeks	The results positive impact on students' well-being and reduced experiences of external regulation to participate in Mathematics and Danish. The qualitative analysis confirms the positive findings. The findings indicate that the impact of game-based classrooms is not due to their fun element, but rather how they enable reframing of social participation and students' engagement with the curriculum.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A040	Herro (2015) USA	To explore the implementation of a game design curriculum, understand the conditions necessary to bring game design experiences to classrooms, and describe the teacher experience.	Teacher implementation or perception of VG	Various	COTS AND Learning through making games	Visual Arts AND Technology	No	Qual Case study	174 students (14 – 17 years; 133 boys, 41 girls) and 1 teacher (male)	1 year	Results of the case study showed that the game-based curriculum led to a culture of support for games, and increased learning opportunities for students. While there were some positive learning experiences, the results demonstrate the difficulty of game-based implementation: providing meaningful game design experiences corresponding with student interest and engagement, while navigating the complexity of school.
A041	Hewett, Zeng & Pletcher (2020) USA	To explore the skills and behaviours of students to generate a model that shows how gamers critically think, create, communicate, and collaborate	Exploratory	Minecraft EDU	COTS	Technology	No	Qual Case study	95 students (18 -19 years; 78 boys and 17 girls)	6 weeks	The data collection generated two educational models that illustrate the participants' leadership and design processes. Four themes emerged from the research study: Leadership: models for design, navigating the 3D World, thinking outside-the-box, and real-world connections.
A042	Hsiao, Tsai & Hsu (2020) Taiwan	To evaluate the effectiveness of a VG in developing student knowledge, perceptions, and behavioural differences in food safety knowledge.	Behaviour change AND Knowledge acquisition AND Affective or motivational	The Poison Riddle Game	Game for learning	Science	Yes	Mixed QE	109 students (12^{th} grade; age not specified; 71 boys, 38 girls)	3 weeks	Results show that students showed significant improvement in the results of the food safety knowledge test following their participation in the VG. The perception test results suggested that most students had a positive attitude toward game participation, although most students held a negative view on whether this game increased cognitive load. Despite this, most students had a relatively positive attitude toward the game. No behavioural change was found.
A043	Johnson (2017) UK	To explore how authoring VGs using Game Maker can support the learning of basic programming concepts in a mainstream UK secondary setting.	Knowledge acquisition AND Exploratory	Game Maker	Learning through making games	Technology	No	Qual Case study	22 students (13 – 14 years; 12 boys, 10 girls)	8 weeks	Findings indicate that as well as learning some basic programming concepts, pupils enjoyed the VG activity, demonstrated positive attitudes to their work, and felt a sense of achievement in creating a game. Findings also suggest that the constructionist approach adopted in the research did not effectively support the learning of programming concepts for all pupils. To improve this, teaching sequences need to incorporate a range of scaffolded activities.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A044	Karsenti & Parent (2020) Canada	To explore the educational impacts of a VG during a history class in a high school located in Quebec, Canada	Exploratory	Assassin's Creed	COTS	Social studies	No	Mixed Survey	329 students (13 years; gender not specified)	One unit (time not specified)	Results showed that teachers used the game in various ways, but none used direct gameplay in class. Students reported that the VG contributed to knowledge of historical events, characters, places, monuments, and cultures. Students and teachers reported that VG use was engaging and motivating.
A045	Kebritchi, Hirumi & Bai (2010) USA	To examine the effects of a VG on maths achievement and motivation, and the role of prior knowledge, computer skill, and language skill on achievement and motivation.	Knowledge acquisition AND Affective or motivational	Dimension M	Game for learning	Maths	Yes	Mixed QE	193 students (9-10th grade; age not specified; 103 boys and 90 girls) and 10 teachers (4 male and 6 female)	18 weeks	The results indicated significant improvement of the knowledge of the experimental versus control group. No significant improvement was found in the motivation of the groups. Prior knowledge, computer skill and English language skill did not play significant roles in achievement and motivation of the experimental group.
A046	Khan, Ahmad & Malik (2017) Pakistan	To identify the impact of a game based learning application on student engagement in secondary school science classrooms.	Knowledge acquisition AND Affective or motivational	Patterns of Reactivity	Game for learning	Science	Yes	Mixed QE	72 students (8th grade; 12 – 15 years; 36 boys and 36 girls)	3 weeks	Results indicated a significant increase in the attention of students who received VG instruction. Girls performed significantly better in post-test after using VG than boys, despite similar scores of girls and boys on the pre-test. Despite this, there was no significant difference found in the pre-test and post-test scores of the students between control and treatment groups.
A047	Kilic & Yildirim (2012) Turkey	To investigate learner's satisfaction, motivation, and mental effort in a VG based 3D multimedia learning environment.	Perceptual or cognitive AND Affective or motivational	GBSc3DM	Game for learning	Science	Yes	Mixed Survey	82 students (9th grade; age not specified; 30 boys, 52 girls)	2 weeks	Results found that students perceived the VG as an effective learning environment, and that learning through the VG was enjoyable and meaningful. The interview data supported the findings of the reflective journals in that all students expressed that learning with scenario was much better than lecture-based instruction.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A048	Kim & Pavlov (2019) USA	To develop and validate a pedagogical framework to use VGs for teaching systems thinking.	Teacher implementation or perception of VG	Food Fight Game	Game for learning	Science	No	Qual Case study	2 'master' teachers and 3 teachers (gender not specified)	1 year	Results confirmed the flexibility of the created unit in teaching systems thinking. Teachers created additional instructional materials that supplemented the unit and addressed the unique limitations and needs of their classrooms.
A049	Koops & Hoevenaar (2012) Netherlands	To develop a model that compares student "gaming" and "learning" states, and exploring the learning gain of students playing VG in these states.	Knowledge acquisition	SPACE CHALLENGE	Game for learning	Science	Yes	Quant QE	41 students (16 – 17 years; 22 boys, 19 girls)	6 lessons	Results show that both experimental groups increased conceptual knowledge, compared to the control group. Results cannot state that forced game cycle interruption improves conceptual learning. Study can conclude that VG is an effective tool in physics education, aiming to improve conceptual knowledge on Newtonian mechanics.
A050	Lee & Probert (2010) USA	To examine the effects of a COTS VG on learning experiences, teacher and student perceptions, and teacher content implementation.	Teacher implementation or perception of VG AND Knowledge acquisition AND Perceptual or cognitive	Civilisation III	COTS	Social studies	No	Qual Case study	12 students (12th grade; age not specified; 5 boys, 7 girls) and 1 teacher (male)	18 weeks	Results found that effective use of the VG entailed taking advantage of specific game contexts to expand on curricular content. Teachers have to be flexible and willing to adapt. Anecdotal evidence from this study suggests that students did develop factual knowledge, however the study did not include a systematic measure of student knowledge pre and post gameplay.
A051	Liu, Rosenblum, Horton & Kang (2014) USA	To examine game-based learning for the purpose of engaging students' learning of science and enhancing student motivation.	Knowledge acquisition AND Affective or motivational	Alien Rescue	Game for learning	Science	No	Mixed QE	371 students (6th grade; age not specified; 203 boys, 168 girls)	3 weeks	Results clearly indicate that students acquired significantly more science concepts after playing the VG. In addition to science content knowledge, the students learned about the processes of using scientific instruments, conducting research, applying problem-solving skills, and interpersonal skills.
A052	Majumdar et al. (2013) USA	To evaluate the efficacy of a VG at promoting energy balance related behaviours (EBRBs).	Behaviour change	Creature-101	Game for learning	Health education	Yes	Quant QE	341 students (11 – 13 years; 173 boys, 168 girls)	9 sessions over 1 month	Intervention students reported significant decreases in frequency and amount of consumption of sweetened beverages and processed snacks compared with the controls. No changes were observed for the other behaviours.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A053	Marklund & Taylor (2016) Sweden	To examine the demands VG implementation and use in formal educational settings puts on teachers' working processes and skillsets.	Teacher implementation or perception of VG	Minecraft EDU	COTS	Maths	No	Qual Case study	One 7th grade class (number not specified; age not specified; gender not specified) and 3 teachers (gender not specified)	5 months	Results show teachers need to take on a wide variety of roles when integrating and using games in their educational environment. The skill sets needed to perform the roles well were also found to be quite diverse as they involved technological know-how, gaming literacy, subject matter expertise, and a strong pedagogical foundation.
A054	Marlatt (2018) USA	To understand how VGs can support traditional literacies such as the reading and analyses of texts in school.	Knowledge acquisition AND Affective or motivational	Minecraft EDU	COTS	English	No	Qual Case study	15 students with 1 student case study (12th grade; 18 years old; female)	One unit (time not specified)	Implementing Minecraft in literature study offered the students opportunity for authentic literacy interaction. Despite previous disdain for literature, they expressed enjoyment with the text and a passion for connecting textual elements to their own life.
A055	Metcalf et al. (2014) USA	To evaluate student motivation in a multi-user virtual environment-based curriculum.	Affective or motivational	EcoMUVE	Game for learning	Science	Yes	Qual Survey	198 students (11-12 years; gender not specified)	10 days	Results found that students found the activity engaging from beginning to end, while student value of its utility in helping them learn science increased significantly. While initial student engagement resided primarily at the technology interface level, with time and experience students became increasingly engaged in the student-led, collaborative inquiry experiences afforded by the VG.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A056	Mifsud, Vella & Camilleri (2013) Malta	A survey of attitudes of students, parents, and teachers towards the use of VGs in the classroom, AND to assess the impact of a VG on learning English as a Second Language in a classroom context.	Teacher implementation or perception of VG AND Knowledge acquisition	The Clue Finders Reading Adventures: The Mystery of the Missing Amulet	Game for Learning	Language	No	Quant QE AND Survey	Survey: 1163 students (11 – 16 years; 464 boys, 699 girls), 149 teachers (47 male, 102 female), 783 parents. QE: 408 students (11 – 13 years; 167 boys, 241 girls)	6 weeks	**Survey:** Most of the students felt VGs can provide an opportunity for learning. The majority of the teachers believed that students could learn through video games, yet only 9.4 per cent of teachers actually use video games in the class. Most parents believe that educational video games are good tools for classroom learning. **QE:** Experimental group obtained significant gains when compared to the control group. All teachers said they were keen on using video games again to teach English as they found the video game to be effective.
A057	Mills, Ketelhut & Gong (2019) USA	To explore teacher practices after 3 years of VG implementations, plus participation in the corresponding PD experience.	Teacher implementation or perception of VG AND Knowledge acquisition	SAVE Science	Game for learning	Science	Yes	Mixed QE	74 students (8^{th} grade; age not specified; gender not specified) and 1 teacher (male)	One module once a year for 3 years	Results showed that students' post-test scores were significantly higher than pre-test scores. Qual data revealed that teacher's self-perception was not in alignment with actual instruction. Surveys and interviews confirmed this.
A058	Monjelat, Méndez & Lacasa (2016) Spain	To explore scaffolding and collaboration between students, presenting data from an ethnographic study where a commercial VG was introduced as part of curricular activities.	Social or soft skills	SimCity Creator	COTS	Social studies	No	Qual Case study	10 students (16 – 17 years; 5 boys, 5 girls) and one teacher (male)	5 sessions	Results show that students assumed different tutor functions. Collaboration and scaffolding processes took place spontaneously around the gameplay, showing that students can effectively guide each other without prompts using VG.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A059	Nadolny, Alaswad, Culver & Wang (2017) USA	To examine teacher selection and implementation of game mechanics in 27 courses designed with game based learning.	Teacher implementation or perception of VG	Various	Games for learning	Various	No	Mixed Survey	27 teachers (26 – 64 years; 19 male and 8 female)	N/A	The game attributes and elements utilized by middle school, high school, and college educators varied depending upon what the educators believed to be important or motivating for their students. Teacher selection and inclusion of game mechanics changed over time to better meet the needs of students.
A060	Navarette (2013) USA	To investigate the creative thinking process of students when creating VGs within an educational setting.	Perceptual or cognitive	Flash	Learning through making games	Technology	No	Qual Case study	12 students (6 - 8th grade, age not specified; 6 boys, 6 girls)	1 year	Results show students enjoyed the learning approach as satisfying and engaging, yet technologically challenging. Students experienced positive opportunities through the creation of VGs. Findings suggest that the creative thinking process in a VG creation learning approach may provide a rich and enjoyable learning experience, as well as provide for deep, insightful learning.
A061	Panoutsopoulos & Sampson (2012) Greece	To examine the effect of a commercial VG on the achievement of standard Mathematics educational objectives.	Knowledge acquisition AND Affective or motivational	The Sims 2: Open for Business	COTS	Maths	No	Quant QE	59 students (13 – 14 years; 2nd grade junior high; gender not specified)	Not specified	Results showed that the experimental group achieved the same results as the control group, with regard to the subject matter educational objectives. The VG supported activities resulted in better achievement of the general educational objectives, and no significant differences were observed in students' attitudes towards math.
A062	Pellas & Peroutseas (2016) Greece	To present students' opinions about participation in a VG creation environment.	Affective or motivational AND Social or soft skills	Second Life and Scratch	Learning through making games	Technology	No	Mixed QE	56 students (14 – 15 years; 33 boys and 23 girls)	6 weeks	Study results found that students' computational thinking skills were enhanced as a result of the game activities. All students were satisfied about their communication with their peers and with the Computer Science teacher in collaborative problem-based processes.
A063	Perry & Klopfer (2014) USA	To explore whether author-developed mobile games could gain adoption and improve learning and engagement outcomes for science students.	Knowledge acquisition AND Affective or motivational	Four UniqBio games	Game for learning	Science	Yes	Mixed QE	239 students (9 - 10th grade; age not specified; 108 boys, 99 girls; 32 unknown)	Between 1 and 2 weeks for each game	Results indicated that only one game had statistically significant differences to the control group for engagement. Two games demonstrated a positive correlation between level of achievement and test score. None of the games showed any significant interaction term for time spent playing and level achieved. Mixed results for all variables.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A064	Proctor & Marks (2013) USA	To identify the perceptions, use, and access of exemplar Primary and Secondary educators of VGs and technology for classroom instruction	Teacher implementation or perception of VG	Various	Various	English, Science, Social studies, AND Maths	No	Mixed Survey	259 teachers (primary and secondary; gender not specified)	N/A	The findings show that teachers believe VG are easy to implement and useful. K-5 educators perceived games as more useful for classroom use than 6–12 educators. In general, the best predictors for classroom game use were the level of access teachers had to computer games and their beliefs about the usefulness of implementing games.
A065	Pusey & Pusey (2015) Australia	To investigate the educational value of the use of video games in the classroom, using MinecraftEDU	Affective or motivational AND Exploratory	Minecraft EDU	COTS	Science	No	Mixed Survey	76 students (13 – 14 years; 47 girls, 29 unknown)	6 weeks	The comparison of the student surveys indicated a clear increase in student interest in science and the use of ICTs in school following the program. A majority of students, 84%, reported enjoying using VGs in the classroom and 94% said they wanted to use VGs in the classroom again.
A066	Reynolds & Chiu (2014) USA	To investigate how student engagement in VG design can lessen the relations between student socioeconomic factors and digital inequality (computer use) among youth.	Behaviour change	Flash	Learning through making games	Technology	No	Quant QE	242 students (middle and high school; avg. age 15.4 years, gender not specified)	100 hours of class time	Results show that participation in the program influences technology engagement in schools. Results suggest that increases in technology use emerge through the provision of designed experiences for students and teachers to be productive, organized, coordinated, creative, and sustained in their engagement, during school hours.
A067	Robertson (2013) Scotland	To explore how a game-making project in computer sciences impacts on learners' attitudes to computing, with a focus on gender.	Teacher implementation or perception of VG AND Affective or motivational	Adventure Author	Learning through making games	Various	Yes	Mixed QE	992 students (10 – 18 years; 369 boys and 326 girls, 297 unknown)	2 hours per week for 9 weeks	Results show that students regarded the project positively. Results indicate that girls did not enjoy the experience as much, and the project may make pupils less inclined to study computing in the future. Teachers noted that student achievements, enthusiasm, pride in their work and willingness to teach their peers had exceeded their initial expectations.
A068	Sadler et al. (2015) USA	To explore student learning in the context of innovative VG biotechnology curricula.	Knowledge acquisition AND Affective or motivational	Mission Biotech	Game for learning	Science	Yes	Quant QE	1888 students and 36 teachers (no demographic info specified)	10 days	The results indicated that both experimental and control curriculum were effective in supporting student learning, with no significant differences in learning gains between the two groups. Results also found no evidence to support the notion that VGs can support the development of interest in science among learners.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A069	Sadler, Romine, Stuart and Merle-Johnson (2013) USA	To test the extent to which students learned biology concepts in the context of a game-based curriculum.	Knowledge acquisition	Mission Biotech	Game for learning	Science	Yes	Mixed QE	647 students (10th grade; 324 boys, 323 girls) and 10 teachers (gender not specified)	12 instructional hours	Results indicated statistically and practically significant gains in student performance on both a proximal (curriculum-aligned) test and a distal (standards aligned) exam of biological content knowledge. Students from classes across all three academic levels demonstrated gains with relatively large effect sizes on the proximal test.
A070	Sanchez, Young & Jouneau-Sion (2016) France	To examine the implementation of a VG in different classroom settings and how ludification impacts classroom interactions	Teacher implementation or perception of VG AND Behaviour change	Classcraft	Game for learning	Social studies and Science	Yes	Mixed Survey	Case study: 98 students (10th and 11th grade; age not specified; gender not specified) Survey: 227 teachers (gender not specified)	1 year	**Case study:** Teachers reported increased motivation and deeper engagement in classwork as a result of VG. A positive effect can be attributed to introduction of the game for the two experiments. **Survey**: Teachers describe VG as effective in providing feedback, modifying behaviours and encouraging student commitment to classroom rules.
A071	Shah & Foster (2014) USA	To explore the ecological conditions necessary for implementing a game-based learning course.	Knowledge acquisition AND Exploratory	Rollercoaster Tycoon 3	COTS	Science AND Technology	No	Mixed QE	21 students (5th and 6th grade; age not specified; 13 boys and 8 girls) and 1 teacher (female)	3 months	All students made statistically significant gains in the knowledge test. Effective game integration requires educators to be able to decipher the relationship between a game, the achievement of curricular goals, and it's fit within the school context prior to and during its educational use.
A072	Siko, Barbour & Toker (2011) USA	To examine the results of a study comparing student performance in a high school chemistry course between created PowerPoint games with the students who used a traditional study guide	Knowledge acquisition	Microsoft PowerPoint	Learning through making games	Science	No	Quant QE	301 students (10 to 12th grade; age not specified; gender not specified)	4 days, taught 8 times	Results indicated no statistically significant difference in performance on either test, for either group. Furthermore, there was no difference in performance between students who created games multiple times.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A073	Stieler-Hunt & Jones (2015) Australia	To explore why some educators embrace the use of digital game-play (DGP) in the classroom.	Teacher implementation or perception of VG	Various	Various	Various	No	Qual Interviews	13 education professionals (5 male, 8 female)	N/A	Results indicate that teachers who believe VGs are valuable for their classroom are more likely to use them. Further, being a parent affects teachers' attitude towards using VGs in the classroom. Integrating VG learning support materials will ensure more teachers consider using VGs, and teachers experiencing their own form of subjective 'success' are more likely to want to use VGs again.
A074	Struppert (2010) Australia	To examine the implementation of a VG to promote intercultural competence, focusing on student perceptions of learning	Knowledge acquisition AND Affective or motivational	RealLives	Game for learning	English AND Social studies	No	Mixed Survey	76 students (7th grade; 12 – 13 years; 31 boys, 40 girls, 5 unidentified), 2 teachers (2 male)	4 months in one, 3 weeks in other	The results noted that learning with VGs is generally considered fun and engaging, although excitement can decrease over time. Students can expand their knowledge, deepen their understanding, and make valuable experiences in a variety of areas by using VGs. Findings suggest that learning with VGs requires teacher support to ensure accurate, relevant, and adequate educational outcomes.
A075	Toomey & Kitson (2017) Australia	To explore the use of computer games as curriculum texts in a Year 9 English classroom.	Exploratory	The Elder Scrolls: Arena and Daggerfall, Myst, Riven	COTS	English	No	Qual Case study	3 students (9th grade; 3 boys) 1 teacher (female)	Not specified	The findings indicate that bringing computer games into the classroom affords students rich opportunities for rewarding and innovative work that can transcend traditional classroom boundaries and notions of literacy.
A076	Tsai, Cheng, Yeh & Lin (2017) Taiwan	To investigate the satisfaction of students with a mobile game-based English learning system.	Affective or motivational	Happy English Learning System (HELS)	Game for learning	Language	Yes	Quant Survey	38 students (10th grade; age not specified; gender not specified)	8 weeks	The results found that students who were more interested in learning English were more satisfied with the VG. Students acknowledged satisfaction with the system and the learning process, and the more time the students spent playing the VG per week, the more satisfied they were with the VG and the learning process.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A077	Tsai, Tsai & Lin (2014) Taiwan	To explore how different modes and feedback types in a VG assessment affect knowledge acquisition and participation perceptions of students.	Knowledge acquisition AND Affective or motivational	TRIS-Q	Game for learning	Science	Yes	Quant QE	109 students (9th grade; 15 years avg. age; 55 boys and 54 girls)	4 weeks	Findings indicated that gaming modes (multiplayer and single player) did not affect the effectiveness of knowledge acquisition. Providing feedback enhanced both knowledge acquisition and student ability when comparing it with no feedback. Different modes and feedback types did not affect perceptions.
A078	Tucker-Raymond et al. (2019) USA	To explore the role of critique in science classrooms in which students engage in creating VGs.	Perceptual or cognitive	Scratch	Learning through making games	Science	No	Qual Case study	44 students (8th grade; age not specified; gender not specified) and 2 teachers (1 male, 1 female)	28 days one class, 17 days other	Data indicated that students focused much more on the game play of game design, rather than content. Spontaneous critiques allow for students to be authorities of knowledge and to determine what is acceptable and what is not. However, formal, teacher-designed critiques may be necessary for students to focus on science as part of the critique.
A079	Turan & Meral (2017) Turkey	To find out the effects of VG student response systems on the achievements, engagements, and test anxiety levels of students.	Knowledge acquisition AND Affective or motivational	Kahoot	Game for learning	Social studies	No	Quant QE	46 students (7th grade; age not specified; 26 boys, 20 girls)	4 weeks	The results of the study showed that game-based student response systems increase the achievement and engagement and decrease the test anxiety level when compared to non-game-based student response systems.
A080	Wallon, Jasti, Lauren & Hug (2017) USA	To examine teachers use of a VG to teach scientific argumentation in a biology classroom	Perceptual or cognitive	The Golden Hour and Why Dread a Bump on the Head	Game for learning	Science	No	Qual Case study	199 students (11 - 12th grade; age not specified; 73 boys, 126 girls), 1 teacher (female)	At least 3 classes	The results found student argumentation was only improved in the second iteration, where supported by significant scaffolding. Gameplay alone was not enough to support improvements in argumentation. These findings also highlight the importance of analysing classroom implementation in VG-based learning.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A081	Wilson et al. (2017) USA	To assess the efficacy of two VGs designed to increase high school students' information literacy skills.	Knowledge acquisition	The Detective: Verona and The Detective: Bavaria	Game for learning	English	Yes	RCT	172 students (15 – 18 years; 82 boys, 90 girls)	1 week	Post-test results indicated that both games effectively transmit targeted skills. Additionally, improved performance (relative to controls) on end-of-instruction testing (EOI; end-of-year state testing) suggest that these skills transfer across important academic domains.
A082	Wilson et al. (2018) USA	To understand the contributions and challenges of teacher implementation of VGs	Teacher implementation AND Knowledge acquisition AND Perceptual or cognitive	Geniverse	Game for learning	Science	Unknown	Quant QE	48 teachers (10th grade; age not specified; gender not specified)	3 weeks	Results show the VG had significant impacts on student content knowledge and argumentation skills. No significant differences were found when the experimental group were compared to the control. Teachers noted that effective implementation required skill in teaching science, addressing technology issues, and scaffolding students' engagement.
A083	Yang (2012) Taiwan	To investigate the effectiveness of VGs on students' problem solving, learning motivation, and academic achievement in two 9th grade Civics and Society classes.	Knowledge acquisition AND Perceptual or cognitive AND Affective or motivational	Tycoon City: New York and SimCity Societies	COTS	Social studies	No	Quant QE	44 students (9th grade; 15 – 16 years; gender not specified)	23 weeks	Results found that the VG strategy was effective in promoting problem solving skills, while the control group showed no improvement. VGs resulted in better motivation in the experimental group, compared to the control. The improvement in problem-solving and motivation suggest that VGs can be a useful tool to support effective learning while enhancing the classroom atmosphere.
A084	Yang (2015) Taiwan	To investigate the effectiveness of VG-based learning for improving student ability to solve problems critically and creatively and respond to changes in economic and social conditions.	Knowledge acquisition AND Perceptual or cognitive	Chief Executive Officer and Capitalism 2	COTS	Social studies	No	Quant QE	77 students (11th grade; 16 – 17 years; 19 boys and 58 girls)	27 weeks	Results demonstrated that the experimental group outperformed the comparison group in terms of creative thinking, critical thinking, problem solving, and academic achievement, with significant improvements on all four measures. While the comparison group was effective in promoting academic achievement and creative thinking, the experimental group was deemed most effective in providing an authentic context for developing employment-related skills and knowledge.

Code	Author/year	Aim/objective of study	Outcomes measured	Game	Game purpose	KLA	Developed by authors?	Method	Participants	Intervention length	Results
A085	Zuiker & Anderson (2019) Singapore	To examine the design and enactment of a secondary physics unit on electromagnetism, using an educational VG to support peer dialogic engagement	Social or soft skills	Escape from Centauri 7	Game for learning	Science	Yes	Qual Case study	36 students (14 – 15 years; 36 boys)	2 weeks	Findings demonstrate that peer dialogic engagement occurred within each play-centred cycle for both classes but that the nature of such engagement varied across cycles and student teams. Additionally, comparative case analyses of focal teams' peer dialogic engagement illuminate how the design of play-centred cycles productively supported play and learning while also highlighting emerging tensions for sustaining dialogic engagement.

Appendix C

Survey Recruitment Text and Questions

Video games and learning: a scoping study of the use of diverse video games in Australian classrooms

Project Summary and Participant Information

Thank you for considering being part of this research survey. We appreciate your time.

The aim of this survey is to investigate the current prevalence and uses of video games in Australian secondary classrooms.

You are eligible to participate in this survey if:

1. You are at least 21 years old; and
2. You are a teacher registered with an Australian teacher regulatory authority; and
3. You have taught in a secondary classroom setting in Australia in at least one instance in the past 12 months.

If you meet these criteria, we would love to hear from you!

Below you will find information about the project, including the context of the project and what is involved if you choose to participate.

At the bottom of this page is a button where you can begin the survey if you meet the inclusion criteria and would like to participate.

1. Project Title:

Video games and learning: a scoping study of the use of diverse video games in Australian classrooms

2. Project Team:

Chief Investigator/Principal Supervisor: Dr Roberto Parada

Chief Student: Caitlin Cole

Other Investigators/Supervisors: Dr Erin Mackenzie

See below for contact information.

3. Project Summary:

The principal aim of this project is to examine how frequently video games (digital game-based learning) are used within Australian classrooms, assess how teachers generally feel about the use of games within the classroom, and what may be the significant barriers to the implementation of digital game-based learning in practice.

4. What will I be asked to do? How long will it take?

You are being asked to complete a short online survey. All information you provide is anonymous, and cannot be linked back to you.

The survey has 33 questions, which are split across five sections. It is likely to take 5 - 10 minutes of your time, depending on how much you choose to write in response to the open-text questions.

Most questions are simple multiple choice. Five questions invite you to contribute a text response regarding your views about video games and teaching practice.

5. Background and Context of the Project:

Video games are a part of everyday life and culture for Australians, and this trend is only becoming more widespread. Video games have become common teaching and learning aids within Australian classrooms, yet little is known about the role of the teacher and their pedagogy in the implementation of video games in the classroom.

In addition to this, very little research has been conducted to investigate the use of video games in Australian classrooms. This is a significant gap in educational research, and a possible barrier to the adoption, development, and evaluation of video game use for education within Australia.

For this reason, this project has been developed as a way to start scoping how teachers are using video games in their classes, how teachers feel about this, and any barriers they face in the implementation of video games in their practice. We do not expect to capture all teacher experiences in Australia, but we expect to get results that will create directions for future research.

6. What are the benefits of this project for the broader community? What are the benefits for me as a participant?

The primary benefit of this project to the Australian community is to provide new evidence of current teacher use, attitudes and barriers to video game use for education within secondary schools. This will help to advance education practice through informing interventions and improvements in teacher practice, at an individual, school and government level.

This study will also aim to identify and refine the promoters and barriers to the adoption of digital game-based learning in secondary classrooms in an Australian context, to promote the development of effective digital game-based pedagogy. As a participant, you can be proud that your response to this survey is helping us advance this agenda.

7. Are there any risks to me if I participate in this study?

This project has a very low likelihood of causing harm or distress. However, we must still note the following possibilities:

There is a risk that you may experience inconvenience or frustration if the survey takes longer than you expect, or if some of the questions are unclear to you. If this happens, you are free to simply close the survey and exit at any time. There is a risk you may experience psychological discomfort if the topics of teaching or video games trigger unpleasant memories. If you expect this may happen, we urge you not to take the survey.

8. How will results of this study be published and disseminated? Will I get a copy of the results?

It is anticipated that the results of this project will be published and promoted in a variety of forums. It is likely that this data will produce at least one academic article, and the results may be presented at an academic conference.

As a participant, you can register to receive any published results after you complete the survey. You will be redirected a separate link so that you cannot be linked with your survey response. If you do not register, the results are likely to be published in late 2020 or early 2021.

Please note that all data from this project will be archived in an open-access location for possible use in future research projects. This is in line with global standards in open knowledge.

9. Can I be identified by participating? What happens to the information?

No – you cannot be identified by participating in this survey, not even by the research team. We are not collecting any identifiable information in this survey because it is not necessary to achieve the aims of the study. The only way we will know if you have participated in the survey is if you register for future information after you complete the survey. But this will not be linked to your survey response in any way, so we will not know what information is yours. Naturally, we will fully protect your privacy if you register separately for future information.

10. Can I withdraw from the study?

No. Once you submit your response, it cannot be withdrawn. This is because the survey is completely anonymous, so we are unable to link your response with your name or email address.

11. Can I tell other people about the study?

Yes! You can tell anyone you want about this study. Feel free to tell colleagues, and to circulate via social media if you wish.

If you know other people who may want to participate, you can send them the following URL:

12. What if I require further information?

If you have any questions about this survey before deciding whether to participate, please contact the Chief Student, Caitlin Cole: 18288041@student.westernsydney.edu.au

13. What if I have a complaint?

This study has been approved by the Human Research Ethics Committee at Western Sydney University. The Approval number is H14158.

If you have any complaints or reservations about the ethical conduct of this research, you may contact the Human Research Ethics Committee on Tel +61 2 4736 0229 or by email at humanethics@westernsydney.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

To commence the survey, please confirm that you meet the inclusion criteria, and that you have understood the above information:

- I confirm that I am over 21 years old, that I am a teacher registered with an Australian teacher regulatory authority, I have taught in a secondary classroom setting in Australia in at least one instance in the past 12 months, and that I have understood the above information.

Section 1: Personal and demographic information

Thank you for choosing to participate in this survey. We appreciate your time.

To begin, Section 1 asks some basic personal and demographic questions.

All information is strictly anonymous, but we ask these questions because we think they will enhance our ability to understand teacher use of video games Australia.

1. How old are you?

2. What is your gender?
   - Woman
   - Man
   - I identify my gender as: (please specify)
   - Prefer not to say

3. What is your residential postcode?

4. What is your main teaching KLA (Key Learning Area), as per the Australian Curriculum? If you have more than one, please select all that apply
   - English
   - Mathematics
   - Science
   - Humanities and Social Sciences
   - The Arts
   - Technologies
   - Health and Physical Education
   - Languages

5. How many years have you been teaching?
   - Less than 1
   - 1 – 2
   - 3 – 5
   - 6 – 10
   - 11 – 15
   - More than 15

6. What year groups do you currently teach? Select all that apply. Please note primary school years are included for those teachers who teach in K-12 schools.
    - K
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10
    - 11
    - 12

Section 2: Personal video game experience

7. Do you play video games in your spare time?
    - Yes
    - No

8. **(Display logic: if Q7=Yes)** As an estimate, how many hours per week do you play video games?
    - Less than an hour
    - 1-3 hours
    - 3-5 hours
    - 5-10 hours
    - 10-25 hours
    - More than 25 hours

9. **(Display logic: if Q7=Yes)** What type of games have you played in the last 12 months? Select all that apply. (Modified from Lee et al., 2014)
    - Action: Games with a heavy emphasis on a series of actions performed by the player in order to meet a certain set of objectives (e.g., Super Mario Bros.)
    - Action/Adventure: Games which are set in a world for the player to explore and complete a certain set of objectives through a series of actions (e.g., The Legend of Zelda, Prince of Persia)
    - Driving/Racing: Games involving driving various types of vehicles as the main action, sometimes with an objective of winning a race against an opponent (e.g., Mario Kart, Gran Turismo)
    - Fighting: Games involving the player to control a game character to engage in a combat against an opponent (e.g., Street Fighter, Mortal Kombat)
    - Puzzle: Games with an objective of figuring out the solution by solving enigmas, navigating, and manipulating and reconfiguring objects (e.g., Tetris, Minesweeper)

- RPG: Games with an emphasis on the player's character development and narrative components (e.g., Final Fantasy, Mass Effect)
- Shooter: Games involving shooting at, and often destroying, a series of opponents or objects (e.g., Doom, Duck Hunt)
- Simulation: Games intending to recreate an experience of a real world activity in the game world (e.g., SimCity, Trauma Center)
- Sports: Games featuring a simulation of particular sports in the game world (e.g., FIFA series, Wii Sports)
- Strategy: Games characterized by players' strategic decisions and interventions to bring the desired outcome (e.g., StarCraft, Total War series)
- Other (please specify) _____

10. In your opinion, how much do you agree or disagree with the following statements? (five point Likert scale: Strongly agree - Somewhat agree - Neither agree nor disagree - Somewhat disagree - Strongly disagree) (An, 2018)
    - Video games can enhance students' motivation to learn
    - Video games can get students interested in the subject matter
    - Video games can be helpful for my students' learning
    - Video games are an effective way to teach low-level concepts or basic skills
    - Video games are an effective way to teach complex content and high-level skills
    - Video games can support the needs of diverse learners
    - Video games can help me provide personalised instruction
    - Video games are an effective way to teach real world skills
    - Video games can help students develop problem solving skills
    - Video games can help students develop decision-making skills
    - Video games can help students develop collaboration skills
    - Video games can help students develop communication skills

11. In your opinion, how much do you agree or disagree with the following statements? (five point Likert scale: Strongly agree - Somewhat agree - Neither agree nor disagree - Somewhat disagree - Strongly disagree) (An et al., 2016)
    - I am interested in using video games in my classroom
    - I have knowledge and skills required for using video games in the classroom
    - I am confident using video games in my classroom

12. In general, how compatible (complimentary/well-suited) are educational games with your own teaching practices? (Justice & Ritzhaupt, 2015)
    - Not at all compatible
    - Somewhat compatible
    - Neither compatible nor incompatible
    - Mostly compatible
    - Extremely compatible

13. In general, how easy do you think it would be to experiment with an educational game or simulation in one of your lessons in your main KLA? (Justice & Ritzhaupt, 2015)
    - Extremely easy
    - Somewhat easy
    - Neither easy nor difficult
    - Somewhat difficult
    - Extremely difficult

14. In your opinion, how much do you agree or disagree with the following statements? (five point Likert scale: Strongly agree - Somewhat agree - Neither agree nor disagree - Somewhat disagree - Strongly disagree) (An, 2018)
    - I believe my school leadership would support me in the use of video games in the classroom
    - I believe other teachers at my school would be supportive of me using video games in the classroom
    - I believe parents at my school would be supportive of the use of video games in the classroom
    - I believe students would be supportive of the use of video games in the classroom

Section 3: Video game use and teaching

In this research, a video game is defined as a technological interaction in which players have a predefined goal to achieve within a set of rules, and are intended to have some entertainment value.

This definition can include games made specifically for educational purposes, commercial games designed for entertainment but used for educational purposes, and education through the act of making digital games.

15. Have you ever used video games as a pedagogical tool in your classroom?
    - Yes
    - No

16. How do you think video games could be useful for educational purposes? Please check all that apply. (Justice & Ritzhaupt, 2015)
    - Games are NOT useful for education
    - Review of material
    - Motivating and engaging students
    - Immediate feedback and self-correction
    - Developing hand-eye coordination
    - Problem solving and critical thinking
    - Differentiated (personalized) learning
    - Peer learning opportunities
    - Pre-test for current skills to assign lessons
    - Post-test for learned skills
    - Foster good-natured competition among students

- Approximate real-life situations
- As a reward for students
- Other (please explain)_____

17. **(Display logic: if Q16 "Games are NOT useful for education" chosen)** Why do you believe that video games are NOT useful for education? Please explain below:

18. **(Display logic: if Q15=Yes)** In the last 12 months, how often have you used video games as a pedagogical tool in your classroom?
    - Very infrequently - not at all, or only once each term or less
    - Somewhat infrequently - two or three times a term
    - Occasionally - four or five times a term
    - Somewhat frequently - at least once every two weeks of term, or multiple lessons in a fortnight
    - Very frequently - every week of term, or multiple lessons in a week

19. **(Display logic: if Q15=Yes)** In the last 12 months, what type of games have you used as a pedagogical tool in your classroom?
    - Entertainment games adapted for education use (e.g. SimcityEDU, Portal 2, MinecraftEDU)
    - Commercial off-the-shelf games (e.g. SimCity, Civilization, World of Warcraft)
    - Educational games (e.g. Filament Games, Jacplus Games, Poptropica)
    - Other (please specify) _____

20. **(Display logic: if Q15=Yes)** Name any video games that you have used as a pedagogical tool in your classroom in the last 12 months.

21. **(Display logic: if Q15=Yes)** Based on your experiences using digital games in your teaching, indicate your level of agreement with the following statements (five point Likert scale: Strongly agree - Somewhat agree - Neither agree nor disagree - Somewhat disagree - Strongly disagree):
    - Video games are an effective way to teach students curriculum content
    - Video games are an effective way to assess students on curriculum knowledge and/or skills
    - Video games are an effective way to teach concepts
    - Video games can help students perform better on standards-aligned assessments
    - Video games are an effective way to teach social skills
    - Video games are an effective way to teach problem-solving skills
    - Video games have been effective in increasing my students' engagement
    - Video games have been effective in increasing my students' motivation

22. **(Display logic: if Q15=Yes)** In what ways do you assess student learning or performance with digital games?
    - o I am able to tell what students have learned through their game play in whole-class or group discussions
    - o I look at student scores in games to assess their knowledge/skills on topics we cover in other formats
    - o I use the built-in assessment system that come with certain games
    - o I create my own test/quizzes to assess what students have learned by playing digital games
    - o I do not assess student performance with/around video games
    - o Other (please explain)

23. **(Display logic: if Q15=Yes)** Since integrating video games into your teaching, what changes, if any, have you observed in classroom situations? (Increased – decreased – no change – N/A)
    - o Sustained attention to specific tasks
    - o Positive collaboration between students
    - o Conflict between students
    - o Delays in delivering content or curriculum
    - o Other, (please explain)

24. **(Display logic: if Q15=No)** Would you like to use games as a pedagogical tool in your classroom?
    - o Yes
    - o Unsure
    - o No

25. **(Display logic: if Q24=No or Unsure)** What is the reason that you do not want to, or are unsure about, using games as a pedagogical tool in your classroom?

26. In your teaching experience, what are the greatest barriers teachers face in using digital games in the classroom? Select all that apply.
    - o Insufficient time
    - o Cost
    - o Lack of technological resources
    - o Not sure where to find quality games
    - o Unfamiliar with technology
    - o Hard to find games that fit the curriculum
    - o Lack of administration support
    - o Emphasis on standardized test scores
    - o Lack of parental support
    - o There are no barriers
    - o Other (please explain)

Section 4: Professional development and video games

27. How did you first develop your understanding about using video games in the classroom? Select all that apply. (Takeuchi and Vaala, 2014)
    - From another teacher, mentor or supervisor
    - I figured it out myself
    - In-service professional development
    - From a conference I attended
    - Pre-service teacher education
    - From my own students, or my own children
    - From an online resource
    - Other (please specify)

28. Have you ever attended professional development for video game use in the classroom?
    - Yes
    - No

29. **(Display logic: if Q28=yes)** Was the most recent professional development you attended for video game use helpful to your classroom teaching?
    - Extremely helpful
    - Very helpful
    - Moderately helpful
    - Slightly helpful
    - Not at all helpful

30. **(Display logic: if Q28=yes)** Did this professional development influence your teaching practice?
    - Yes
    - Unsure
    - No

31. **(Display logic: if Q28=no)** Would you be interested in attending professional development for video game use in the classroom?
    - Definitely yes
    - Probably yes
    - Might or might not
    - Probably not
    - Definitely not

Section 5: Teaching during COVID-19

32. To what extent do you feel that COVID-19, and the related interruptions to regular classroom teaching, has influenced your use of video games in the classroom?
    - A great deal
    - A lot
    - A moderate amount

- o A little
- o Not at all

33. **(Display logic: if Q32=any except 'not at all')** In what way has COVID-19, and the related interruptions to regular classroom teaching, influenced your use of video games in the classroom?

Appendix D

Teacher Video Game Use Attitudinal Scale Items

Educational benefits of games

- Digital games can enhance students' motivation to learn
- Digital games can get students interested in the subject matter
- Digital games can be helpful for my students' learning
- Digital games are an effective way to teach basic skills (e.g., addition, subtraction)
- Digital games are an effective way to teach complex content and high-level skills
- Digital games can support the needs of diverse learners
- Digital games can help me provide personalized instruction

The potential of video games to foster real world skills

- Digital games are an effective way to teach real-world skills
- Digital games can help students develop problem-solving skills
- Digital games can help students develop decision-making skills
- Digital games can help students develop collaboration skills
- Digital games can help students develop communication skills

Teacher interest and self-efficacy

- I am interested in using digital games in my classroom
- I am confident using digital games in my classroom
- I have knowledge and skills required for using digital games in the classroom

External Support for Video Game Use Scale Items

- I believe my school leadership would support me in the use of video games in the classroom
- I believe other teachers at my school would be supportive of me using video games in the classroom
- I believe parents at my school would be supportive of the use of video games in the classroom
- I believe students would be supportive of the use of video games in the classroom

Appendix E

Social Media Recruitment Text and Posting Schedule

Social media page	Dates posted
WSU MTeach Secondary Alumni	9/12/2020, 14/01/2021, 2/03/2021
AARE SIG Technology and Learning	2/12/2020, 14/01/2021, 2/03/2021
NSW Proficient Teachers Maintaining Accreditation	9/02/2021
Teachers in Remote Communities (Past, Present and Future) and Remote Teachers Australia (Joint Facebook managed groups)	3/12/2020, 14/01/2021, 2/03/2021
Secondary Teachers Ideas and Support Community (Australia)	14/01/2021, 2/03/2021
Secondary Teacher Life	2/12/2020, 9/02/2021, 2/03/2021
English Teachers Australia	2/12/2020, 15/01/2021, 2/03/2021
Geography Teachers Online Australia	14/01/2021, 2/03/2021
NSW Technology Teachers	14/01/2021, 2/03/2021
TAS and HOME EC Teachers (Secondary)	3/12/2020, 9/02/2021, 2/03/2021
QLD Teachers	9/12/2020, 15/01/2021, 2/03/2021
Art Teachers Australia	9/12/2020, 9/02/2021, 2/03/2021
Western Australian Teachers	2/12/2020, 15/01/2021, 2/03/2021
Teachers Supporting Teachers – Australia	15/01/2021, 2/03/2021
Victorian Teachers Going Online 2020	9/12/2020, 9/02/2021
Melbourne Teachers	14/01/2021, 2/03/2021
Teachers of Darwin & NT	3/12/2020, 14/01/2021, 2/03/2021
Personal Facebook page	14/01/2021
Mathematics Teachers of NSW	19/01/2021, 2/03/2021
Australian Secondary Mathematics Teachers 7-12	19/01/2021, 2/03/2021
Teachers in NSW - Western Suburbs	19/01/2021, 2/03/2021
Secondary Math Teachers South Australia	19/01/2021, 2/03/2021
NSW Chemistry Teachers	19/01/2021, 2/03/2021
Queensland Senior Mathematics Teachers	19/01/2021
NSW Biology Teachers	19/01/2021
NSW PDHPE Teachers	4/02/2021 2/03/2021
PDHPE Teachers	19/01/2021, 2/03/2021
NSW Casual Teachers	19/01/2021, 2/03/2021
Aussie Teacher Support Group	4/02/2021
Aussie New Teacher Community	8/02/2021
History Teachers Resources Australia	4/02/2021
Casual Relief Teachers in Australia: Let's unite!	4/02/2021
Science Teachers - Advisory Group for Australia	4/02/2021
Australian Early Career Teachers Association	4/02/2021
Cool History Teachers Australia	8/02/2021
Australian Teacher COVID 19 Support Page	4/02/2021
Society and Culture Teachers Australia	8/02/2021
Reddit r/AustralianTeachers	04/2021

Sample recruitment text:

Appendix F

Research Ethics Approval

HUMAN RESEARCH ETHICS COMMITTEE

18 November 2020
Doctor Roberto Parada
School of Education

Dear Roberto,

Project Title: "A Scoping Study of the Use of Diverse Video Games in Australian Classrooms"

HREC Approval Number: H14158
Risk Rating: Low

I am pleased to advise the above research project meets the requirements of the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018).

Ethical approval for this project has been granted by the Western Sydney University Human Research Ethics Committee. This HREC is constituted and operates in accordance with the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018).

Approval of this project is valid from 18 November 2020 until 18 November 2021.

This protocol covers the following researchers:

Roberto Parada, Caitlin Cole, Erin Mackenzie

Summary of Conditions of Approval

1. A progress report will be due annually on the anniversary of the approval date.

2. A final report will be due at the expiration of the approval period.

3. Any amendments to the project must be approved by the Human Research Ethics Committee prior to being implemented. Amendments must be requested using the HREC Amendment Request Form.

4. Any serious or unexpected adverse events on participants must be reported to the Human Research Ethics Committee via the Human Ethics Officer as a matter of priority.

5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the Committee as a matter of priority.

6. Consent forms are to be retained within the archives of the School or Research Institute and made available to the Committee upon request.

7. Approval is only valid while you hold a position or are enrolled at Western Sydney University. You will need to transfer your project or seek fresh ethics approval from your new institution if you leave Western Sydney University.

8. Project specific conditions:

There are no specific conditions applicable.

Please quote the registration number and title as indicated above in the subject line on all future correspondence related to this project. All correspondence should be sent to humanethics@westernsydney.edu.au as this email address is closely monitored.

Yours sincerely

Professor Brett Bowden
Presiding Member,
Western Sydney University Human Research Ethics Committee

Western Sydney University
ABN 53 014 069 881 CRICOS Provider No. 00917K
Locked Bag 1797 Penrith NSW 2751 Australia
westernsydney.edu.au

Appendix G

Stem-and-Leaf Plots and Box Plots for Bootstrapping and Regression Analysis

Educational Benefits of Games Subscale Mean Stem-and-Leaf Plot

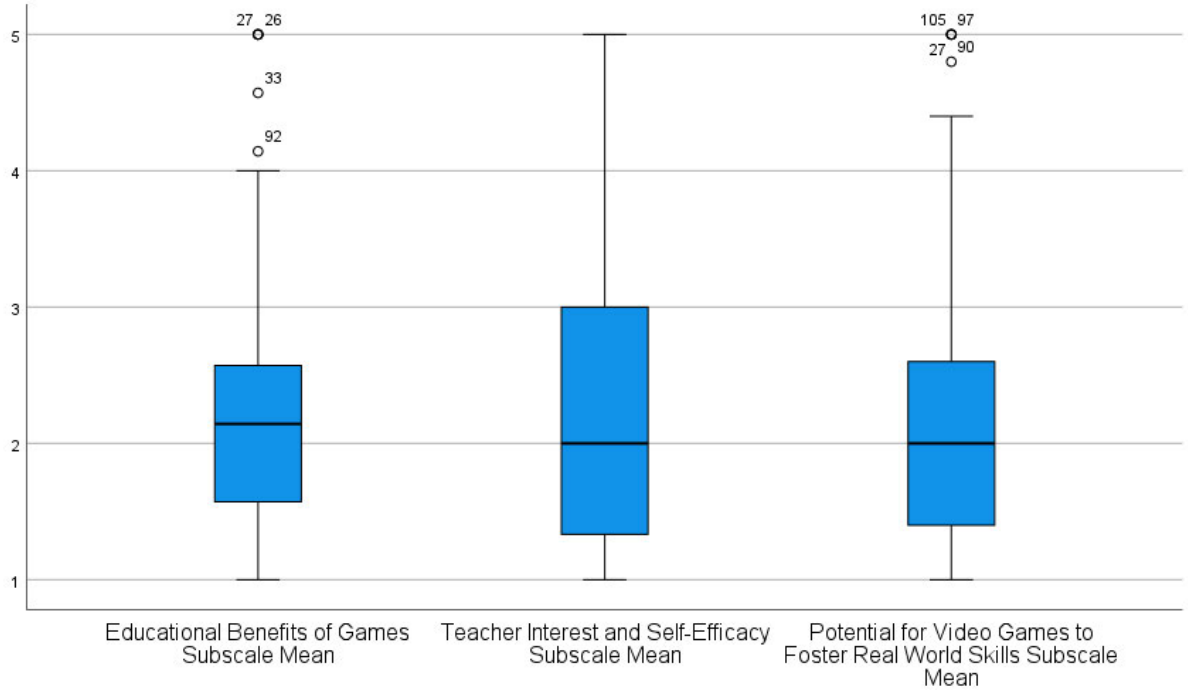
```
 Frequency    Stem & Leaf

    13.00        1.  0000000000011
    10.00        1.  2222222222
    12.00        1.  444445555555
     9.00        1.  777777777
     4.00        1.  8888
    16.00        2.  0000000001111111
    13.00        2.  2222222222222
    17.00        2.  44444445555555555
     2.00        2.  77
     5.00        2.  88888
     4.00        3.  0011
     2.00        3.  22
     4.00        3.  4445
     1.00        3.  7
     2.00        3.  88
     1.00        4.  0
     5.00 Extremes (>=4.1)

 Stem width:      1.00
 Each leaf:        1 case(s)
```

Teacher Interest and Self-Efficacy Subscale Mean Stem-and-Leaf Plot

```
 Frequency    Stem & Leaf

    34.00        1.  00000000000000000000000000333333333
    15.00        1.  666666666666666
    23.00        2.  00000000000000033333333
     4.00        2.  6666
    24.00        3.  000000000000000003333333
     6.00        3.  666666
     8.00        4.  00003333
     2.00        4.  66
     4.00        5.  0000

 Stem width:      1.00
 Each leaf:        1 case(s)
```

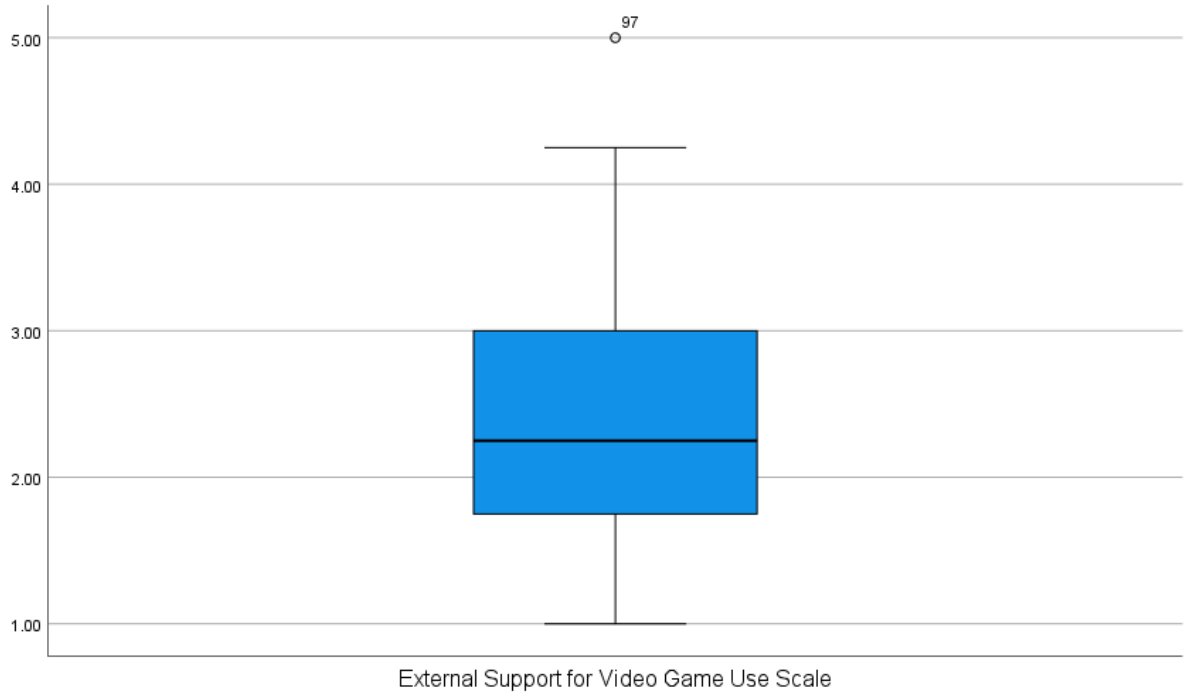
Potential for Video Games to Foster Real World Skills Subscale Mean Stem-and-Leaf Plot

```
 Frequency    Stem & Leaf

    15.00        1.  000000000000000
    14.00        1.  22222222222222
    13.00        1.  4444444444444
    10.00        1.  6666666666
     5.00        1.  88888
    12.00        2.  000000000000
    10.00        2.  2222222222
    10.00        2.  4444444444
     9.00        2.  666666666
     4.00        2.  8888
     6.00        3.  000000
     2.00        3.  22
     2.00        3.  44
     1.00        3.  6
     1.00        3.  8
      .00        4.
      .00        4.
     2.00        4.  44
     4.00 Extremes (>=4.8)

 Stem width:      1.00
 Each leaf:        1 case(s)
```



External Support for Video Game Use Scale Stem-and-Leaf Plot

```
 Frequency    Stem & Leaf

     8.00        1.  00000000
     5.00        1.  22222
     9.00        1.  555555555
    15.00        1.  777777777777777
      .00        1.
    13.00        2.  0000000000000
    18.00        2.  222222222222222222
    10.00        2.  5555555555
     9.00        2.  777777777
      .00        2.
     7.00        3.  0000000
    11.00        3.  22222222222
     6.00        3.  555555
     3.00        3.  777
      .00        3.
     3.00        4.  000
     2.00        4.  22
     1.00 Extremes (>=5.0)

 Stem width:      1.00
 Each leaf:        1 case(s)
```



Appendix H

Papers Identified in Systematic Review Search

A list of all papers identified in the initial search for the systematic review is available through this link. Papers retained for the review are highlighted

Appendix I

Mean and standard deviation for Teacher Video Game Use Attitudinal Scale and External Support for Video Game Use Scale

Variables			Teacher Video Game Use Attitudinal Scale			External Support for Video Game Use Scale
			Educational benefits of games	Video games and real world skills	Teacher interest and self-efficacy	
All		*n*	139	139	139	139
		Mean	15.38	10.37	6.94	9.47
		SD	6.25	4.78	3.27	3.34
Gender	Male	*n*	51	51	51	51
		Mean	14.65	9.02	5.65	9.2
		SD	6.84	3.84	2.99	3.58
	Female	*n*	87	87	87	87
		Mean	15.91	11.22	7.74	9.64
		SD	5.84	5.1	3.19	3.22
Age	21-30	*n*	55	55	55	55
		Mean	14.3	9.29	6.93	9.6
		SD	5.24	4.10	3.3	3.46
	31-40	*n*	47	47	47	47
		Mean	15.4	10.36	6.81	9.23
		SD	6.41	4.38	3.19	3.45
	41-50	*n*	26	26	26	26
		Mean	16.54	12.23	7.1	9.81
		SD	5.27	4.85	2.98	2.48
	51+	*n*	11	11	11	11
		Mean	18	11.36	7.18	9
		SD	10.75	7.80	4.4	4.27

Variables			Teacher Video Game Use Attitudinal Scale: Educational benefits of games	Teacher Video Game Use Attitudinal Scale: Video games and real world skills	Teacher Video Game Use Attitudinal Scale: Teacher interest and self-efficacy	External Support for Video Game Use Scale
Number of years teaching	Less than 1	*n*	8	8	8	8
		Mean	14.75	10.38	7.38	11.63
		SD	6.45	6.39	3.16	3.25
	1 – 2	*n*	24	24	24	24
		Mean	14.46	10	6.04	8.96
		SD	5.11	4.77	3.13	3.18
	3 – 5	*n*	38	38	38	38
		Mean	13.53	9.13	7.11	9.39
		SD	4.47	3.24	3.27	2.9
	6 – 10	*n*	26	26	26	26
		Mean	15.19	9.65	6.23	8.96
		SD	6.18	3.43	2.8	3.57
	11 – 15	*n*	13	13	13	13
		Mean	14.69	9.69	6.46	9.08
		SD	3.17	3.4	2.73	2.4
	More than 15	*n*	30	30	30	30
		Mean	19.1	13.13	8.13	10
		SD	8.54	6.47	3.80	4.04

			Teacher Video Game Use Attitudinal Scale			External Support for Video Game Use Scale
			Educational benefits of games	Video games and real world skills	Teacher interest and self-efficacy	
KLA taught	English	*n*	39	39	39	39
		Mean	13.72	9.28	6.38	9.03
		SD	4.9	3.85	2.84	3.09
	Social Studies	*n*	39	39	39	39
		Mean	14.26	9.72	7.18	9.28
		SD	6.1	4.71	3.51	3.01
	Science	*n*	30	30	30	30
		Mean	15.97	10.97	7.63	9.77
		SD	3.55	3.75	2.99	3.06
	Maths	*n*	22	22	22	22
		Mean	16.5	12.14	7.23	10.32
		SD	7.44	5.23	3.35	4.1
	Technology	*n*	33	33	33	33
		Mean	14	9.21	5.36	8.7
		SD	6.58	4.08	2.46	3.16
	Art	*n*	13	13	13	13
		Mean	13.31	8.69	5.69	8.15
		SD	4.27	3.04	2.18	3.29
	PE	*n*	10	10	10	10
		Mean	19.4	13.5	9.5	11.1
		SD	7.63	6.24	3.98	4.63