



Review

Massively Multiplayer Online Role Playing Games (MMORPGs) and the 21st century skills: A comprehensive research review from 2010 to 2016



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ABSTRACT

In the past decade, there has been increasing interest in studying the educational affordances of Multiplayer Online Role Playing Games (MMORPGs). Using the KSAVE (Knowledge, Skills, Attitudes, Values, Ethics) 21st Century Skills framework, this paper presents the current state of the art in MMORPGs empirical research from 2010 to 2016, considering the latest overview reported in 2010. This review sought to determine the level of maturity of the body of MMORPGs research and to identify lacks of knowledge, with respect to 10 types of 21st Century Skills. The current work considered 120 research publications and categorized 49 empirical studies according to their research foci and results on one or more types of 21st Century Skills. The results revealed a strong body of evidence suggesting that MMORPGs are spaces in which a variety of 21st Century Skills can be fostered. Yet, most MMORPGs research focuses on the investigation of the communication skill (22% of the skills examined), whilst creativity and innovation as well as problem solving and information literacy are largely unexplored in this context. The discussion focuses on understudied areas in MMORPGs research aiming to advance future inquiry that addresses current challenges.

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1. Introduction

Massively Multiplayer Online Role Playing Games (hereafter MMORPGs) have already drawn significant attention from scholars in various learning oriented academic disciplines. These video games are designed in ways that promote sociability, communication and collaboration amongst players pursuing missions (quests) in the environment (Yu, 2009). As Squire (2006) argues, "... the most intense social learning is found in massively multiplayer games, where players interact with thousands of other players in real time over the Internet" (p.23). MMORPGs require players to synthesize, analyze and evaluate information, apply critical thinking and solve problems thus, they may be considered as learning environments that support players in gaining, the so called, 21st century skills which can be potentially transferable in real life (Dickey, 2007; Susaeta et al., 2010). The acquisition of these skills – collaboration, communication, leadership, problem solving, to name a few – is considered by academics and policy makers to be essential as societies move into the new century (Dede, 2010; Klopfer, Osterweil, & Salen, 2009; Voogt & Roblin, 2010).

A few researchers have investigated MMORPGs and their potential to nourish the development of the 21st Century Skills. Spire (2008), for example, elaborated on that MMORPGs such as World of Warcraft (WoW - Us.battle.net/en, 2014) can instigate players to analyze new situations, interact with people that don't really know, solve problems, think strategically, and collaborate effectively, all of which are essential skills for the knowledge workers of the 21st century workspace. Similarly, Galarneau and Zibit (2007) argued that via engagement with MMORPGs the 21st century skills are cultivated spontaneously and learning is a product of the interaction with the game. Yet, empirical research has yet to prove or refute these assumptions.

The most recent report on MMORPGs research and learning comes from Anderson (2010) who concluded that research in the field is scattered across multiple disciplines and is difficult to synthesize. Using the KSAVE (Knowledge, Skills, Attitudes, Values, Ethics) 21st Century Skills framework, this review maps the current state of the art in MMORPGs empirical research from 2010 to 2016, aiming to determine the level of maturity of the body of research and identify lacks of knowledge with respect to 10 types of 21st Century Skills. The structure of this manuscript includes the definition of MMORPGs adopted in the review, the KSAVE theoretical framework of the 21st Century Skills, the survey methodology, the results of the categorization, and an extensive discussion of the review's findings, aiming to evoke further inquiry that addresses current research challenges. Given the increasing interest in studying the educational affordances of MMORPGs, the authors consider this work timely and relevant to the research community whilst informative to academics, educators and users of MMORPGs.

1.1. What are MMORPGs?

Definitions of MMORPGs abound. In fact, a few works on MMORPGs as claimed by the original authors, could be more accurately described research on multiplayer online games, since they do not take into account some unique characteristics of MMORPGs as described hereafter. A MMORPG is a network-based, three dimensional, interactive, narrative environment which is permanent and consistent (Achterbosch, Pierce, & Simmons, 2008). It is *narrative* because it follows a certain plot and *consistent* because when a player logs out of the game or just takes a break, the game continues to exist in real time and "space" on the internet (VanFossen, Friedman, & Hartshorne, 2008). *Massively Multiplayer* refers to the mass participation of players that can reach millions of users per game. *Role Playing* refers to the fact that the player

assumes the role of a fantasy avatar in-game; the player is responsible for his/her avatar's actions and interacts with other players in-game (VanFossen et al., 2008; Yee, 2006). Players "train" their avatars (also known as "characters") through accomplishing various missions (quests). These quests reward the player's "character" with experience points (XP points) which can be used, accumulated or exchanged with power ups (leveling), magic abilities and in-game objects. All of the above in turn, help the character to advance in further stages/levels of the game while this process is becoming repetitive, more difficult and challenging (e.g. Achterbosch et al., 2008; Ducheneaut, Moore, & Nickel, 2004; Peterson, 2012; VanFossen et al., 2008). Because MMORPGs have game rules, provide feedback, and users are in a state of continuous interaction with the environment and other users, they are different from social worlds such as Second Life (Secondlife.com, 2016), which have no embedded gameplay (Bartle, 2010; Bell, Smith-Robbins, & Withnail, 2010). The present review adheres to all the nuances of the MMORPGs definition expressed above.

1.2. KSAVE theoretical framework of the 21st century skills

Researchers have recently studied the kinds of skills needed to succeed in the ever changing digital world (Spire, 2008; Voogt & Roblin, 2010), whilst different research groups have developed different frameworks to describe this skillset (e.g. EU - Eurlex.europa.eu, 2014; USA - The Partnership for Twenty-first century skills - p21.org, 2016; Assessment & Teaching of 21st Century Skills - atc21s.org, to name a few). The present review adopted, the KSAVE 21st Century Skills framework proposed by Binkley et al. (2012), with four dimensions and 10 categories of skills as outlined in Table 1. KSAVE derived from a synthesis of previous existing frameworks around the world and "... is sufficiently broad and comprehensive to accommodate all approaches" (Binkley et al., 2012, p. 36).

2. Methodology

Considering the existing report by Anderson (2010) who over-viewed MMORPGs in support of learning, this review covers the newer period from 2010 to 2016 and includes works published in refereed journals, conference proceedings and book chapters. Following the survey methodology described in Dünser, Grasset and Billingham (2008) – which is.

Characterized by a process of iterative selection, filtering and classification – the data set was searched and filtered by two researchers and co-authors of this review, as follows:

2.1. Step 1-database search

A search was conducted by the first author of this work (coder A) in the following electronic databases: ACM Digital Library, Biomed Central, Cambridge University Press, Ebsco, editlib, Emerald, ERIC, JSTOR, Oxford Journals, Proquest, Sage, Science Direct, Scopus, Springer Link, Taylor and Francis Online, Wiley, Web of Science, and Google Scholar. The search terms were: "Massively Multiplayer Online Role Playing Games" or "MMORPGs" in conjunction with keywords based on the KSAVE model skills e.g., "collaboration", "communication", "problem solving", "citizenship" etc. The search was expanded with keywords such as "learning", "teaching", "21st century skills", "education", and names of MMORPGs based on popularity (Mmodata.blogspot.com, 2014) including "World of Warcraft" (or "WoW"), "Everquest", "Lineage", "Runescape", "Eve online", "Aion", "Star Wars: The Old Republic" (or "SWTOR"). The database search yielded 120 relevant manuscripts published during 2010–2016.

Table 1

Binkley et al.'s (2012) KSAVE framework of 21st Century Skills with four dimensions and 10 categories of skills.

Dimension 1: Ways of thinking
1 Creativity and innovation
2 Critical thinking, problem solving and decision making
3 Learning to learn, Metacognition
Dimension 2: Ways of working
4 Communication
5 Collaboration (teamwork)
Dimension 3: Tools for working
6 Information literacy
7 ICT literacy
Dimension 4: Living in the world
8 Citizenship – local and global
9 Life and career
10 Personal and social responsibility – including cultural awareness and competence

2.2. Step 2 - excluding false positives

Coder A undertook a careful examination of the MMORPG definition in all 120 manuscripts. Incorrectly selected papers in which the game(s) elaborated did not match the abovementioned MMORPGs definition were identified and excluded, with 100 papers remaining in the pool. The excluded papers were reviewed, independently, by the second author of this manuscript (coder B), to ensure exclusion criteria was correctly applied (100% agreement existed between coders).

2.3. Step 3 – filtering empirical work on 21st century skills

Coder A carefully inspected the content of the 100 manuscripts, considering what the original authors of the manuscripts claimed to have studied. Only papers with empirical data examining one or more types of 21st century skills were of interest for this review, with 49 papers remaining in the pool. In particular, theoretical or position papers, or papers only examining attitudes and behaviors, gender differences, and game design or usability issues were excluded from the pool. The excluded papers were reviewed, independently, by coder B, to ensure exclusion criteria was correctly applied (100% agreement existed between coders).

2.4. Step 4 – categorization

All 49 selected papers were thoroughly read by coder A. Coder B independently read a randomly selected subset of these manuscripts (i.e., 10 manuscripts - approximately 20% of corpus). The coders aimed to go beyond what the original authors claimed to have studied, to detect the true foci and results on one or more types of 21st Century Skills. The manuscripts were then, classified accordingly to Binkley's et al. (2012) KSAVE framework and the 10 categories of skills as in Table 1. The classification in the 10 skill-categories was fully consistent with the original definitions

reported in Binkley et al. (2012; please review Binkley et al. (2012) for these definitions). For example, a manuscript was categorized as *Communication*, if the skill being studied matched the term defined as “the ability to communicate in written or oral form ..., the ability to listen to various spoken messages ..., read and understand different texts ... (Binkley et al., 2012, p. 45). Upon completion of the coding, a reliability check between the coders revealed 100% agreement between them.

3. Results

Table 2 provides an overview of the paper classification useful to understand the overall distribution of the papers along the different dimensions of KSAVE. Frequency (f) and percentage (%) of papers in each category of the four dimensions of KSAVE are reported. The sum of frequencies (n = 64) exceeds the number of selected papers (n = 49) because some manuscripts researched more than one skill. The reader interested in knowing the 49 papers and how each of them was classified may consult the Appendix. The section that follows analyzes selected papers within each KSAVE dimension, providing insight into the current stage of knowledge.

3.1. Ways of thinking

The review revealed that *Creativity and Innovation* (n = 0), in MMORPGs are understudied. Very few studies (n = 4) were found to examine *Critical thinking, problem solving, and decision making* (Hou, 2013; Silva & Mousavidin, 2015; Voulgari & Komis, 2010a; Voulgari, Komis, & Sampson, 2015). For example, Voulgari and Komis (2010a), examined factors that promote problem solving in MMORPGs and concluded that problem solving processes are affected by the task, the group structure, the characteristics of the members involved and the group interactions. On the other hand, Hou (2013) implemented an educational MMORPG designed to support second language learning. Although positive learning

Table 2

Paper classification - frequency (f) and percentage (%) in each category of the four dimensions of KSAVE.

1. Ways of thinking		2. Ways of working		3. Tools for working		4. Living in the world	
Categories	f (%)	Categories	f (%)		f (%)		f (%)
1 Creativity and innovation	0 (0%)	1 Communication	14 (22%)	1 Information literacy	3 (5%)	1 Citizenship – local and global	3 (5%)
2 Critical thinking, problem solving, decision making	4 (6%)	2 Collaboration (teamwork)	6 (9%)	2 ICT literacy	9 (14%)	2 Life and career	5 (8%)
3 Learning to learn, Metacognition	11 (17%)					3 Personal and social responsibility	9 (14%)
Total	15 (23%)		20 (31%)		12 (19%)		17 (27%)

outcomes were found in this work, the game did not enhance students' problem-solving skills (especially those with low learning performance), possibly due to the lack of feedback by the game itself, as the author argues (Hou, 2013). With regards to *Learning to learn and Metacognition* ($n = 11$), a consistent finding in the literature appears to be that learning in MMORPGs is a progressive complex process that involves the use of in-game and external resources (Golub, 2010; King, 2013; Kongmee, Pickard, Strachan, & Montgomery, 2012; Kong, Kwok, & Fang, 2012; Kongmee, Strachan, Montgomery, & Pickard, 2011; Sarbu, 2011; Silva & Mousavidin, 2015; Thorne, Fischer, & Lu, 2012; Voulgari & Komis, 2010). For example, Golub (2010) found that by utilizing external resources such as forums and wikis, players developed retainable knowledge, which was used to efficiently defeat bosses in-game. Monem (2015) reported that a player could develop metacognitive skills by connecting prior in-game acquired knowledge to new knowledge. Additionally, it was found that students playing a modified for educational purposes MMORPG, maintained their concentration and developed ways to mine knowledge faster (Melissourgos, Mysirlaki, & Paraskeva, 2015). Furthermore, Kong et al. (2012), sought to investigate the reasons of players' intentions to learn in a MMORPG and concluded that peer extrinsic motivation positively influenced the intention to learn individually.

3.2. Ways of working

The skill of *Communication* ($n = 14$) has been extensively studied in the context of second language learning. Studies in this category included quest texts (Thorne et al., 2012), information retrieval from external resources (Kongmee et al., 2011, 2012; Thorne et al., 2012), in-game communication between players (Peterson, 2012; Zheng, Newgarden, & Young, 2012) and vocabulary learning (Bytheway, 2013, p. 39; Huang & Yang, 2014; Yang & Hsu, 2013; Zheng, Bischoff, & Gilliland, 2015). It was also reported that positive learning outcomes derived from being and interacting in-game including improved reading, writing and listening skills (Suh, Kim, & Kim, 2010). A main finding was that communication in MMORPGs is necessary for coordination, socialization, and teamwork thus the learning of a second language acquisition is essential (Bytheway, 2013, p. 39; Kongmee et al., 2011, 2012; Peterson, 2012; Rama, Black, van Es, & Warschauer, 2012; Silva, 2014; Wu, Richards, & Saw, 2014). For example, Rama et al. (2012) reported that games like WoW are designed in ways that promote communication, making language learning an authentic experience that involves interaction with native speaking co-players. They also observed that collaboration between experts and novices can be beneficial for both in the case where: a player is an expert in game mechanics but a novice in language learning while another player is an expert in language but a novice in game mechanics. Furthermore, Strachan, Kongmee, and Pickard (2016) concluded that the communication skills learned are transferable from game to game. As far as *Collaboration* ($n = 6$) is concerned, collaborative activities were found to increase motivations for learning (Kong et al., 2012) and successful team coordination (Chang & Lin, 2014) while the design of the environment impacts the former (Voulgari & Komis, 2010). Voulgari and Komis (2010, pp. 28–30) support that the social environment is equally important in the collaborative process and reported that players seek interactions with others as a motivation to play. These interactions were described to have a central role in collaborative play and create bonds that lead to the effectiveness of teamwork (Voulgari & Komis, 2010, pp. 28–30). Some indications exist pointing that novices are not skillful in collaborative tasks (Wang & Chen, 2012). Nevertheless, either playing frequently or infrequently, MMORPGs foster collaborative activities (Dickey, 2011).

3.3. Tools for Working

Fewer studies examined Tools for Working in MMORPGs. *Information literacy* ($n = 3$) was addressed by Martin and Steinkuehler (2010) who detailed the forms of Information literacy that emerge from MMORPGs by reporting findings from a broader research that aimed at observing practices of participants around WoW. Unlike what other studies suggested about information literacy, which is conceived to be an individual process, in MMORPGs information literacy is conceived to be collective (Martin & Steinkuehler, 2010). The above is confirmed by King (2013) who reported that information literacy is both individual and collective process. It takes place individually when players search through online multimodal information resources such as wikis, online forums, YouTube videos and collective via human resources and social networks such as raiding guild members, friends in-game, chat in-game (King, 2013). Similar findings were reported by Silva and Mousavidin (2015) who further concluded that individual and collective information literacy in MMORPGs is essential in order for a player to solve the many challenges presented in game. The studies on *ICT literacy* ($n = 9$) inform that MMORPGs have the potential to lead to ICT literacy: (i) in-game with players acquiring knowledge of technical nature (Bennerstedt, Ivarsson, & Linderöth, 2012; Liu, 2015; Malliarakis, Satratzemi, & Xinogalos, 2014; McCreery, Schrader, & Krach, 2011), (ii) indirectly with players utilizing external resources to develop “mods” or “add-ons”- programs that the players develop to alter their interface for better gaming experience (Behnke, 2012; Golub, 2010) or using tools like VoIP (Golub, 2010) and (iii) by learning to code by using an educational MMORPG (Graven & MacKinnon, 2010). Furthermore, Golub (2010) stated that players continuously modify their UI in order to acquire more knowledge of the game mechanics. De Souza, e Silva, & Roazzi, (2010) noted that MMORPG players spend more time using all kinds of digital tools than non-MMORPG players or non-gamers and this was accompanied by evidence in their study of superior logical, mathematical skills and school efficiency performance. Additionally, Stone et al. (2016) reported in their study that students developed specific ICT literacies associated with WoW like the language of MMORPGs (which is gamers' “language” including words like “boss”, “wipe”, “loot”), gear management and interface reading, and ways of communication in-game.

3.4. Living in the world

A large number of studies have investigated Living in the World. *Citizenship* ($n = 3$) was studied by Zhong (2011) who reported that participatory activities in game communities, as may lead to organizational and communicational skills on behalf of a player which result to offline civic engagement. Additionally, Hartshorne, VanFossen, and Friedman (2012) reported civic engagement activities by WoW players both in-game and in the real world at a higher rate than non-players and furthermore that guild leaders were more likely to be civically engaged than the rest of the guild ranks. Lastly, Sarbu (2011) concluded that online citizenship includes not only rights, but obligations as well with all players contributing to a cause in-game and learning not to work only for their own individual benefit. Though *Life and Career* includes various skills, a major body of the literature was found to study *Leadership* in particular ($n = 5$). Leadership is reported to be cultivated in-game and presents similarities to leadership practices found in the real world businesses (King, 2013). Jang and Ryu (2011) reported that leadership MMORPGs have the potential to increase leadership skills regardless of the player's gender. Additionally, leadership spillover effects are reported by Xanthopoulou and Papagiannidis (2012) though Rausch, Fasshauer, and Martens

(2012) research indicated unclear results that certain competencies can be developed and used in real-life by playing WoW. As far as in-game leadership is concerned, Van Dijk and Broekens (2010) found that distributed leadership enhanced the teams' ability to overcome problems. Last, as far as *Personal and Social Responsibility* ($n = 9$) is concerned, researchers agree that social interactions revolve around and in the MMORPGs; reasons that catalytically contribute to player effectiveness in coordination and communication (Herodotou, 2010; Koot & Garde, 2013; Voulgari & Komis, 2010c, pp. 28–30). In addition to the above and as far as older adults are concerned, it was found that playing with family enhances off-line relationships (Zhang & Kaufman, 2015). Furthermore, the socialization skills are reported to be depended from the designed environment (Voulgari & Komis, 2010c, pp. 28–30) and the individual's social skills though the more the player is engaged in collaborative activities, the more his/her social skills and social competence will improve (Zhong, 2011). Both Voulgari et al. (2015) and Herodotou (2010) agreed that players develop social bonds that extend to the real world. Furthermore, Voulgari et al. (2015) reported that one of the most important components of MMORPGs is the emergence of communities which practice social interactions that resemble real life. Similarly, Dickey (2011) observed that players who did not act according to conventions of behavior in-game were socially excluded, something that seemed to extend to the real world among students under study in her class. From another point of view, McCreery et al. (2011), compared expert and novice players as to the level of social activity each group engaged and reported that novices engaged in high social activity and novices did not. In contrast to other studies, Visser, Antheunis, and Schouten (2013) found that WoW had neutral effects on social competence. They also found that time spent playing the game was not affecting social competence either.

4. Discussion

Overall, this review revealed a strong body of evidence suggesting that MMORPGs are spaces in which a variety of 21st Century Skills can be fostered. It is clear that research in the past six years (2010–2016) focused on *Communication*. Though fewer papers were found to study other skills, authors in general report positive learning outcomes in relation to the 21st Century Skills, either these were studied directly or derived from the results of the research. Yet, a few important aspects remain understudied. The following recommendations have been developed through the analyses of the results and aim to guide further MMORPGs research in this area.

1. *Research the currently understudied skills.* The skills of *Creativity and Innovation* are the least examined in the context of MMORPGs ($n = 0$). Despite the growing interest in creativity and innovation - see for example, the European Commission's Joint Research Centre discussing how new technologies can nourish innovation and creativity for individuals and organizations (Ala-Mutka, Punie, & Redecker, 2008), these skills are largely understudied in the context of MMORPGs with virtually no empirical work to date. In fact, there seems to be a general agreement on the lack of creativity research in video games (Hsiao, Chang, Lin, & Hu, 2014; Qian & Clark, 2016). Yet at a theoretical level, video games (extending to MMORPGs) are considered supportive to the enhancement of creative skills (Ott & Pozzi, 2012) therefore, this review calls for more empirical MMORPGs research linked to creativity and innovation, as this could generate further useful insights into the educational value of these games. The authors of the current work consider the examination of the

forementioned skills being critical since, if they are proven to be learnt within the MMORPGs environment, then we will be possibly looking at the latter as complete online spaces for the cultivation of the 21st Century Skills.

2. *Critical thinking, Problem solving and Decision making.* Very few articles were found to examine this. Questions such as the following could be considered: "How do players or guilds solve problems creatively?"; "Where and when in the game does problem-solving actually occur?"; "How problem solving skills and strategies differ for players in different expert guilds or roles?". *Problem-solving*, in particular, is often mentioned in the literature but few articles were found to actually examine the skill. Where and when, in the game, problem-solving actually occurs (e.g. during a raid), would be an interesting question to investigate in MMORPGs. Typically, players in MMORPGs have to devise a plan, ask for help, and collaborate with others in order to come to a solution of a given quest. But, has the allowance of the use of add-ons ("mods") in some games (e.g., WoW) somehow automated some processes previously considered as problem-solving? That is, if a player has an add-on enabled which helps her/him complete a quest, then the solution is given by the add-on and not the player. It would be informative to document the different problem-solving capabilities of players who use add-ons and those who don't. Someone could argue that during a raid, raiders are involved in problem solving procedures to bring down a "boss". Yet, this may not be entirely true as many guilds involved in raids are well prepared before the first ever "boss" encounter. Many other guilds downed the same "boss" before and shared their "solution" online via wikis or videos and even online streaming for other players to read or watch. Is the "encounter" less of an authentic problem in this case? Or perhaps, seeking for shared solutions online is problem solving itself? Furthermore, perhaps not all of the players are involved in problem-solving since the officers of a guild are the players that usually make decisions of how a fight must be given. What are the particular hierarchies within a guild that are linked to problem-solving activity? Overall, to further understand the educational potential of MMORPGs, the review calls for more MMORPGs research on problem solving, providing clear explanations of how players are involved in problem-solving situations.
3. *Consider MMORPGs as Personal Learning Environments.* Few studies were found to examine *information literacy*, as well. An interesting subject which was systematically observed in the current review was that of players seeking information about the game (Golub, 2010; King, 2013; Kongmee et al., 2011) outside the game. External resources were utilized for the above purpose such as websites, videos, wikis, forums and guild forums. All these are interrelated thus making the game a Personal Learning Environment (PLE) (Attwell, 2007; Van Harmelen, 2006). An important 21st century skill is *learning to learn, metacognition* which refers to a self-directed learner who can regulate her/his learning, hence being a lifelong learner (Van Harmelen, 2006). This is related with the *information literacy* skill since the players must carefully select the recourses which suit their needs in order to accomplish their goals. In this case, could MMORPGs be used as means for learners to create their own personal learning environments and possibly further expand them? How do players organize and keep up with the evolving MMORPG environment (including external resources) in order to progress in the game? Future studies should address

MMORPGs as PLEs and examine how they connect to the broader PLEs of an individual.

4. *Consider expert guilds.* The vast majority of MMORPGs research results, spanning across all 21st skills, derives from the investigation of novice players. In addition, when expert players are studied, their level of expertise is not reported. In MMORPGs such as WoW, users may be casual gamers, medium-core players and hard-core gamers thus the level of expertise differs even if all the above reach the current highest level of the game which is 100. With the exception of Golub (2010) who provided a detailed account on how guilds utilize skills (e.g. previous knowledge) in order to accomplish their goals, there are no other studies focused on hard-core or even medium-core guilds. Considering the long established evidence that differentiates experts from novices in a range of cognitive abilities (Bransford, Vye, Adams, & Perfetto, 1989), the authors of this review would argue that hardcore and medium-core MMORPGs guilds should be examined, since their membership are “professional” gamers. Further studies are needed to realize how these communities, in particular, collaborate, communicate and eventually achieve goals. For example, “hardcore guilds” are the first to encounter a new “boss” and are the guilds that originally share their solutions online. Does their successfulness in “downing bosses” derive from the capability to quickly solve problems? Do they take decisions collectively or the whole problem is solved by a few or even one person (e.g. the raid leader?). As Rausch et al. (2012) suggested, it is possible that raid/professional guilds are better structured in leadership than real life professional environments. Valuable insights could emerge, with regards to the development of the 21st Century Skills in MMORPGs, if expert guilds are followed and examined.
5. *Consider in-game roles.* Alike the lack of research with expert guilds, there is no research examining different roles (so called, classes) in MMORPGs and the kinds of skills that are developed by playing a specific class. For example, a player that chooses the role of a tank (characters that can take massive amounts of damage) has to perform a very different set of actions than a player who chooses the role of a healer (characters that restore health points on friendly characters during battles). These players face the game from different perspectives. Interesting insights could emerge from the investigation of players in specific roles in the game, potentially exhibiting different types of 21st century skills.
6. *Study the boarder age range of MMORPGs players.* The vast majority of MMORPG research is conducted with college students and does not extend to include younger players or older adults. Although an age restriction for children is often enforced in MMORPGs (e.g. WoW allowed to be played after the age of 12), a very large number of players are adolescents or older adults (Theesa.com, 2014). For the purposes of producing findings that are generalizable to the MMORPGs players' population, we recommend that MMORPGs studies involve representative samples of players in terms of age. Moreover, a holistic understanding how 21st Century Skills are developed within MMORPGs requires an inclusive consideration of players of all ages.
7. *Conduct longitudinal studies to tackle long-term effects.* With the exception of very few studies that have lasted more than a semester (e.g., Golub, 2010; Sarbu, 2011; Voulgari & Komis, 2010a), this review revealed lack of work examining the long-term effects of playing in MMORPGs in relation to the development of the 21st century skills. Today's plethora of streaming data (e.g. Twitch TV streaming WoW) allows researchers to observe trends for gaming and skill development across long periods. Future work could take advantage of the streaming resources to conduct longitudinal studies that will shed light into how 21st century skills are nourished within MMORPGs.
8. *Conduct more quantitative studies and include the game.* The majority of MMORPG research (see Appendix) is qualitative. Although many of these studies agree that MMORPGs cultivate the 21st century skills such as communication, their results are not generalizable. More quantitative studies are needed in order to establish links and relationships between play and skill development. What is more, when quantitative studies are reported, the details of playing the game are often absent or inadequate (e.g., De Souza et al., 2010; Hartshorne et al., 2012; Silva, 2014) creating difficulty in understanding how the particular use of an MMORPG relates to the development of 21st Century Skills. Reporting the details of playing the game might be challenging, especially when researchers aim to reach large numbers of gamers or specific groups (e.g., high-end guilds). Yet, as discussed in the lines above, online platforms like Twitch TV can now help reach thousands of MMORPG players who broadcast their gameplay.
9. *Continue the discussion on MMORPGs in formal education.* Although there are many theoretical positions from academics discussing the potential value of MMORPGs in school contexts, there is virtually few empirical evidence reporting on conditions and mechanisms for successful integration of MMORPGs in formal education. Though educational MMORPGs were utilized in some studies (e.g. Graven & MacKinnon, 2010; Liu, 2015; Suh et al., 2010), they were used to examine a specific skill only (e.g. ICT literacy). Susaeta et al. (2010) discussed how the overcrowded curriculum leaves little time for the integration of MMORPGs in the classroom. Indeed MMORPGs demand hours of game play in order for the player to familiarize with the environment; the process of learning to play, leveling and questing can take several hours, if not days. Overall, introducing MMORPGs to a classroom environment involves a number of matters to be addressed (links to the curriculum, assessment, pedagogical methods etc.); therefore, it is time for the discussion to evolve on the basis of empirical data. Given the findings of this review, the authors believe there is enough evidence of the potential educational value of MMORPGs to motive further research in the area. Yet, the authors' also recognize the possibility of the existence of unpublished null findings relating to the role of MMORPGs in formal education. In this case, there might be a wider evidence base for non-effects of MMORPGs, which has not received attention from published outlets. (i.e., see discussion on publication bias, Ioannou, 2009).
10. *Use the label “MMORPGs” carefully.* This literature review revealed that the label “MMORPGs” was used by some authors for work on games that don't match the actual term (thus they were excluded from the current study) as it was defined by previous research (Achterbosch et al., 2008; Ducheneaut et al., 2004; Peterson, 2012; VanFossen et al., 2008). The above could possibly create confusion between the researchers as to what a MMORPG is and is not. For example, many designed environments that could be considered virtual worlds (e.g. Second Life) or massively multiplayer video games in general (e.g. online strategy games) were labeled as “MMORPGs” and in most cases, the actual “role-play” was absent. The authors of this paper,

argue that future work should do better defining MMORPGs and distinguishing them from other types of games.

5. Conclusion

Given the increasing interest in studying the educational affordances of MMORPGs, mapping the current stage of the art in relation to the 21st Century Skills using the KSAVE framework is timely and relevant to researchers and practitioners. This review sought to determine the level of maturity of the body of research and to identify lacks of knowledge with respect to 10 types of 21st Century Skills. Overall, this review revealed a strong body of evidence suggesting that MMORPGs are spaces in which a variety of 21st Century Skills can be fostered. It can be concluded that although important progress has been made, there is still work to be done, especially with the understudied 21st Century skills – creativity and innovation as well as problem solving and information literacy. Academics are encouraged to advance research in this area, so that they can potentially harness the power of MMORPGs in formal, informal and lifelong learning in the 21st century. At the same time, the authors of this review hope that it will serve as a guide for researchers to focus on other important issues and directions that MMORPGs' research seems to have overlooked in the past six years (2010–2016).

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.chb.2016.10.020>.

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