

A Review of Research Questions, Theories and Methodologies for Game-Based Learning

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ABSTRACT

One of the main tensions in both media studies and education studies can be found in the discourse on the impact of digital media on audiences and learners as connected to a dichotomy of risks and affordances. Contemporary forms of media literacy build on multiple forms of literacy to support critical analysis and critical production in a variety of forms as central to learning. This study reviews research on games and learning conducted from 2010-2016 and published in SAGE Publications, ACM publications, IEEE, Google Scholar and Science Direct databases from a sample of 52 peer reviewed articles. The review of the literature analyzes variables such as authorship, paradigms and learning theories, research questions and methodologies and type of the games used in game-based learning. The central research questions for this literature review build on a history of games for learning and seek to identify good practices that can be used to design meaningful learning experiences and to inform future research related to game-based learning.

Keywords: game-based learning research, gamification, media literacy, literature review

1. Introduction

The way we communicate and make meaning in a mediatised world demands a bundle of literacies, often referred to as media literacy, information literacy, visual literacy, multimodal literacy, computer literacy/ICT literacy, media and information literacy (Drotner and Erstad, 2014; Gutiérrez & Tyner, 2012). Regardless of definitions and approaches, these multiple literacies open critical discussions about the changing relationship of literacy and learning. Frau-Meigs, Flores, Tort, & Velez, 2014 state that core media and information skills include operational skills (including coding and computing), editorial skills (including multimedia writing-reading-producing and mixing) and organizational skills (including navigating, sorting, filtering, evaluating) are central to media education in a digital age. Beyond its importance as an individual skill, media literacy opens social and cultural dialogue that emphasizes its plurality. People don't create meanings individually, but as members of "interpretive unities" (Radway, 1998; Livingstone et al., 2013) where particular literacy practices evolve.

One area of study focuses on the educational uses of games as a pathway to media literacy. Video games, particularly multiplayer games, involve collaboration, competition, sharing, searching for information on chat rooms and web sites (Gee, 2008) and these practices enable the development of communities of learning. In addition, research that investigates the cognitive learning potential of game play, game analysis and game design increasingly demonstrate the ways that games can support other literacies (Gee, 2007; Buckingham & Burn, 2007) and creativity (Caperton & Sullivan, 2009). A growing body of evidence supports the integration of game analysis and production across the curriculum (Freitas & Ott, 2013) and in particular, as a pathway to enhance and support students' contemporary media literacy skills and knowledge.

Games can be integrated in teaching in several ways, such as using commercial titles, developing games with specific learning goals (serious games) or leading the students to create their own games (Van Eck, 2006). If the latter has traditionally been practiced as a way of teaching programming and problem-solving skills (Ibid.), it also has been used "to teach about games as a cultural medium in their own right, just as we teach about film or television or literature" (Buckingham and Burn, 2007, p.324). In addition to these approaches, game play and creation can be used as a reflexive tool that children can use for establishing and developing their own critical understanding of media. First of all, some have noted that critical media literacy requires the development of reflexive knowledge: a child

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needs to know a topic to be able to produce a related game. Secondly, in the process of game creation, children engage in collaboration and peer-learning, which has been shown to support critical literacy and learning across the curriculum (Salen& Zimmerman, 2003; Torres, 2009). Third, game design and content creation also provides children with opportunities to integrate and reflect on their everyday media experience.

Framed in this emerging educational trend, the main goal of this study is to conduct a literature review of recent studies and research in the area of game-based learning, aiming to identify trends and lessons from the field to the study of games creation by children aged 9-12 years old to improve their media literacy competences in two different regions of the 'Occidentalized world'. Therefore, a sample of 52 peer reviewed articles published from 2010-2016 was selected and a content analysis in NVivo was conducted to answer the following research questions: a) what are the most discussed theories in game-based learning? b) Who are the most cited authors? Where are these studies taking place? c) What are the terms and the most common keywords/concepts? d) What are the most used research methods? What type of games are the most cited by authors in the sample, in relation to learning experiences?

2. METHODS

2.1. Sample Collection

A review of research in the area of games for learning was conducted through the use of the following indexed databases of scientific production: SAGE Publications, ACM publications, IEEE, Science Direct, EBSCO, Web of Science and also web via Google Scholar search engine. To access a list of potential relevant publications a search was conducted using the key terms: *games and learning, gamification, game-based learning and games for education, games for learning, video games for education, videogames for learning*. Only peer-review papers were included. The range of the sample was limited to literature published between 2010 and 2016.

2.2. Coding System and Data Analysis

The coding guide used in this study is based on a general review of previous studies (Damásio, Mackert, &Henriques, 2012; Mackert et al, 2014). The coding was adapted based on a formative analysis of the coding frame and a subsequent preliminary field test was conducted to review and further refine the coding before it was applied.

Table 1

Coding Guide for NVivo

| Name | |
|------|--|
| 1. | Paradigms – Learning theories 21 st Century Skills Constructionism Constructivism Design-Based Research Experiential Learning Flow Game Theory Gamification New Literacies Theory Self-Determination Theory |
| 2. | Authors |
| 3. | Place |
| 4. | Key concepts |
| 5. | Method |
| 5.1. | Theme Hypothesis Problem |
| 5.2. | Sample |
| 5.3. | Method Strategy |
| 5.4. | Data Collection Techniques |
| 6. | Type of Game Casual Games Commercial Titles Game creation Gamification Platform Multiplayer Serious Games Simulation Strategy |
| 7. | References |

The coding was designed to provide evidence to better answer and explore the research questions previously described. Data analysis was conducted using NVivo software (v11). The sample publications (sources in NVivo) were therefore categorized according to the coding guide.

3. RESULTS

3.1. Year of Publication

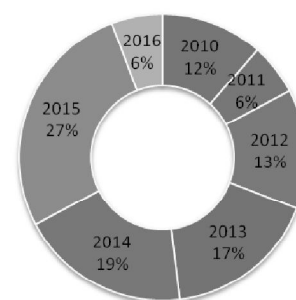


Figure 1 - Year of papers' publication in our sample

The distribution of sources by year illustrates a growth trend in publications related to game-based learning (GBL) from 2010 to 2016. It is worth to notice that sampling procedures and paper collection was finished in March 2016, therefore the sample size for that year is small compared to previous years.

3.2. Geographic distribution of publications

Results indicate that GBL is an international field of practice and research. The highest percentages of studies in the sample (39%) were conducted in the United States, followed by Europe (30%), Taiwan (13%), China (6%) and Canada (4%), as Table 2 illustrates.

Table 2

Geographic origin of studies in sample

| Country | | |
|--------------------------|----|-----|
| Belgium | 1 | 2% |
| France | 2 | 4% |
| Germany | 2 | 4% |
| Hungary | 2 | 4% |
| Norway | 1 | 2% |
| Spain | 2 | 4% |
| UK | 5 | 10% |
| Europe Total | 10 | 30% |
| Brazil | 1 | 2% |
| Canada | 2 | 4% |
| China | 3 | 6% |
| Taiwan | 7 | 13% |
| Turkey | 2 | 4% |
| USA | 20 | 39% |
| More than one place (1+) | 1 | 2% |

3.3. Paradigms and Learning Theories

Many paradigms and learning theories are referenced in the 52 sources but in only 19 sources design research for learning related to educational paradigms or learning theories was defined (or clearly stated). The main referred theories are indicated in Table 3.

Table 3

Main referred theories in sample

| Name | Sources | References |
|--------------------------------|---------|------------|
| 1. Paradigms-Learning Theories | 1 | 2% |
| Gamification | 6 | 19 |
| Flow | 4 | 7 |
| Experiential Learning | 3 | 7 |
| Design-Based Research | 3 | 3 |
| 21 st Century Sills | 2 | 4 |
| Constructionism | 2 | 3 |
| New Literacies Theories | 1 | 4 |
| Self – Determination Theory | 1 | 4 |
| Game Theory | 1 | 1 |

In Table 4 each Paradigm or Theory is presented, quoting authors from our sample.

Table 4

Most referred Paradigm and learning Theories

| Paradigm/Learning Theories | Theory explanation from source |
|---|--|
| Gamification or Theory of Gamified Learning | "The theory of gamified learning provides a theoretical framework to test the impact of gamification efforts upon learner behaviors and attitudes, as well as the effect of these behavioral and attitudinal changes on learning. It does so by providing mediating and moderating processes linking specific game elements to learning outcomes. (Landers & Landers, 2014)" " Gamification is the process of game-thinking and game mechanics to engage users and solve problems. It is a strategy to infuse ordinary activities or processes with principles of motivation and engagement based on the gaming concept. Gamification can be used in applications and processes to improve user engagement and learning." (Nah et al, 2013, p. 99). " Gamification is generally considered to be the use of game design elements in non-gaming contexts" (Decker & Lawley, 2013, p.233). |
| Flow | "Several studies have been published on video games and flow : a state of being pleasantly and completely absorbed by a goal-driven activity. Matching the level and tempo of challenge to a player's skills increases the likelihood of achieving flow (Annetta, 2010; Kiili, 2005; Sherry, 2004). (Olson, 2010, p. 182)" "Challenge is simply defined as the difficulty level of a game. If the game is too difficult, then the players will be frustrated with the game-play which brings down their enjoyment level. If the game is too easy then the players will be bored with their experience, again bringing down the enjoyment level. Grey et. al. (2011) argued that "challenge must be balanced and re-balanced perfectly in order to achieve and maintain flow and the motivation it provides. (Alkhafaji, Grey, & Hastings, 2012, p. 49)". "Crystal Island–Outbreak and similar game-based environments have been shown to elicit engagement or flow as the most frequently occurring affective state (D'Mello, 2013 in (Nietfeld, Shores, & Hoffmann, 2014, p. 3)" |
| Experiential Learning | "In Kolb (1984)'s experiential model of learning , individuals are encouraged to reflect on their actions and consequences, so as to foster understanding and re-application of this understanding in future actions. Kolb's experiential learning model has been revisited in order to support the development of virtual environments and serious games, for instance the exploratory learning model (de Freitas & Neumann, 2009) that promotes reflections and debriefing motivated by the use of a virtual learning environment."(Sylvester, et al., 2013, p. |

| Paradigm/Learning Theories | Theory explanation from source |
|----------------------------------|---|
| | <p>17).</p> <p>" (...) literature suggests that games can foster high interactivity and experiential learning, improving players' health-related self-efficacy and behaviors; engage young people who are difficult to influence through traditional health education interventions; provide supportive and informative feedback on health choices; support self-paced progress; offer opportunities for social interaction and health-related social support (both within the game and around it), increasing players' motivation towards improving health behaviors; and offer opportunities to rehearse self-care skills, which can be applied in real-life situations (MH Li, Chau, Wong, Lai, & Yip, 2013)". "Learners' experience and play time also play a critical role in the success of the GBL efficiency of the students. It is interpreted from that game design strategies should inspire the experiential learning to generate a positive effect in players, and students can be engaged and motivated through direct experiences with the game world (Chang and Wu in Ucus, 2015, p. 402)"</p> |
| Design-based research | <p>" (...) some of the origins for design-based research can be placed in the earlier work at MIT relating to children designers. And, scholars in the area of computer science education or "computing education" continue to draw upon the early Constructionist research in their exploration of best instructional theories and strategies in teaching students to effectively learn programming and computer science principles. For instance, Guzdial and colleagues report that introducing students to programming through creation of "computational media" products in constructionist interventions is an especially motivating way to teach computational thinking to undergraduate novices and can provide new pathways for under-represented students and groups to develop technical expertise and career interests, leading to greater diversity in the computer science disciplines (Guzdial and Soloway 2003; Rich et al. 2004; Forte and Guzdial 2005)." (Squire, K., Patterson, N., 2010)</p> |
| 21st Century Skills | <p>"Creative thinking allows learners to produce something new or original. 21st-century skills for creativity and innovation include brainstorming and refining ideas, seeking diverse perspectives, and implementing innovations (P21, 2009a) . Creative thinking includes a wide range of cognitive skills to pattern knowledge in new, innovative ways (L.W. Anderson, 2009)" (Kingsley, T. L., & Grabner-Hagen, M. M., 2015).</p> |
| Constructionism | <p>"Constructionism is a philosophy and framework for learning and educative action developed by Seymour Papert, Idit Harel and colleagues at the MIT Media Lab in the 1970s and 1980s. Constructionist learning interventions typically involve students in project-based design work over time in a collaborative workshop-based setting, and engage students in technology programming activity to design and build a computational artifact representing an original idea, for instance a mathematical concept in a simulation, a digital game, or a robot's programmed movement and action." (Reynolds, R., & Caperton, I. 2011, p. 269)</p> |
| New Literacies Theory | <p>"New Literacies theory recognizes research within multimodality theory and asserts that new literacies involve reading, examining, and creating with both print and digital texts (Jewitt & Kress, 2003 ; Kress, 2003) . Creating and comprehending multimedia messages is the key to multimedia literacy (Mayer, 2008) . Learners today, many using 1:1 devices, are able to engage in multimodal digital composing, using both linguistic and media modes to create and share artifacts (Dalton, 2013) . Further, new social practices evolve from the use of new literacies (Leu et al., 2013) . The characteristics and combination of New Literacies creates a new, contemporary mind-set, fully acclimatized within Web 2.0 modalities." (Kingsley, T. L., & Grabner-Hagen, M. M., 2015)</p> |
| Game Theory | <p>"Game theory (or decision theory) is the study of mathematical systems that model the behaviour of rational agents, either in cooperation or in conflict" (Collier & Kawash, 2014, p. 160).</p> |
| Self-Determination Theory | <p>"Ryan's (2000) research on self-determination theory, which holds that autonomy is a primary construct integral to self-determined behavior, and autonomy-supportive environments in which perceived competence and social relatedness are also supported are particularly conducive to supporting intrinsically motivated learning and engagement (which is particularly fulfilling for the individual) (Reynolds & Caperton, 2011)."</p> |
| Constructivism | <p>" (...) One of the main tenets of constructivism is that students construct their own knowledge. As Bruner (1966) mentions:</p> <p style="text-align: center;"><i>The will to learn is an intrinsic motive, one that finds both its source and its reward in its own exercise. The will to learn becomes a 'problem' only under specialized circumstances like those of</i></p> |

| Paradigm/Learning Theories | Theory explanation from source |
|----------------------------|--|
| | <i>a school, where a curriculum is set, students confined and a path fixed. The problem exists not so much in learning itself, but in the fact that what the school imposes often fails to enlist the natural energies that sustain spontaneous learning. (p. 127) (Amr, K., 2012, p. 54-55)</i> |

3.4. Most cited authors

In addition to the main educational paradigms and theories, each publication was assessed for the authors who are most cited in the sample. James Paul Gee stands out as the most cited author. Gee is a prominent scholar in the fields of language, discourse analysis, learning and literacy. From 2003, his research introduces games and video games as powerful tools in the learning environment, arguing that the potential of video games promotes effective learning principles. Kurt Squire is the second most cited author in our sample.

A seminal scholar in digital media scholarship, his work focuses on game design for learning and systemic educational change. Yasmin B. Kafai was ranked third in the cited authors in the study. She is an expert in the intersecting fields of digital media, learning and serious games. Her research supports the use of computer programming by children to design games, tell stories, express and develop creative skills and broaden their participation in computing (see Table 5).

Table 5

The most cited authors in the sample

| | |
|------------------|----|
| Gee, J.P. | 41 |
| Squire, K. | 29 |
| Kafai, Y.B. | 22 |
| Prensky, M. | 21 |
| Lyytinen, H. | 20 |
| Hwang, G.J. | 18 |
| Csikszentmihalyi | 16 |
| Landers, R.N. | 16 |
| Kendall, P.C. | 15 |
| Shaffer, D.W. | 15 |
| Hung, C.M. | 14 |
| Tsai, C.C. | 13 |
| De Freitas, S. | 13 |
| Malone, T.W. | 13 |
| Mayer, R.E. | 12 |

3.5. Most frequent 30 words

A query created in NVivo to summarize the 30 most frequent words in all sources (with stemmed words and a minimum length of 4) in sample revealed that *game* and its forms is the most frequent, followed by *students*, *learning* and *educators*, what makes sense in the review conducted (Table 6).

Table 6

Most frequent 30 words in sample

| Word | Length | Count | Similar Words |
|--------------|--------|-------|---|
| gaming | 6 | 1653 | game, game', games, games', games', gaming |
| students | 8 | 573 | student, students, students', students' |
| learning | 8 | 492 | learn, learned, learning |
| educators | 9 | 343 | educate, education, educational, educationally, educative, educator, educators |
| participated | 12 | 268 | participant, participants, participants', participate, participated, participating, participation |
| study | 5 | 258 | studied, studies, study |
| tests | 5 | 254 | test, tested, testing, tests |
| plays | 5 | 242 | play, played, playful, playfully', playing, plays |
| design | 6 | 241 | design, designed, designers, designing, designs |
| motive | 6 | 233 | motivate, motivated, motivates, motivating, motivation, |

| | | | |
|--------------|----|-----|--|
| motive | 6 | 233 | motivate, motivated, motivates, motivating, motivation, motivational, motivations, motivator, motivators, motive |
| questions | 9 | 233 | question, questions |
| serious | 7 | 212 | serious |
| revision | 8 | 200 | revise, revising, revision |
| school | 6 | 174 | school, schools |
| quiz | 4 | 172 | quiz |
| social | 6 | 170 | social |
| data | 4 | 164 | data |
| research | 8 | 162 | research, researcher, researchers, researchers', researches |
| survey | 6 | 161 | survey, surveyed, surveys |
| simulations | 11 | 152 | simulate, simulation, simulations |
| knowledge | 9 | 144 | knowledge, knowledgeable |
| effective | 9 | 124 | effective, effectively, effectiveness |
| experiment | 10 | 124 | experience, experiences, experiment, experiments |
| extrinsic | 9 | 122 | extrinsic, extrinsically |
| gamification | 12 | 119 | gamification |
| development | 11 | 117 | develop, developed, developer, developers, developing, development |
| activity | 8 | 115 | active, activities, activity |
| integration | 11 | 114 | integrate, integrated, integration, integrity |
| items | 5 | 113 | item, items, items' |
| score | 5 | 113 | score, scores, scoring |

In addition, the word *participated* is related to audience of the study (participants) and not with active learning. *Motivation* is a concern in most studies in our sample and seen as positively related with *knowledge* construction. The frequency of terms *serious* (games) and *gamification* are accordingly the main genres of games and paradigms referred in sources and *development*

connect game-based learning experiments with games and gamification platforms developed for educational purposes. The corresponding word cloud is presented in Figure 2.



Figure 2 - Cloud of the 30 most frequent words in sample

3.6. Research Method

In this section, research problem, hypotheses, general theme, sample size, method strategy, methodologies and type of paper (e.g., a theoretical positional paper, empirical paper, qualitative study, and quantitative study, mix of qualitative and quantitative), were assessed. Data indicate that the most common research questions or problems addressed in recent game-based learning studies are concerned with:

1) How can games be integrated into the learning environment to support motivation, appeal, challenge and engagement with learning outcomes?

These studies intend to inform questions and to model best practices for design, development and deployment of games for education, such as: what/ how are the best game design, game mechanics, game elements and practices to promote learning? How relevant is game design or game mechanics to game adoption and effectiveness? How might game mechanics support learning?

2) How are learning goals and relevant academic content supported via game play? How does the use of games foster learning, motivation and engagement in learning activities?

Studies in this area intend to analyze whether and how particular learning resources and strategies can best be integrated into game design and how particular games can support learning goals. These studies analyze the ability of games to promote particular learning contents, motivation and engagement, skills acquisition and development.

3) What are the learning benefits and educational impact of games for learning in traditional school content?

These studies make use of games to promote learning and to analyze learning outcomes and levels. Impact assessment strategies are usually seen in empirical studies that use an experimental method that measures impact and outcomes before and after playing a game. Comparative pre- and post-data is then used to assess a game's effectiveness and real impact on the intended learning goals. These studies analyze the effectiveness of serious games in formal education contexts, applying an empirical research design.

4) Can recreational commercial games be used to promote learning for particular subject matter?

In this case, the studies identified the use of common commercial games that were not developed to teach particular subject matter in

educational contexts. These studies explore whether these commercial games, with no stated educational goals, can lead to learning gains, analyzing how playing these of games can facilitate, motivate and prepare students to learn and promote higher levels of attention to and engagement with particular school curricular content. The main goal of this type of research is to test whether recreational games can promote pre-disposition and motivation for learning.

3.7. Methods and strategies for data collection

This section identified the most commonly used techniques of data collection (focus group, interviews, knowledge text, multiple choice test, participant observation, scales inquiry, software analytics, survey questionnaire, textual analysis, and think-aloud usability), as well as the game models and design used or developed.

3.7.1. Sample

The majority (80%) of the literature selected for review reported sample sizes. The number of subjects participating in the research range from 8, the smallest sample, to 1254 subjects, the largest sample. The subjects included in these studies mostly consisted of students (60%), from primary school to university students, as well as educators and instructors (12,5%). Most of the studies in the review were conducted in school sites.

3.7.2. Study design

Overall, experimental study design and methodologies were the most common strategy used (57,7%), followed by a mixed methods approach with qualitative and quantitative methods (40,4%), qualitative methods (12%), quantitative methods (12%) and theoretical positional paper (7,7%).

Table 7

Study design

| Study Design in Sources | N | % |
|--------------------------------|----|------|
| Experimental | 30 | 57,7 |
| Mix Qualitative & Quantitative | 21 | 40,4 |
| Qualitative | 12 | 23,1 |
| Quantitative | 12 | 23,1 |
| Theoretical positional paper | 4 | 7,7 |

3.7.3. Methods of data collection

The percentage of data collection methods used in the review sample are ranked as follows: survey questionnaires with open-ended questions (48,1%); scales and inquiries with quantitative analysis (32,7%); textual analysis (21,1%);, interviews (19,2%), multiple choice test (17,3%);

knowledge test (13,5%); focus group (9,6%); participant observation (7,7%); software analytics (direct measures from a particular software, such as time-on-task, number of times accessed) (7,7%), usability (3,8%) and think aloud protocol (1,9%); Table 6 shows the results achieved for data collection methods. Surveys questionnaires, scales inquiries, textual analysis and interviews are the most often used data collection methods in our sample.

3.8. Types of video games in relation to learning

The vast majority of studies in this sample developed and deployed a particular game, used an already existing one, or adapted particular school curriculum goals in a gamified way with rewards, credits and leader boards, meaning in this very last case that extrinsic motivation was in place. An analysis of the type of games used in the sample was performed.

Video games for learning were a term mentioned in 38 of the 52 sources. Most of the authors discuss several types of games, besides the particular game genre or gamified platform adopted in their studies. *Serious games* and *simulation* are the most referenced. The term *multiplayer* is mentioned 9 times. *Commercial titles* category refers to games produced by the entertainment industry that were also used in the learning experience. In this sample, most of the commercial titles are related to the Second World War in the context of History classes (such as *Civilization*) but also cultural heritage. Two additional categories, *edutainment* and *exergame*, fall under the *commercial titles*. *Edutainment* was frequently used for titles marketed for parents to be played by children.

This term declined over time and is not common in more contemporary scientific publications. The *exergame* category is related to exercise within the context of the Wii console or apps on mobile phones that help to personalize physical training. Finally, the *game creation* category refers to authoring tools and game engines used by the learners. Only two sources in the sample mentioned *game creation*. This has pedagogical implications for the integration of game based-learning across the curriculum. With an emphasis on games as a mode of content delivery, few studies indicate that games are a source of hands-on, project-based learning. The following tables summarize these findings.

Table 8

The most referred types of games and gamified activities in sources

| Name | Sources | References |
|-----------------------|-----------|------------|
| Type of game | 38 | 221 |
| Serious Games | 20 | 88 |
| Simulation | 17 | 65 |
| Multiplayer | 9 | 22 |
| Strategy | 6 | 15 |
| Gamification platform | 6 | 19 |
| Commercial titles | 5 | 7 |
| Edutainment | 3 | 8 |
| Exergame | 1 | 2 |
| Game creation | 2 | 3 |
| Casual games | 1 | 5 |

Table 9

Authors' Conceptualizations in selected sources (from our sample) about types of games

| Type of Game Referenced | Definition in Source Document | Title of Source Document | Journal | Authors | Year |
|-------------------------|---|---|-------------------------------|--|------|
| Serious Games | "The term serious games describe a relatively new concept, computer games that are not limited to the aim of providing entertainment, that allow for collaborative use of 3D spaces that are used for learning and educational purposes in a number of application domains. Typical examples are game engines and online virtual environments that have been used to design and implement games for non-leisure purposes, e.g. in military and health training [114,204], as well as cultural heritage." | Developing Serious Games for Cultural Heritage: A State-of-the-Art Review | Virtual Reality 14 (4), 2010. | Eike Falk Anderson Leigh McLoughlin Fotis Liarokapis Christopher Peters Panagiotis Petridis Sara de Freitas | 2010 |

| Type of Game Referenced | Definition in Source Document | Title of Source Document | Journal | Authors | Year |
|-------------------------|--|--|---|---|------|
| | "To address challenges faced by science teachers, the authors have developed a SEG [2] built upon the training principles found in Serious Games used for training military, corporate, and medical personnel. The intent is to simulate laboratory scenarios for teachers to train in, as it is often too expensive, resource intensive, and dangerous to train in actual science classrooms. Adapting SEGs into secondary science-teacher education programs has enormous pedagogical and cost saving potential. In adult training settings, simulations have taught people to set up refugee camps in troubled areas, orchestrate disaster relief, negotiate environmental treaties more effectively, make better health policy choices, and handle complex air traffic [32]." | Safe science classrooms: Teacher training through serious educational games | Information Sciences 264 (2014) 61–74 | Leonard Annetta Richard Lamb James Minogue Elizabeth Folta Shawn Holmes David Vallett Rebecca Cheng | 2014 |
| Simulation | " Simulation-based training combined with ludic-based approaches for learning have been associated with behavioral gains including the development and reinforcement of sensory, motor, and cognitive skills that might otherwise be more difficult, or even too dangerous, to learn under more typical training settings (e.g., Kupper-Smith et al., 1996; Pataki et al., 2012; Rizzo et al., 2012). It has been proposed that realistic and immersive virtual environments allow individuals the opportunity to interact with objects and events in novel and meaningful ways, acquire relevant contextual information, and "integrate knowledge by doing" (Shaffer et al., 2005). | Virtual environments for the transfer of navigation skills in the blind: a comparison of directed instruction vs. video game based learning approaches | Frontiers in Human Neuroscience (published: 01 May 2014 doi: 10.3389/fnhum.2014.00223) | Erin C. Connors Elizabeth R. Chrastil Jaime Sánchez Lotfi B. Merabet | 2014 |
| | "The use of games and simulations for educational purposes may be traced to the use of war games in the 1600s (Gredler, 2004). In higher education, diagnostic games and simulations were originally developed for medical education (Gredler, 2004; Lane, Slavin, & Ziv, 2001). Nurse educators first became interested in gaming as a teaching strategy in the early 1980's (deTomyay & Thompson, 1987). | Gamification: An Innovative Teaching-Learning Strategy for the Digital Nursing Students in a Community Health Nursing Course | The ABNF Journal | Crystal Day-Black Lois Konzelman, Tammie T. Williams Natalie Hart | 2015 |

| Type of Game Referenced | Definition in Source Document | Title of Source Document | Journal | Authors | Year |
|-------------------------|--|---|---|--|------|
| Multiplayer | " Multiplayer games can provide a safe space for young people to negotiate rules and discover the boundaries of acceptable behavior—such as the point where creative strategies are viewed as crossing the line into cheating or taking unfair advantage (Barnett & Coulson, 2010; Chen, 2005; Ku'chlich, 2008). Similarly, a boy whose avatar throws things at someone else's game character may be engaged in competition, friendly teasing, aggression, or (in the case of throwing at a girl) flirting, depending on the circumstances and type of projectile" (Searle & Kafai, 2009)." | Children's Motivations for Video Game Play in the Context of Normal Development | American Psychological Association | Cheryl K. Olson | 2010 |
| Commercial Games | " Commercial games with a cultural heritage theme are usually of the 'documentary game' [23] genre that depict real historical events (frequently wars and battles), which the human player can then partake in. These are games that were primarily created for entertainment, but their historical accuracy allows them to be used in educational settings as well. " | Developing Serious Games for Cultural Heritage: A State-of-the-Art Review | Virtual Reality 14 (4), 2010. | Eike Falk Anderson Leigh McLoughlin FotisLiarokapis Christopher Peters PanagiotisPetridis Sara de Freitas | 2010 |
| Edutainment | " (...) edutainment video games, i.e. commercially developed games adapted or modified for educational purposes." | Effectiveness of Interactivity in a Web-based Simulation Game on Foreign Language Vocabulary Learning | Procedia - Social and Behavioral Sciences 182 (2015) 313 – 317 | Huifen Lin | 2015 |
| | "However, edutainment games may also lack coherent models of educational game play, privileging marketing or commercial goals over educational values." | Games and Simulations in Informal Science Education | Games and simulations in informal science education (WCER Working Paper No. 2010-14). | Kurt Squire Nathan Patterson | 2010 |
| Exergame | " (...) commercial programs like the Wii and of an exergaming program called TANGO:H, developed by our research group (Gonzalez et al., 2013a,b). TANGO:H was designed in keeping with the principles of educational, collaborative and active videogames (Collazos et al., 2014; Gonzalez & Navarro, 2015a)." | Learning healthy lifestyles through active videogames, motor games and the gamification of educational activities | Computers in Human Behavior | Carina S. Gonzalez NazaretGomez Vicente Navarro Mariana Cairos Carmela Quirce Pedro Toledo Norberto Marrero-Gordillo | 2015 |

| Type of Game Referenced | Definition in Source Document | Title of Source Document | Journal | Authors | Year |
|-------------------------|--|---|---|--|------|
| Game Creation | "The genre of authoring grows out of a constructivist approach to learning and hacker subcultures, and becomes a tool for children to create their own virtual worlds and challenge the authority of adults." | Games and Simulations in Informal Science Education | Games and simulations in informal science education (WCER Working Paper No. 2010-14). | Kurt Squire Nathan Patterson | 2010 |
| | Modern interactive virtual environments are usually implemented using game engines, which provide the core technology for the creation and control of the virtual world. A game engine is an open, extendable software system on which a computer game or a similar application can be built. It provides the generic infrastructure for game creation [204], i.e. I/O (input/output) and resource/asset management facilities. The possible components of game engines include, but are not limited to: rendering engine, audio engine, physics engine, animation engine. | Developing Serious Games for Cultural Heritage: A State-of-the-Art Review | Virtual Reality 14 (4), 2010. | Eike Falk Anderson Leigh McLoughlin FotisLiarokapis Christopher Peters PanagiotisPetridis Sara de Freitas | 2010 |

* Selected sources mean that some articles quotes (not all) are chosen.

4. DISCUSSION

This paper presents an extended review in the area of game-based learning. Main findings identify trends in learning theories, methodologies and operationalization of research related to games in education. Results indicate a robust interest in scholarship related to the potential of game play in the learning environment. This potential encompasses game-based learning in both formal schooling and informal contexts, such as museums, libraries, and, other community-based settings. Results from this study identify most common practices in this area and lessons learned in the field that can contribute to research and implementation of game-based learning approaches. In addition, the study identifies common research methods used that can be refined and operationalized to support future research in the field.

It is clear that more research is needed about the impact of game-based learning in formal and informal education and, in particular, research about the way games are integrated into the cultures of traditional, formal schooling with its models of efficiency and efficacy. Evidence of efficacy is particularly relevant to decision-makers for educational institutions and policies.

Results from this study are used to inform the

authors' ongoing research related to the potential of game creation and game design to support media literacy competencies in children, aged 9-12 years old, in formal school settings. The review provides evidence for game-based learning as an interdisciplinary field of knowledge creation, but also provides grounds for further research. With a predominance of quantitative studies, the results indicate that game-based learning research would benefit from the collection of additional qualitative data to further contextualize and inform the uses of games in unique learning environments. In particular, results indicate that research related to game creation is an emerging area in game-based learning research.

More research is needed to assess the relevance of game creation as an expression of knowledge, in relationship to other forms of game play in the formal classroom. Finally, results indicate that more research is needed to establish *good practices* and relationships between game-based learning and media literacy competencies. Moreover, it reinforces the idea that until middle 2016 (in our sample) games' creation was not mainstream in GBL as an expression of knowledge and learning process. From this review and with a particular interest in children, researching if games' creation could be as motivating as play (and in what

conditions) and how it improves media literacy competencies at formal education needs not only to be researched, as well to be documented and available for all stakeholders in education.

Finally, future research about the quality of game design, game play and aesthetics, as well the impact of time in the experiments that support good practices in game-based education, also have the potential to inform research about the social uses of games as a manifestation of popular culture.

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