Play to Learn: from Serious Games to just Games

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ABSTRACT

Games have been used for a few decades in research, formal education, and training of children and adults, and digital games are no strangers to educational uses. After all, everyone likes to play games, so it should stand to reason that educational digital games are going to be a hit. Unfortunately, this is not the case. In fact, educational digital games are often criticized for being too focused on educational content and not enough on engaging, challenging, and entertaining players. Making games for entertainment is difficult and requires multidisciplinary expertise. Making educational games that are engaging and entertaining is also difficult and requires additional input from educators and domain experts, and rigorous evaluation methodologies, all of which must revolve around the players. In this position article, we introduce the early stage "EduGames: Play to Learn" research project aimed at supporting the public in acquiring Critical and Computational Thinking skills to tackle the problem of detecting misinformation, and supporting the game development and research communities in creating and evaluating games that are entertaining and educational. As part of this project, we call for more, and more structured, synergy between academia, educators, and the game development industry.

CCS CONCEPTS

• **Applied computing → Education**.

KEYWORDS

digital games, video games, serious games, entertainment

1 INTRODUCTION

Play is central to the experience of many animals, including humans, and, like many animals, humans have been playing as a way of socializing, learning, and teaching for a long time [69]. Play is a form of exploration and imitation [32], and therefore can help teach rules and skills, and promote behaviour changes [15, 62, 94, 110]. Play is also something that many people are willing to engage in for

many hours of their lives [13], suggesting that it is a widely enjoyed activity [69]. Digital games are one of the most recent forms of play and shine in their ability to attract many different demographics due to the many different genres, themes, and styles available [27]. This richness makes digital games appealing to different player personalities [138] and demographics, allowing a quasi-laser focus on individual players to match their needs and desires [58, 63, 158]. Therefore, it makes intuitive sense to investigate the use of digital games and interactive technologies as educational tools, and, in fact, the study of "serious games" is a lively and open field of research [58]. However, the thought of using digital games as educational tools sometimes elicits unenthusiastic reactions from players [148, 157], with common criticism that includes lack of entertainment value, poor use of game mechanics, and a general feeling that many educational games are simply "*a thinly veiled reskin of curriculum*" [38] and ultimately not that fun to play. Furthermore, concerns about inappropriate content and detrimental influence on players [60, 146, 160] may have tarnished the reputation of digital games from the point of view of the public and policy makers, although this is changing [45, 72]. Nevertheless, even the most open-minded and technology-friendly educators can have reservations about the effectiveness and ease of integration of games into the curriculum, when it comes to use inside and outside of the classroom [49, 58, 73].

If fun and deep engagement facilitate learning [60, 106, 130], then the educational game design process should have these as part of its core values. This is a big *if*, which only means that more research is needed [71, 152], especially since good arguments have been proposed and promising research in this direction has been done [63, 119]. However, as Fleissig et al. [51] found, it is hard for academics and educators to create games, having to work around the constraints of academic calendars and the inconsistent availability of technical expertise. On the other hand, game developers possess the design and development expertise to produce successful entertainment products, but may lack access to domain experts, educators, and researchers to incorporate and evaluate the educational value of their games.

In this article, we will discuss the use of games in education and training, the role of voluntary and mandated play, and the importance of fun and deep engagement in relation to learning. We will also discuss the term "serious games" and its relation to educational and recreational games, and we will review a selection of games that have been used for education and research, as well as a selection of the scientific literature focused on these games. In doing this, we will highlight some of the challenges and opportunities in developing games that are both educational and entertaining, and we will argue for more synergy between educators, game designers, and researchers.

As a result of this discussion, we introduce "EduGames: Play to Learn," a research project that is in its early stages and has the two-fold objective of i) promoting synergy between game designers and developers, educators, and researchers through the development and study of digital games to support the public in acquiring and practising Critical and Computational Thinking skills to tackle the problem of detecting misinformation,[1] and ii) creating a set of guidelines for the design and research of educational digital games.

2 IT'S ALL FUN AND GAMES UNTIL NOBODY PLAYS YOUR GAME

Play is fundamentally voluntary [88], therefore it is not a given that people will play anything that looks like a game unless they are intrinsically motivated or required to do so. Digital games used as educational interventions often violate voluntariness [149] in the sense that play can be mandated, which may negatively affect one's willingness to play. However, this only partially explains the lack of enthusiasm of players when presented with a self-described educational game. Like every educational intervention, digital games can be more or less adequately designed, appealing to players, and effective as educational instruments, and the resulting experience can be less than ideal [104, 148]. From poor graphics to bad story-telling, from a disconnect between game mechanics and educational content to an excessively overt educational intent, many factors determine the players' acceptance of a digital game, not to mention whether the game is fun to play and play again. However, commercially successful games are being used in education.[2] For example, Age of Empires [47] and Assassin's Creed [156] both contain notes on historical events and characters that can foster curiosity and tie into history reading and social studies, as well as improve reading comprehension [57, 74, 101–103]. Minecraft: Education Edition [118] comes with official and unofficial lesson plans on a wide variety of subjects and has a lively community of players and "modders" who create *mods*,[3] scenarios, and mini games on different themes and topics [46, 123, 147]. This shows that it is possible to create recreational games that also have educational uses.

However, one school of thought suggests that games for purposes other than entertainment should not necessarily or primarily be fun, or at least they should be just enough fun to keep the player interested long enough to transfer the intended information [15]. This may be a valid view in environments where the intended task is something other than playing, and where typically there is extrinsic motivation given in the form of requirements compliance or other external rewards. This is often the case in corporate training [90], military training, health and healthcare education, and government training and education [37, 41, 44, 149] where play is rewarded, for example, with certifications or career progression. The use of games in the classroom follows a similar pattern, where the intended outcome is learning and acquiring a deeper understanding

of a subject, but if learners do not find the game fun or rewarding enough, they may have to be motivated externally, although this may not always be as effective as we would like to believe [9, 107].

In both formal and informal education, it seems clear that the problem is creating interest and motivation to get players to play. Sometimes, an educational game is attractive enough to encourage players spontaneously for one playthrough [20, 29], but it may not be designed for replayability [29, 129]. Replayability, in an educational context, can be valuable beyond repeated exposure to educational content, which can be seen as a lightweight form of spaced repetition. A game built with replayability as a core value may, for example, allow the player to explore different choices and their consequences, explore different branches of the narrative, and even find alternative ways to achieve the same results [54, 120, 129]. This is valuable whether the educational content comprises practical skills, in which case replayability means repeated practice, or whether it aims at influencing behaviour, in which case it means an opportunity to reinforce and correct.

3 WHY SO SERIOUS?

So far, we have avoided using the term "serious games" as much as possible. Yet, this is the currently established term for a game with a primary purpose other than entertainment. Serious games are typically designed to educate, train, or inform players, and can cover a wide range of topics, such as healthcare, public policy, environmental conservation, social justice, requirements gathering, decision making, professional training, and physical and mental therapy.

Abt [1] is widely credited for creating the term "serious games" to distinguish games explicitly designed for educational purposes from games designed for pure entertainment, although he recognized that this should not mean that "serious" games are not, or should not be, entertaining. There are many nuanced definitions of the term "serious games," mostly variations of "games designed for a primary purpose other than pure entertainment" [110, 151], although some of these definitions can be inconsistent [18]. Djaouti et al. [44] and Wilkinson [163] argue that the term has contributed to fragment and polarize the research and development space, particularly in the wake of the 1983 crash of the video game market that contributed to the public's perception that digital games are primarily toys for children instead of a flexible medium able to appeal to a wide range of demographics and able to communicate a wide range of content in a variety of formats. Marsh [108] argues that serious games exist in a continuum that covers defining characteristics that go beyond those commonly associated with gaming. These characteristics encompass digital media and experiential territory, providing space to better situate other media products with a purpose other than entertainment – for example, serious storytelling [100], virtual worlds [42] – allowing serious games to reclaim their place as simply "games" without having to restrict themselves with labels that fragment and polarize the research and development space. Although fun is not a primary requirement for a serious game [15], it is a desirable component, especially when we want to engage players over time without losing motivation and for multiple play sessions. We recognize that there needs to be consideration of what "fun" means in certain contexts and when dealing

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[1]Adams et al. [3] define the terms *misinformation* and *disinformation* and, together with Lewandowsky and van der Linden [93], provide a discussion of the efforts and risks involved in addressing and countering these.

[2]These are sometimes called Commercial Off-The-Shelf (COTS) games, but we think this term may be a little restrictive so it is best avoided.

[3]A *mod*, short for modification, is an alteration by players and third party developers of various aspects of a game, including looks, behaviour, and mechanics.

with sensitive themes [164]. However, this is a good argument for further investigation on the meaning of fun and, perhaps more appropriately, deep engagement, more than an argument against their incorporation in serious game design.

We think that re-framing so-called serious games as simply games has the fundamental benefit of removing the shadow cast by the "serious" label. For as superficial as this may seem, this can help legitimize and encourage the design of games that are educational, fun, deeply engaging, empathetic, informative, opinionated, and any combination of these and other characteristics, as required and appropriate for the themes and subjects these games will deal with. This will certainly not get rid of "bad" educational games, but it will show that it is possible to design games that are both educational and entertaining, with the hope of changing perceptions and attitudes towards the medium, and encouraging the participation of educators, players, researchers, and game designers in its development.

4 TAKE A LOOK AROUND

It is worthwhile to examine some interesting examples of educational digital games. However, it is not in the scope of this article to perform a complete and thorough review of the landscape of educational digital games and the literature around them. The sheer amount of results returned by an online search for "educational video games" makes this daunting on its own, but it is also unlikely to be useful, practical, or interesting to play and review large amounts of self-described "educational" games simply because they exist. In fact, even only considering what is freely available online, many are just rehashes of the same game concepts and educational materials, and are often worksheets barely disguised as games.

Before we proceed, we feel the need to address a pretty big elephant in the room: the country of origin. Discussions on educational video games often only feature games produced in North America, Europe, and Japan. This is more a reflection of the bias in the types of video game exports by country than a reflection of the quality of these games. For example, by market size, China is at the top of most global lists of video game exports with widely played and appreciated titles, an extraordinary result coming after a near-complete ban on foreign-made video game consoles imposed in 2000. Since the ban was lifted in 2015, the Chinese market expanded greatly, focusing on games that favoured monetization, including massively multiplayer online games, social games, and mobile games, but hardly any titles that could count as educational have been produced in China, at least for export. Other countries have lively video game industries, but we suspect that education is a weak motivator for development when revenue growth or financial stability are bigger concerns. Therefore, we speculate that this is part of the reason why it is harder to find widely distributed and played educational video games coming from outside of North America, Europe, and Japan.

4.1 Methodology

While we did not aim to perform a complete and thorough review of the landscape of educational digital games, we did follow a number of criteria for inclusion and exclusion of games and literature in our survey, to ensure that we provide enough of a big picture without losing focus. The criteria are as follows and the selection is listed in table 2, the heading of which is described below.

We have selected a number of digital games described as "educational" in a variety of sources, including scholarly archives (Google Scholar, Internet Archive Scholar, Scopus, and JSTOR), references from scientific literature (most of which are cited in the references section) and specialist websites (including the Open Education Database,[4] the Interactive Software Federation of Europe,[5] the Entertainment Software Association,[6]) as well as conversations with educators. Some of these games were made with educational intent (EI), while others were not. However, the latter have been used for educational purposes, so we included them in the list. The selection includes games that are currently publicly available to play (PA) or have been in the past, are now of limited access, or have been retired. Some games on the list require access to special or uncommon hardware (HW) but still represent instances of educational gaming that are at least worth considering – for example, OHR [112] is a problem-solving game based on a custom-made tangible interface, Drive That Train [135] requires the full immersive installation only available at the museum hosting it, and Packy & Marlon [161] requires a SNES console and physical cartridge, or a suitable emulation setup.

We have excluded games according to two criteria. First, we looked at whether a game was indeed a game and not simply drill-and-practice exercises in disguise, for example quizzes, or games in which progress was tied to correctly answering direct questions. An infamous example in this category is "Math Gran Prix" – released as "Maths Grand Prix" in Europe – in which the player's car advances based on whether they respond correctly to elementary algebra problems presented on screen. Second, we considered a game's potential exposure and reach, which means how likely a game is to be played by a large and diverse audience. Often, self-described educational games appear in lists or dedicated web sites among many others, but there is no clear indication of whether these are widely used, nor how much effort the developers and publishers devote to publicizing these games among players and educators. Because these titles often appear to be generic cookie-cutter-type games with little apparent effort devoted to original gameplay and content development, we did not consider them interesting for our analysis.

Table 2 also contains a sample of scientific publications that significantly focus on each of the games, and therefore provide insight on the games examined and not a simple reference. As a result, we selected articles in the formats of reviews, analyses, critiques, case studies, and experimental evaluations of each game being used for educational purposes.

4.2 Discussion

It is interesting to observe the imbalance in the amount of publications that focus directly on the games: while we recognize that the sample is limited, it was certainly easier to find research on the educational applications of games that did not have an explicit educational intent or that were not developed for research. A

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[4]https://oedb.org
[5]https://www.isfe.org
[6]https://www.theesa.com

notable exception is Re-Mission [65], a video game developed in collaboration with oncologists and caregivers to improve treatment compliance and communication with young oncological patients, which has been used in hospitals around the world, achieving positive results. Often, games developed for research are only used in research by their own authors. This may well be justified by the fact that these games are custom-designed to satisfy very specific needs, so it would be difficult to adapt them to a different context. On average, we found more publications that focus on games that do not have an educational intent than we did on games that do. In this respect, Minecraft [118] stands out because it has now expanded into educational applications, after an initial phase in which educational applications had to be developed unofficially and were unsupported by Minecraft's developers. Minecraft: Education Edition is now available and officially supports the creation of educational mods and games. Its open world nature and ability to be customized make it the perfect "base game engine" on top of which specific games can be developed, and it is a fairly common sight in schools, as also evidenced by published research. On the other hand, for games that were developed with education and research in mind, the publications listed here were often authored by some of the authors of the games, whereas this is not the case for games without educational intent. With such a limited sample and lacking more direct insight, we can only speculate that part of the reason for this imbalance is a game's ability to adapt to a diverse range of educational situations, and so games designed without specific educational goals can more easily be reused and adapted to different educational scenarios and goals.

In our list, the games not designed for education are certainly designed for recreation. It is therefore interesting to see the range of topics covered in the publications associated with these games, listed in table 1. Here we find anything from fundamental skills such as reading comprehension, logic, and mathematics, to higher-level subjects such as ethics, history, and social studies. The imbalance in publications also highlights a gap between games developed in academic and entertainment settings. There is interest in making games for education and research, but it is difficult for academic teams to develop games that can appeal to a generalist audience and do well outside of academic studies [51], and this in turn deprives the gaming public of opportunities to be exposed to curated, well crafted, validated, and entertaining education, including sections of the public who would most benefit from lifelong informal learning [35, 39, 40]. The other side of the coin is that the developers of entertainment games who may want to create an educational game may struggle to access expertise and support from educators and researchers in the first place, and therefore risk creating products based on trial and error rather than educational principles and expert input. Minecraft is an exemplary case of "if you build it, [they] will come" where, given the opportunity, educators and developers created mods and mini-games with accurate content and often presented with the appropriate scaffolding, inside a game that players are already drawn to. Interestingly, Pentiment [99] and Lausanne 1830 [55] are two games that sit nicely in the intersection of entertainment and education, but for which we have found no published research. Pentiment is a mystery adventure video game where the player investigates and solves a crime on a fairly accurate, though fictional, backdrop of 16th century Bavaria. The game

was not developed for education but its level of historical accuracy makes it a good vehicle for history reading, improving reading comprehension, fact-finding, and hypothesis making and testing. Lausanne 1830 is an award winning role-playing game based on the history of 19th century Lausanne, Switzerland, developed in collaboration between academics and game developers with the purpose of allowing players to learn about life in Lausanne at the time through the stories of some of its famous citizens. Despite their high potential, it is possible that the reason for the lack of published research on these two games is that they were only released as recently as 2022.

5 FROM SERIOUS GAMES TO JUST GAMES

It is clear that digital games for education attract interest from researchers, game designers, and educators. However, there seems to be limited interaction between the three actors, with varying degrees of success. We acknowledge that this review of games has limits, not least of which is the number of items reviewed. Nevertheless, we think that the divide between games developed for academic research and education, and games developed for entertainment that can also be used in education, shows an opportunity for bridge-building between the three actors, with each providing their own strengths and gaining support to overcome their weaknesses. Game designers can provide expertise in how to make engaging and entertaining games that players will want to play, including ways of weaving educational content into the game using narrative and progression, supported by educators. Educators can provide expertise in specific domains and their pedagogical best practices to ensure that the educational content is appropriately scaffolded and incorporated in a way that makes educational sense. Researchers can provide evaluation and validation to ensure that the games succeed in their educational objectives, supporting both educators and game designers in promoting the use of games as educational interventions.

The literature reviewed in this article shows some instances of limited collaboration, but not a single clear example in which game designers, researchers, and educators worked together to bring their respective expertise to the same table emerged. In fact, there is at least one instance in which the researchers lamented having limited access to knowledge, expertise, and structure [51]. In the case of serious games, there is a lack of consensus and standardization on how to build and evaluate them [81], but at least there are some shared guidelines and principles [15, 117]. However, when it comes to games for the acquisition of skills and knowledge that also work as entertainment products, there seems to be a scarcity of shared guidelines and principles between game designers, educators, and researchers.

6 EDUGAMES: PLAY TO LEARN

We launched the "EduGames: Play to Learn" project[7] with the objectives of i) promoting synergy between game designers and developers, educators, and researchers through the development and study of digital games to support the public in acquiring and practising Critical and Computational Thinking skills to tackle the problem of detecting misinformation, and ii) creating a set of guidelines for

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[7]https://edugames.andreafranceschini.org/

Table 1: Games that can be, and have been, used to teach and learn about various topics, according to published research (see table 2)

	Title	Topics
[47]	Age of Empires (series)	history, social studies
[156]	Assassin's Creed (series)	history, social studies
[50]	Kerbal Space Program	engineering, orbital mechanics, management
[118]	Minecraft	engineering, history, language skills, mathematics, science, …
[126]	Orwell (series)	language skills, procedural rhetoric
[131]	Papers, Please	critical thinking, ethics, language skills, social studies
[92]	Professor Layton (series)	lateral thinking, logic, mathematics, problem solving
[109]	Sim City (series)	infrastructure management, urban planning

the design, development, evaluation, and use of educational digital games that are engaging, entertaining, and effectively reach educational goals. The project aims at exploring interventions in lifelong learning, capturing not only the segment of the public involved in formal education, but also, and perhaps more importantly, people who have left formal education and may find it difficult to consistently develop skills to navigate the whirlwind of information in which we find ourselves immersed. Providing a lightweight way of consistently acquiring, practising, and honing skills in the Critical and Computational Thinking skill sets can have a positive impact on people's ability to navigate the complex and fast-paced world we live in, improve their engagement in public life, and become better participants in the democratic process.

Critical Thinking is "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" [36]. Computational Thinking is "the thought processes involved in modelling a situation and specifying the ways an information-processing agent can effectively operate within it to reach an externally specified (set of) goal(s)" [122]. These skill sets are becoming progressively more important in our increasingly complex and rapidly changing environment. Understanding causal relationships, following logical reasoning, grasping basic math to understand statistics, and being able to identify false or misleading information: these are all skills that enable us to interpret the world around us.

As a way of achieving the objectives stated above and in section 1, and as a methodological proof-of-concept and test bed, we want to tackle the problem of acquiring and practising skills and notions that enable us to detect false or dubious information. This is becoming a critical skill as it is increasingly easy to produce, distribute, and weaponize misinformation with serious real-world consequences [3, 93]. The idea of using games to approach this problem is not new [12, 40, 56, 91], but results have been mixed at best, possibly because the predominant format of these games seems to be quiz-like, resembling more a lecture than a game [39]. We propose that providing the foundational skills necessary to become autonomous in learning and adapting to new information stimuli may be a better option, something that games like the Orwell series [126] have attempted by placing the player in the role of the investigator and constructor of truth. Therefore, we wish to explore

the use and role of digital games to transfer skills necessary to, for example, spot common errors and fallacies in the presentation of data and in the construction and delivery of arguments. We think that these skills can positively contribute to raise the alertness of people in the face of potentially misleading information, and to increase the awareness of one's own biases, and one's ability to circumvent them.

The gaming population is more diverse than it may seem, if we go beyond the stereotypes evoked by the term "gamer" and instead consider that more or less casual gaming is an almost daily reality for many owners of a smartphone, crossing gender and age groups [48, 70]. When it comes to educational interventions that target a demographic that may or may not see themselves as gamers [83], casual and hyper-casual digital games appear to already have a foot in the door. Games of this type engage players in brief sessions, typically using a portable handheld device [62, 82, 137], and players tend to play throughout their day, whenever they have a spare moment, for example during their commutes or while taking a break. Therefore, casual games seem particularly suited to engage players over time due to the gameplay which is typically structured in short sessions that provide rewards and encourage players to come back – although designers must take care not to encourage problematic behaviour [33, 64, 98, 162]. Nevertheless, there is a case to be made for other types of games in education, as shown by titles such as Minecraft: Education Edition, which encourages longer play sessions, and also for technology-supported interactive activities in public spaces, such as events and museums [23, 66, 97, 124, 154].

If we wish to attract and engage a wide demographic with the aim of promoting informal, lifelong learning, there are a number of ethical issues that we need to consider. These issues include the need for avoiding the exclusion and discrimination of individuals from both the research and development side and the player side, avoiding or limiting the use and perpetuation of harmful stereotypes, and the need to avoid the promotion of harmful behaviour such as addiction and anti-social habits through gameplay [4, 33, 64, 98, 160]. To address these problems, we commit to consider these issues when planning and carrying on project activities, such as design and methodology workshops, as well as to monitor and review the games that will be designed, developed, and studies within the scope of the project. In particular, we will apply principles of

Design for All[8] to the design of the games and interactive experiences produced within the project. Design for All promotes the development of technologies that are accessible and suitable for a wide range of users, accommodating tech-savvy people as much as people with diverse physical or cognitive abilities, neurodiverse people, the elderly, and other groups traditionally neglected by digital technologies. Furthermore, the perception of gender imbalance with regard to the video gaming community is still skewed towards a majority of young males, which could create an invisible barrier to approach and access to people who identify differently. In practice, the gender distribution among people who play video games is much more spread, although not yet as uniform as it could be [48, 61, 67, 70, 98]. To ensure that gender issues are considered in all aspects of this project, we will follow the principles of "Gendered Innovations," a framework that provides a comprehensive approach to integrating gender analysis into research and innovation processes. In the words of the Directorate-General for Research and Innovation of the European Commission, "integrating sex and gender analysis into research and innovation (R & I) adds value to research and is therefore crucial to secure Europe's leadership in science and technology, and to support its inclusive growth" [43].

7 CONCLUSION

In this article, we have seen that the case for digital games in education has been made several times in several different ways, but at the same time there is a lack of consensus on how to design and evaluate them. At the heart of this problem, there is the limited synergy between the three actors that can most contribute to the development and evaluation of educational digital games: educators, game designers, and researchers. Each lacks specific knowledge and skills that can be provided by the others, yet they seldom sit at the same table.

The "EduGames: Play to Learn" project is in its early stage, and it aims to be a first step in systematizing the process of designing, developing, and evaluating digital games and technology-supported interactive experiences to tackle the problem of detecting misinformation, by encouraging synergy between game designers, educators, and researchers. There are certainly overlaps with other similar or related research projects. However, to the best of our knowledge, there has not been a project that aimed at fostering systematic synergy and integration between the different stages of educational video game production, and much less that has produced a set of guidelines and good practices that can be applied and validated rigorously. To achieve these aims, we are planning a number of actions, including: creating a network of partners from the game research community, the education community, and the game industry; organizing workshops to identify and put together strengths, weaknesses, and processes of each participating partner; iteratively creating educational digital games and interactive experiences to develop and validate the design and research methodologies, and turning lessons learned during the process into methodological guidelines for the research and development of such products. We are currently running a questionnaire survey aimed at educators on the themes of misinformation, and the educational use of video games more generally.[9] As a practical outcome, we aim to produce a series of educational video games and interactive experiences revolving around the themes of misinformation and its constituent elements, to document the process, and to distil lessons learned in the process into practical methodological guidelines and good practices that can be re-used and applied by third parties for further validation.

The discussion of digital games as educational interventions has traditionally focused on their use in formal education and training, but there is reason to suspect that their role and impact on informal education may be as powerful and effective, if not more. The gaming population is more diverse than it may seem [48, 70], therefore we want to encourage the adoption of inclusive development and research methodologies, such as "Design for All" and "Gendered Innovations." We also need to consider the objectives of educational digital games, as different scopes and levels of detail may adapt better or worse to the medium. As a highly flexible medium, digital games may be more suited to manipulating and simulating higher-level concepts and skills – such as, but not exclusively, reading comprehension, logic, and critical thinking – rather than more practical and physical topics such as algebra and fractions, for which perhaps Cuisenaire rods may be better suited. On the other hand, technology-supported interactive installation and activities in public spaces may fit the topics that benefit from hands-on experience, for which a video game may not be well suited. As always, more research is needed.

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[8]https://dfaeurope.eu

[9]The questionnaire is available at https://edugames.andreafranceschini.org/a-chat-on-games-videogames-education-and-misinformation/ and archived [53]. Responses and conversations are always welcome.

Table 2: The list of games surveyed that have been described as "educational." EI: Educational Intent; PA: Publicly Available; DR: Developed for Research; HW: Requires special or uncommon hardware; GA: papers published by the Game's Author; PC: Papers Count.

	Title	EI	PA	DR	HW	GA	PC	Citations
[47]	Age of Empires (series)		✓				3	[102, 103, 127]
[156]	Assassin's Creed (series)		✓				3	[57, 74, 101]
[50]	Kerbal Space Program		✓				5	[26, 76, 105, 140, 141]
[118]	Minecraft		✓		✓		11	[7, 8, 10, 17, 22, 28, 46, 121, 125, 142, 147]
[34]	Myst (series)		✓				0	
[112]	OHR			✓	✓	✓	2	[112, 113]
[126]	Orwell (series)		✓				2	[80, 155]
[131]	Papers, Please		✓				8	[21, 25, 52, 77, 95, 111, 128, 155]
[99]	Pentiment		✓				0	
[92]	Professor Layton (series)		✓				2	[31, 139]
[109]	SimCity (series)		✓				5	[2, 6, 16, 79, 114]
[11]	SpaceChem		✓				1	[143]
[86]	A Slower Speed of Light	✓	✓			✓	2	[84, 145]
[154]	Capture The Museum[10]	✓					1	[23]
[132]	Crafty Cut	✓					0	
[135]	Drive That Train[11]	✓	?		✓		0	
[159]	Frequency 1550	✓		✓		✓	2	[5, 68]
[59]	Interland	✓	✓				2	[89, 144]
[87]	Kirchhoff's Revenge	✓	✓	✓		✓	1	[85]
[133]	Launchball	✓	✓				0	
[55]	Lausanne 1830	✓	✓				0	
[115]	Movers and Shakers[12]	✓	✓	✓		✓	1	[116]
[62]	OrderUP!	✓		✓		✓	1	[62]
[161]	Packy & Marlon[13]	✓	✓	✓	✓		1	[19]
[65]	Re-Mission[14]	✓	✓	✓			1	[78]
[65]	Re-Mission[15]	✓	✓	✓		✓	4	[14, 30, 75, 150]
[136]	Story Cards	✓					0	
[153]	Total Darkness	✓	✓				0	
[96]	Transmission	✓	✓				0	
[24]	Wired	✓	✓				0	
[134]	Zero Threat	✓					0	

[10] Limited runs depending on the museum's events management.
[11] May only be available on site, may require paid entry.
[12] APK available for download.
[13] Requires a SNES console or an appropriate emulator to run.
[14] Only some versions may be publicly available.
[15] Re-Mission appears twice because both the game's authors and others have published research.

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