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Are Educational Games Worth the Effort? A Review of the Literature on the Usefulness of Serious Games

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Abstract: *Educational games have grown in popularity during the previous decade. There are numerous instructional games available, as well as a variety of other games. Educational games that have been effectively used as entertainment. The goal of the EduGameLab initiative is to encourage the usage of games in the classroom. This research gives a meta-analysis of the efficacy of game-based learning, with an emphasis on empirical data from the previous decade on the usefulness of employing games in education. Furthermore, the research focuses on structured school environments, such as pre-school, elementary school, secondary school, high school, and higher education.*

Keywords: Games; Education; Literature Survey; Effectiveness.

I. INTRODUCTION

Educational games have grown in popularity in recent years (e.g. [1]). There are a plethora of instructional games available [1], [2]. There are also numerous Games for enjoyment that have been utilised for training or teaching [3]. Educational games are serious games designed primarily for educational purposes. Serious games, on the other hand, are a notion with multiple definitions. In a broad sense, the phrase refers to the concept of employing games (both planned and amusement games) for objectives other than pure enjoyment. The purpose of this research is to do a meta-analysis of scientific studies on the educational value of games in order to determine what sorts of studies exist and what conclusions they reach. With the widespread usage of educational games, there is an obvious need to examine how the efficacy of game-based learning has been examined and how the findings of such studies might be used. Practitioners should be informed. From the perspective of a practitioner, there is a need not only to establish the usefulness and efficacy of educational games, but also to provide meaningful input for the effective creation and use of educational games in practise. A secondary goal is to present an overview of the many types of studies that evaluate educational games and whether there are any special methodological trends in the field of serious games research.Finally, our research looks for evidence of a relationship between the outcomes of empirical evaluations in the field of serious games and the evaluator's engagement as a stakeholder in game creation. In order to narrow our survey, this study focuses on the sub-group of instructional games. According to Tobias et al. [1], no overview of game research can list every study that has been conducted. The study was conducted as part of the EduGameLab, which aims to promote the use of serious games in the classroom. Based on the project's objectives, we limit our research to studies published in the previous decade (between 2002 and 2012) and studies that have empirically proven their findings. In some method, the learning impact was tested. We also restrict our research to structured school environments, such as preschool, elementary school, secondary school, high school, and higher education. We decided to narrow our investigation even further by only include publications published in scholarly journals. Furthermore, Tobias et al. [1] contend that the advantage of games for education has yet to be proven. We ascribe this to a variety of factors. We have a variety of obstacles when working with educational games from both a practitioner and an academic standpoint. One significant problem is demonstrating their usefulness and efficiency as instructional tools. The problem of efficacy is concerned with how successfully We can separate and quantify the true learning benefit of games. This is an essential issue because we want to know if and how games may be used as instructional tools in addition to incidental learning. Even if we are able to uncover a lot of studies that demonstrate effectiveness, there is still the question of practical

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application in teaching. There are other issues to address in this regard, including user approval (from instructors, students, and parents), technology constraints, and curriculum and content concerns.

II. HISTORY AND RELATED RESEARCH

There are multiple delineations of computer games, as well as generally held generalisations. Salen and Zimmerman(4) assay eight indispensable phrasings that each focus on a different element and arrive at a veritably terse description" A game is a system in which actors share in an artificial conflict specified by rules, the outgrowth of which is quantifiable." The description is restrictive, particularly in terms of the demand for a quantitative consequence. A more open categorization, similar as Prensky's(5), comprising the aspects rules, pretensions and objects, results and feedback, conflict, competition, challenge, opposition, commerce, and representation or tale, is applicable in numerous situations. The notion of collaboration is also a significant point of games and game play, and numerous games don't emphasise competitive rudiments or winning. Some Simulation games like The Sims(thesims.com) or Minecraft's open sandbox are exemplifications(minecraft.net). Serious games, as we define them, comprise numerous forms of educational games as well as games for other objects similar as training, recuperation, marketing, and societal betterment." Serious game a internal contest, played with a computer in line with precise rules, that employs recreation to achieve government or business training, education, health, public policy, and strategic communication objects," according to Zyda(6). This description is relatively broad, although its emphasis on recreation sometimes clashes with what's billed as serious games. Marsh(7) describes soberness as Games on a scale between games for purpose and immersive surroundings for purpose. numerous serious game operations, for illustration, use technology typically associated with computer games rather than the game play element. These apps are known as virtual surroundings and digital media since they warrant typical gaming rates(7). For our purposes, serious games are defined as games that involve the stoner and contribute to the attainment of a specified thing other than pure recreation(whether or not the stoner is purposely apprehensive of this). A game's purpose can be defined by the stoner or by the game's developer, which implies that a marketable off- the- shelf(COTS) game used fornon-entertainment reasons can live. be regarded as a serious game. It's worth noting that the use of gaming and visualisation technologies, simulations, and virtual worlds for reasons other than recreation can also be included in this description. While this description coversnon-digital games, it should be noted that the maturity of references to serious games are to digital serious games. Several recent assessments of computer gaming exploration have been conducted. As the issue has grown in fashionability, so has the volume of examinations, as demonstrated by Tobias etal. Tobias etal.(1) conclude that the examined exploration shows pledge for educational games. still, because they set up a number of issues, these commitments are considered primary. places where there's still a need for further disquisition and theoretical advancement. Tobias etal.(1) conclude that" there is significantly further enthusiasm for describing the affordances of games and their motivating parcels than for conducting exploration to demonstrate that these affordances are used to attain educational pretensions or to resolve problems discovered in former exploration." One interpretation of this review is the community's desire to design and test prototypes rather than fastening more on factual classroom use. Empirical exploration on educational games, according to Ke(10), is scattered. likewise, Ke(10), citing Dempsey etal.(11), reveals that utmost of the assessment of The substantiation for games has been anecdotal, descriptive, or judgemental. Ke(10) examines whatever methodologies were employed and what the issues of these empirical exploration were. Unexpectedly, no study of the annotator is performed, i.e. if the annotator is unprejudiced or a shareholder in the game's development.

III. METHOD

No overview of game exploration can list every study that has been conducted because the number of studies has expanded vastly in the last many times and the discipline has progressed fleetly. As a result, in We limit our bean grounded on a variety of criteria in order to give an accurate summary of the present status of the exploration. There are three crucial limitations to this review 1. It spans the times 2002 through the first half of 2012. 2. It focuses on exploration that has empirically assessed the literacy impact in some way. 3. It only contains workshop published in scientific publications, thus conferences aren't included. The literature hunt was conducted in May and June 2012, and the following computerised bibliographic databases and search machines were chosen as the stylish fit for the task. Academic Hunt nobility(Ebscohost), arXiv, LibHub, Inspec, ScienceDirect, ERIC, PsyhINFO, SAGE Online, Emerald,

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ACM Portal, SocINDEX, Google Scholar, Springer Link, IEEEXplore, CiteSeer, and Scopus are some of the coffers available. The findings only included peer- reviewed journals. We rejected conferences and unpublished papers in order to concentrate on empirical studies with well- proved exploration styles that we'd anticipate to see in journals. likewise, we anticipate that high- quality findings presented at conferences will be published in expanded editions in journals. The following crucial words and crucial word combinations were used in database searches • Computer game • Computer game • Education • Training • Evaluation • Empirical evaluation • Effectiveness and Game- Grounded literacy/ Training. To drop the quantum of applicable successes, crucial words were concatenated. We specifically sought empirical exploration that included some type of effect dimension. The two pens separated the data sets, and the quests returned 120 results that were judged applicable grounded on an examination of titles, keywords, and objectifications. After removing duplicates from the colorful databases, 99 papers remained to be completely examined. Each of them was examined collectively by the two pens, performing in a final selection of 40 workshop on which the authors could agree. Only studies presenting Factual substantiation on the literacy effect of computer games in structured classroom settings were included in the final selection. Pre-school, abecedarian academy, secondary academy, high academy, and advanced education are exemplifications of settings. We neglected the service, profitable, and vocational training sectors since the multitudinous games in these disciplines would divert our attention down from institutionalised classroom tutoring. We also neglected exploration on the connection between videotape games, violence, hostility, and social Eventually, the named papers were distributed among the pens to be summarised.

IV. THE LITERATURE SURVEY'S RESULTS

Mathematics, cancer treatment, computer science, conceptual learning, bullying, engineering, fire fighting, language, geography, history, health, natural sciences, nutrition, physics, problem solving, social sciences, software development, and surgery were among the 40 papers chosen for the final round. Table 1 summarises the categorisation. The table also specifies the educational setting, whether the evaluator was impartial or a stakeholder in the game's production, the assessment technique utilised, and the evaluation outcome. According to the number of research (13/40 studies evaluated) in that discipline, mathematics lends itself well to game-based learning. However, the survey results reveal In terms of learning impact, the results were fairly varied. 7/12 assessments show a good learning impact, 5/12 are neutral, and 1/12 is negative (at least for some groups). Positive impacts are seen for motivating components in general. Seven of the studies chosen carried out some type of controlled experiment, indicating a preference for classroom experiments and trials in the field of mathematical games. One noteworthy example is the breadth of the application of games and simulations It is [12] to teach maths. Kim and Chang [12] used empirical data from the National Assessment of Educational Progress (NAEP) database in the United States to determine the impact of computer games on fourth-grade mathematics proficiency. This database holds information regarding school successes in various topics as well as study outcomes and the frequency of computer game use in class as reported by teachers. In terms of background and gender, the results are relatively varied. English-speaking kids who played computer mathematics games in school every day performed much worse in math than those who never played.

Positive benefits of everyday computer use, on the other hand, were observed among male students whose first language was not English. Male minority language students Male English-speaking students who played computer games in mathematics on a daily basis outperformed male English-speaking students who never played. According to Kim and Chang [12], the amount of time spent in class playing mathematical games may be an essential component to consider. Male pupils who played mathematical games every day performed poorly in math. In contrast, when girls played computer games in mathematics class less often, they outperformed male students who did not play computer games at all. Furthermore, Kim and Chang [12] caution that the results should be regarded with caution because the study employed a secondary database that has no information about which games were used. Language acquisition is another common topic taught via serious games, with four research chosen out of 40.

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Author	Educational context	Evaluator	Method	Result	Topic
Rub11 [13]	Elementary	Developer	Mixed-method	Positive	Bullying
Kato08 [14]	General	Independent	Experiment	Positive	Cancer treatment
Pap09 [15]	Secondary School	Developer	Experiment	Positive	Computer Science
Sind09 [16]	Higher Education	Developer	Experiment	Neutral	Computer Science
Rou06 [17]	Elementary	Unclear	Experiment	Neutral	Conceptual learning
Ebn07 [18]	Higher Education	Developer	Experiment	Positive	Engineering
Chu07 [19]	Elementary	Independent	Experiment	Positive	Fire fighting
Vos11 [20]	Elementary	Independent	Experiment	Positive	First language
Asa12 [21]		Independent	Experiment	Positive	Geography
Tüz09 [22]	Elementary	Independent	Mixed-method	Positive	Geography
Vir05 [23]	Elementary	Developer	Experiment	Positive	Geography
Tüz07 [24]	Elementary	Developer	Mixed-method	Unclear	Health
Hui09 [25]	Elementary	Independent	Quasi-experimental	Positive	History
Kenn11 [26]	Higher Education	Independent	Single instance trial	Positive	History
Conn11 [27]	Secondary School	Developer	Experiment	Negative	Language
Cho11 [28]	Higher Education	Independent	Case study	Positive	Mathematics
Kim10 [12]	Elementary	Independent	Survey	Negative	Mathematics
Kab10 [29]	Higher Education	Developer	Experiment	Neutral	Mathematics
Ke06 [30]	Elementary	Independent	Experiment	Positive	Mathematics
Ke08 [31]	Elementary	Independent	Mixed-method	Neutral	Mathematics
Kord11 [32]	Elementary	Developer	Pilot-study	Positive	Mathematics
Lia11 [33]	Elementary	Developer	Pilot-study	Positive	Mathematics
Main11 [34]	Elementary	Independent	Pilot-study	Positive	Mathematics
Pan12 [35]	Elementary	Independent	Experiment	Neutral	Mathematics
Sung08 [36]	Pre-school	Developer	Experiment	Positive	Mathematics

Three of the studies use specially created language learning games, while the fourth uses a commercial entertainment game. Maybe the popularity of Language learning games may be explained by the fact that learning a language necessitates not only the ability to read and write, but also the ability to listen and speak. Because teaching listening and speaking through printed materials is challenging, audio and video are often used. Games are more interactive than movies and can necessitate both passive and active command of the language, making them ideal for language acquisition. Furthermore, because many games are published globally in English, any game can give (first and second) language learning opportunities. potential because many are published in English on a global scale. Piirainen-Marsh and Tainio [45] provide an intriguing example, both methodologically and as a case study. Learning that occurs on its own. They provide findings from a qualitative research that used a social-interactional model to examine learning via video games. They looked at two 13-year-old Finnish boys who were playing a fantasy role-playing game. Data was collected from 13 hours of computer gaming interactions by teens. The research does not seek to "quantify" the learning impact, but rather presents in-depth studies of how players engage and interact with the game. These activities and interactions give numerous opportunities to read and utilise English, and these learning contexts are examined. The findings demonstrate that players regularly repeated voice-overs and texts aloud, as well as borrowed phrases and concepts from the game, while discussing game events with one another. every other. Another intriguing finding is how the players anticipate the game's speech and co-create their own versions as they play. To summarise, Piirainen-Marsh and Tainio [45] show how the game provides a diverse range of interactional chances for utilising English. The investigation demonstrates how players pay close attention to the game's textual and auditory resources, as well as how they acquire gaming terminology while memorising parts of game speech and reproducing or adapting them in suitable circumstances.

Several research (three studies) investigate the use of game-based learning for teaching higher cognitive abilities such as teamwork, argumentation, and problem solving. behavioural modification (three studies). Huang et al. [43] created the Idea Storming Cube (ISC), a method that attempts to assist and engage students in divergent thinking during the problem-solving process. The technology was specifically designed to aid in problem resolution in connection to debris

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flow issues, which are regarded an urgent issue in Taiwan due to their frequency. The approach is based on the Rubrik's cube, which is used to mix and correlate concepts. Participants will produce and discuss ideas as the session progresses. The technology prompts them to develop and describe ideas in normal language. The algorithm validates the ideas, and all fresh and original ideas will get points, allowing users to spin the cube and see ideas from their peers. The outcomes are favourable. However, although game-based training appears to have a favourable influence on collaborative argumentation and problem solving in respect to civic and society-related themes, the impact on problem solving in relation to debris flow concerns is less obvious. Students who were taught using the game developed more and more valid ideas, but when test results were compared, the control group really learned more [43].

Yang [46] investigated the effectiveness of a game-based learning strategy vs traditional learning in a quasi-experiment conducted over a full semester (23 weeks) in two Civic and Society classrooms in ninth grade (44 students, aged 15-16). The study aimed to evaluate problem-solving abilities, motivation, and academic accomplishment between an experiment group (using digital game-based learning) and a control group (using traditional learning). The control and experiment groups received the same teaching and learning materials for the first two classes of the week, but different instruction during the third and final class of the week, known as the intervention period. The control group heard lectures for 50% of the intervention period and spent the rest of the time asking questions, completing handouts, and reporting. findings, and getting comments. Half of the intervention time was spent by the experiment group playing digital games. Tycoon City: New York and SimCity Societies are two games that were played. The instructor began by outlining the game tasks and then allowed time for pupils to create their strategy before playing.

The extent to which eating habits were altered is unknown, despite the fact that the secondary purpose following learning about nutrition is to modify eating habits. This might be attributable to the fact that altering eating habits is a long-term commitment that is difficult to measure unless a longitudinal research is used. Another element that may impact children's eating habits, particularly younger children, is parental influence. Computing is also a prominent topic among serious game creators (four studies selected). This might be due in part to the fact that many significant game creators are also computer professors and practitioners. It is also a fairly specific issue, making evaluation inside a game simple. The studies chosen are mostly good. The strategy appears to be more appropriate for university students than for high school students, and one of the research provided finds that there is a favourable effect. based on student's opinions despite the scores not demonstrating a substantial difference. Interestingly, we find that teaching computers through games covers both 'hard' and'soft' issues, ranging from computer fundamentals and software measures to more ambiguous areas like requirements collecting and analysis. Traditional teaching strategies such as role-playing, live-through case studies, and paper-based case studies, according to Hainey et al. [51], are insufficient and that additional approaches are necessary. The overall goal of the game is for the team (represented by one or more players) to manage and deliver various software development projects. Players can engage with one another. Through a text-based interface, players interact with non-player characters (NPCs) and with one another. NPC responses take the form of written transcripts that include basic background information as well as requirements that the player must identify and document. At some point, the analyst must give the list of criteria to the designer in order for the designer to create an outline high-level design. Surgery differs from most other disciplines taught using serious games in that it is exclusively taught to university students. As a result, good simulation and game-based techniques can save considerable sums of money while also lowering patient risk. This implies that The emphasis is on determining if these simulations and games are viable training tools in their own right and whether success on these tools corresponds with real-world performance rather than comparing them to traditional approaches. This implies that the techniques may be used to determine if a student can safely advance to actual patients.

Even though only two studies were included for this survey, there has been a growth in the use of technology in natural sciences instruction, whether mobile in the field or behind the computer. These spaces allow students to investigate their surroundings, and research on teaching natural sciences demonstrate an increase in interest and learning. gains. The use of digital technology in geography is widespread, and it is anticipated to grow with the introduction of devices such as GPSs and smart phones with maps. Three examples representing more typical 3D games for learning were chosen for this study, and they reveal that geography is a popular topic for the application of game-based learning. The studies on this topic uncovered in this study demonstrate that serious games for teaching geography may be quite effective, particularly with students who struggle with standard ways of teaching geography. There are further

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categories in addition to the ones listed above. various studies of games that teach a range of subjects including : orienteering, civil engineering, firefighting, first-aid, Amsterdam history, and historical studies Epidemics are outbreaks of illness. We included five such research since they meet our selection criterion.

V. CONCLUSION AND DISCUSSION

We have reviewed the present state of study on the influence and efficacy of serious games in this paper. We discovered publications from a number of sources using a systematic manner. of databases. A number of factors were used to choose papers. As seen in Figure 1, the recognised study provides a substantial amount of evidence that serious games have a good influence on learning. 29 of the 40 research we chose yielded good outcomes, seven yielded neutral results, and only two yielded negative results. The findings of two research are rather ambiguous. . We might deduce from this that if they are not always better than Unlike other forms of learning resources, data suggests that serious games may be good learning tools in their own right. We come across some intriguing examples of commercial amusement games being used in education. Despite the fact that the majority of serious games are expressly developed, There appears to be a possibility of employing amusement games in teaching. Even though they are not in a formal teaching context, Piirainen-Marsh and Tainio [45] present an intriguing example of language learning. Yang [46] demonstrated that a game-based technique based on commercial entertainment games was demonstrably helpful in improving students' problem-solving skills, whereas the control group showed no change. Furthermore, the experimental group's learning motivation improved as a result of the game-based learning technique. Finally, there was no statistically significant difference between the two groups on the academic performance exams. These findings are intriguing since they show certain advantages. from utilising entertainment games without any damage in academic progress. In 21 of the situations, the developer was also a key evaluator. 14 of the 21 studies show a good outcome, four show a neutral outcome, one is negative, and two are uncertain. Independent evaluators conduct the evaluations in 17 studies. 14 of these studies provide favourable results, one produces negative results, and two produce neutral results. Overall, it appears that there is a trend toward more positive evaluation findings. There is a definite trend toward stakeholder assessments in game creation; also, these studies tend to have favourable findings (14/21).

Garg et al. [52] examined the development and evaluation of clinical decision support systems and discovered a strong trend toward positive evaluation results when the developer was also the evaluator, compared to studies in which the authors were not the developers (74% success vs. 28%; respectively). Even while our study shows some indicators of a minor bias, the effect is not as substantial as in other domains [52]. Surprisingly, the prevalence of research with confusing findings rises when the assessor is a game development stakeholder. It is unclear why this is the case, however it might be due to overly ambitious assessment setups of stakeholders seeking to offer as much proof as possible for their claims. Notably, little study has been conducted on how games are employed in the classroom. This involves user approval (teachers, students, and parents), technology constraints, and curriculum and content problems (see, for example, [53], [3]). Other impediments, according to Egenfeldt-Nielsen [9], include the fact that the educational environment employs short courses in a specific physical location, differences in gaming abilities among pupils, and practical difficulties like as installation and teacher training expenses. In terms of user acceptability

Egenfeldt-Nielsen [9] observes some scepticism among pupils and instructors. There are numerous reports of practical use. problems According to Kirriemuir and McFarlane [3], it is unlikely that entertainment games will be integrated into the curriculum for a variety of reasons, including: it is difficult for a teacher to identify how a particular game might be relevant with respect to the curriculum; it is difficult to persuade other school stakeholders of the benefits of using games as educational tools, particularly entertainment games; and there is a lack of time for teachers to learn how to use games as teaching tools. Once we have established the theory, we believe that practical pedagogical issues like these should be addressed in study. The possibility for employing games in education. This is a new stream of study, however, that requires for longitudinal investigations in actual teaching scenarios, which has both practical and ethical consequences beyond what we have seen thus far. The field's richness, as revealed by earlier assessments [2], [9], [10], undoubtedly necessitates a range of scientific methodologies to research it. However, there is a noticeable absence of so-called longitudinal empirical investigations of actual usage of games for learning among the body of data reviewed in this study. These are studies that look at the impact over time. So, does game-based learning have any medium to long-term good benefits on students? Can games be used as effective teaching aids in schools? a longer time frame? If

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true, how should game-based learning be organised? And, if a game becomes an established form for teaching particular portions of the curriculum, do the benefits of learning with it stay, or is some of its effect due to students (and maybe teachers) reacting to the novelty factor?

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