

A Systematic Literature Review: The Conceptual of Educational Game Design with Augmented Reality

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ABSTRACT

Augmented Reality enhancements can apply into all senses. The ability into extraordinarily engage sight, hearing, touch, taste and smell. Augmented reality is one technologies revolution, bringing the full power of the creative and adaptive human mind to the digital-physical world. Therefore, this article explains a systematic literature review (SLR) methodology and concept to educational game design in augmented reality applications. The review studies include filtering relevant information on augmented reality and education game design from five databases to answer research questions. A total of 13 published between 2016 to 2020 randomly were used in the analysis. The literature review shows that most authors focusing only on the methodology, genre, tool, classification of augmented reality type, and the device's interface game design and limited on their development model. conclusion, we hope the conceptual of augmented reality in educational game design can be further inspiring and expanded by combining more knowledge and skills.

Keywords: Educational Game design, Augmented reality, and Systematic literature review

I INTRODUCTION

Augmented Reality has emerged as a technology that can overlay images, text, video, and audio components onto existing images or space. That's because augmented reality apps, headsets, and smart glasses hold the promise to add value to virtually every industry - from retail to industrial manufacturing. Augmented reality is already showing the key drivers of the tech economy and the potential to solve some of the biggest problems. (Ayer,S.K.,et al, 2016 and Pombo,L., and Marques, M.M., 2018)

Augmented reality was a bit different from virtual reality the user will experience virtual objects that appear in the real world and do not only interact with a virtual object. (Chantzi, A.E., et al 2013) Investigating prior researcher in a field is important, as this reveals the current state of the field and offers guidance to researchers who are seeking suitable topics to explore.

Currently, there are many multimedia and online resources provided in the library, but reviews of research on augmented reality technology are less explored. The objective of this paper is to design the user motivation model by using augmented reality in educational game design. More specifically, the main research question (RQ): How to develop characteristics model to improve user motivation in augmented reality educational game design and why?

It is found that the existing model development criteria to increase motivation are only focused on characteristics, usability, effectiveness and appropriation in technology and model (Samaden, I.S et al.2020, Khan,T., et al. 2019, Tekedere,H., 2016, Li,J., et al 2017, Juan Vargas, C.G 2020) and the criteria of characteristics for model to improve user motivation in augmented reality of educational game design are limited in discussed.

II SYSTEMATIC LITERATURE REVIEW APPROACH

The approach was used Systematic Literature Review (SLR), to search, appraise, synthesize, and analyze all the studies relevant to a specific field of research. The methodology utilized is described by Kitchenham in "systematic approaches to success literature review" (Kitchenham, B., et al 2009).The planning defines the scope, searching, screening, data extraction, synthesis analyzing, and writing was seven steps utilized the SLR.

A. The planning for searching

In this phase, available online scientific databases to search for the literature. Therefore, Researchgate.net, ACM digital library, IEEE Xplore, Science Direct, and Google Scholar was five (5) relevant literature databases have been selected.

B. The scope defining

The PICO framework (Problem or Population, Intervention, Comparison or control, Outcomes - Outcomes should be measurable as the best evidence comes from rigorous studies with statistically significant findings) to define the scope in properly formulated answering research questions. For this study, **P** – identify the characteristic features of the

internal interface concept Augmented Reality in educational game design. I- validation by experts surveys and questioner, observe, read the document. C- characteristic features of the external interface AR educational game design and O- new model.

C. The searching

The keywords used to search and find the relevant contents in a paper's title and content is "Augmented reality educational game design," Augmented reality and educational game design" OR "Educational game design and Augmented reality" since the word 'augmented reality' and 'mixed reality is interchangeable.

D. The screening

Documents are screened to narrow down the documents to a final number of documents that are relevant for answering the research questions. Articles published from 2016-2020 are taken into consideration for inclusion in the search criteria. The exclusion criteria were: studies that are not related to the augmented reality as in technological perspective; Augmented Reality, and educational game design, educational game design. (Figure. 1)

The process for selections involved skimming the title abstract and result; skimming the introduction and conclusions; skimming full text; exclude duplicates; and quality as-Quality Assessment (QA). In this review, we developed three QA criteria to assess the quality of each study as presented below:

QA1: that the topic addressed in the paper related?

QA2: that the research methodology described in the paper?

QA3: that the data collection method described in the paper?

Each publication was assessed according to the ratio scale: Yes = 1 point, No = 0 point, and Partially = 0.5 point. The total quality score for each selected study was measured between 0 (very poor) and 4 (very good). Finally, 10 selected papers were retrieved and chosen which was related to Augmented Reality and educational game design setting.

E. The Data Analysis

After reviewing the final selected papers, categorization was made to identify the type of potential educational game design in AR. (Figure 1)

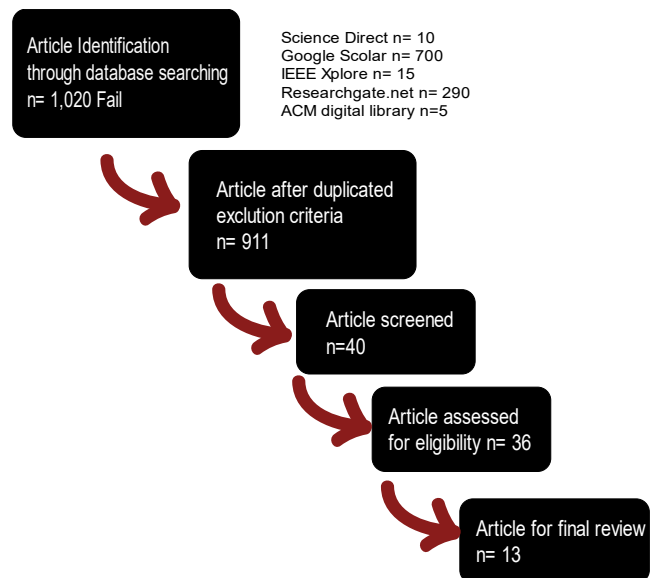


Figure 1. Article identification through the database.

III RESULT

The search process provided a total of 13 primary studies. The following sections summarize the results of SLR according to the research question designed based on primary studies identified. Most related articles were retrieved from these databases because these databases published articles that are related to computers and education.

Based on this study, the number of articles published increased from 2016 to 2020. The drastic increase may have been caused by technological advances. However, in 2017, 2018, and 2020 there is an increased every year of publications related to use the of augmented Reality for educational game design.

Results indicated that the most discussed potential on augmented reality with education game design is in eight (8) following categories. (Table 1) shows the results from the SLR studies, which are the identified categories of concept and tool in augmented reality education game design about 2016-2020.

A. Reading Materials

Information can come from virtually anywhere. Look at the table below examining different sources of information.

B. Distinguishing Features

A textbook is an organized body of material useful for the formal study of a subject area. A good textbook is distinguished by:

- A discrete, well-bounded scope
- Use of examples and problems
- An internally consistent style
- A structure that makes sense

C. Academic Journals

An academic is providing good quality research articles, a peer-reviewed periodical that focuses on a narrow field of study. Academic journals serve as forums for the introduction and presentation for scrutiny of new research, and the critique of existing research to give inspiration to another researcher. In this case, in addition to searching through journal writing and proceeding, researchers also obtain information through related journals, books, news, and magazines.

Augmented reality is taking digital or computer-generated information, whether it be images, audio, video, and touch or haptic sensations, and overlaying them over in a real-time environment. augmented reality technology can be used to enhance all five senses, but its most common present-day use is visual. While, augmented reality devices can be broadly categorized into four types: head-up-display (HUD), holographic display, smart glasses optical see-through a display, and handheld/smartphone-based.

The augmented reality educational game design model has attracted users to share knowledge more engaging way, based on the previous researcher, mostly has focused on the exploration of model design to enable model production to meet target groups, such as tool, the edutainment gameplay genre, kindness, dan effectiveness

Results and discussion for his section the results reviewing and analyzing 13 published articles from 2016- 2020 choose by randomly, that were related to Augmented Reality in education. In (Table 1), was a summary of the literature review.

V CONCLUSION

The conclusion for a previous review article from 2016 until 2020 explains a method review studies following a predefined procedure on educational game design in augmented reality application. Based on (Table 1), the concept of educational game design with Augmented Reality there come out with many concepts, example: simulation game technologies, virtual objects such as story animations, game-based learning and storytelling, combination with non-digital and digital elements, focusing on their interface design field, combination with diversity of fields, and combine with augmented reality with virtual reality.

Findings from this research showed us that more researches, teachers, students, and learning materials should be developed by using augmented reality and implemented in learning. To develop augmented reality first the technology and required 3D models should be prepared and the framework also should be considered accordingly and the augmented reality techniques in education, the exploration of different types of augmented reality, and the combination with the Al-Quran ayah concept still need to be explored. It to create a balance between the knowledge of the world and the knowledge of the hereafter.

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Table 1. Summary of Literature Review

Reference	number of samples	methodology	Genre	Classification	Devices	Concept and tool	Learner Outcome(s)
Augmented Reality Gaming in Sustainable Design Education (Ayer, S.K et al 2016) (Paper 1)	34 architectural engineering students, 47 architecture students, and 27 civil engineering students were given the same design activity using augmented reality 65 students completed a similar design activity using only blank sheets of paper, and another group of 23 students used a paper-based approximation of the computerized eco Campus	simulation game technologies	Action-game	Interaction simulation game technologies	ecoCampus mobile computing system	simulation game technologies would influence students' design processes during the activity: eco Campus	students in all disciplines who used eco Campus were able to break the tendency toward design fixation. students were also able to use the application to assess their designs and generate additional concepts with better overall performance across all disciplines compared with the students who used paper-based formats.
Educational magic toys developed with augmented reality technology for early childhood education. (Yilmaz, R.M. 2016) (Paper 2)	Mix method was used and the sample consisted of 30 teachers and 33 children aged 5 to 6 in early childhood education	magic toys (EMT) Mix method	Idle games	Interaction virtual objects such as story animations, 3D objects, and flash animations appear on the toys.	Educational magic toys (EMT) mobile computing system	EMT because virtual objects such as story animations, 3D objects, and flash animations appear on the toys. EMT has included puzzles, flashcards, and match cards to teach animals, fruits, vegetables, vehicles, objects, professions, colors, numbers, and shapes for average 5 to 6 age children in Early Childhood Education	Shaping children's experience, enhancing their imagination, affecting their behaviors, toys have great importance. that these toys can be effectively used in early childhood education. However, collaborative and interactive learning with these toys should be provided. Moreover, this study will provide an important Contribution to present a new educational AR application, and fill the gap in the educational technology field.
Science spots AR: A Platform for science learning games with Augmented Reality. (Laine, T.H. et al 2016) (Paper 3)	Leometry game prototype, and (3) mixed-method formative evaluation of Leometry with 61 Korean 5 th -grade elementary school children.	Leometry game the Van Hiele model	Sport game	Interaction Game-based learning and storytelling	Mobilephone Science Spots AR (SSAR)	Game-based learning and storytelling are prominent methods Leometry game, which contains geometry problems based on the Van Hiele model. concept and architecture of Science Spots AR, (2) design and implementation of the Leometry game prototype, and (3) mixed-method formative evaluation of Leometry elementary school children.	three aspects of SSAR through Leometry: (1) features, (2) storytelling approach, and (3) impact. The formative evaluation results suggest that the Korean children appreciated the game's features and its storytelling approach, and their answers regarding the overall impact were encouraging. The results also indicated that AR can be a powerful motivator, and other research has shown its potential in education (see Background).
A design-based approach to augmented reality location-based activities: Investigating immersion in relation to student learning. (Georgiou, Y., and. Kyza, E.A 2017)(Paper 4)	11 th -grade students, comprised of two design iterations (n1=18, n2=10);	A design-based approach to augmented reality location-based activities	Adventure game	Tracking AR Application	Tablet. Global Positioning System (GPS), and AR application	Augmented Reality (AR) location-based learning activities are argued to promote students' immersion, and the facility ate learning.	indicate that the students who participated in the second iteration reported being more immersed in the augmented reality activity, provided explanations of higher quality, and managed to solve the problem-based case

Augmented Reality Board Game for supporting learning and motivation in an indigenous community. (Pinto, D., et al 2017)(Paper 5)	20 students of fourth and fifth grades of elementary school, the average age of 10 years old	CoDesigning Game-Based learning with Augmented Reality with Teachers (Co-CreARGBL) (Training, Iterative Design and Classroom Evaluation)	Idle game	The interactive	tablet	to strengthen the educational processes of appropriation of the traditions, and values of the Nasa culture. the process of design of the ARBG, the evaluation in the classroom, and the results	positive results
SEE ME ROAR: Self-determination Enhanced Engagement for Math Education Relying On Augmented Reality. (Jingya Li et al 2017)(Paper 6)	one primary school teacher and two primaries school students, which indicate the game is fun and might be helpful for their study. primary school students. learning subject is mathematics for students aged 7 to 8.	PLEX framework SEE ME ROAR	Adventure game	Interaction Unity 3D and Vuforia plugin for Augmented Reality features	mobile game	designed and made a prototype of SEE ME ROAR, an AR-based social learning game. The game is focused on helping primary school students engage in mathematics learning and interact with their classmates.	researcher plan to follow a practice-led approach to develop the game and instructional design, where the base prototype is modified to include these new levels.
An empirical study on the motivations underlying augmented reality game use: The case of Pokémon Go during and after Pokémon fever. (Zsila.Á., et al 2018)(Paper 7)	the final 37-item, first-order, 10-factor model had appropriate factor structure and internal consistency. a sample of Pokémon Go players (N= 621)	geo-located augmented reality (AR)	Action-adventure games	The tracking	smartphone	geo-located augmented reality (AR) Outdoor Activity, Nostalgia, and Boredom. Impulsivity was unrelated to Pokémon-Go motives.	to obtain a deeper understanding concerning the motivations underlying Pokémon Go use and to create a measure that assesses these motivations.
Augmented Reality Experience: Initial Perceptions of Higher Education Students. (Sural, I., 2018) (Paper 8)	82 candidate teachers at Department of Computer Education and Instructional Technology in 2017-2018 fall term. male is 44 (%53,66) and female is 38 (%46,34)	marker-based mobile augmented reality application Descriptive research	Adventure-games	The tracking	marker-based mobile augmented reality application has been developed and computer hardware devices are used as teaching material	to explore the candidate teachers' opinions about using augmented reality (AR) in classrooms. marker-based mobile augmented reality application has been developed and computer hardware devices are used as teaching material.	very excited about using augmented reality.
Augmented reality gamification for human anatomy (A. Argo et al 2019) (Paper 9)	medical learning.	interactive exercises like quizzes and simulations to enable users to have a fellfield learning experience on the 3D human organ model enriched with dynamic virtual content. three main modules: server, content designer, and a mobile AR interface	Action-adventure games	The interaction	mobile AR interface. "education tags"	introduction of game design elements to support university medical students in their learning activities during a human anatomy laboratory. the designed consist of three main modules: server, content designer and a mobile AR interface. "education tags"	the gamification process can substantially improve the learning experience of the students.
Application of the ubiquitous game with augmented reality in Primary Education	A quasi-experimental study was carried out with 91 sixth-grade primary school students;	augmented reality application "WallaMe"	Adventure game	The interaction	mobile phones	to analyze the impact that the integration of ubiquitous game approaches with augmented reality has on learning.	the experimental group obtained statistically significant improvements in the academic

(Sáez-López, J-M., et. al 2019) (paper 10)	The experimental group: 34 girls and 35 boys; The control group had 13 girls and 9 boys. The control group was formed of 22 students in a class that studied the same unit but using a textbook and “traditional” forms of teaching.	academic performance, student skills in searching for, and analyzing, information, level of fun, and collaboration established among the students.				augmented reality application “WallaMe” academic performance, student skills in searching for, and analyzing, information, level of fun and collaboration established among the students	performance of the subject, motivation, in the search for, and analysis of, information, level of fun and collaboration.
Hybrid Board Game Design Guidelines (Ville, K., and Janne, P., 2019) (Paper 11)	The survey was online two weeks in December in 2016, and it had 329 respondents.6 The employees of the project and project partners distributed the survey through email lists and on social media 133 respondents	Hybrid board games combine non-digital and digital elements to introduce a new kind of game experience.	Adventure game	Display	Mix Hybrid board games combine non-digital and digital elements	combine non-digital and digital elements to introduce a new kind of game experience.	These guidelines are the result of an iterative process of workshopping with industry experts and academic researchers, supported by developer interviews and player surveys. They are presented as starting points for hybrid board game design and aim to help the designers to avoid common pitfalls and evaluate different trade-offs.
Augmented Piano in Augmented Reality (Santin, G., 2020) (Paper 12)	the audience and designed accordingly	Augmented Instruments and Hyper instruments	Action-game	AR Application	Head Mounted Display (HMD) Augmented Piano	To show some examples of different designs of AR piano augmentation from the composition Studi sulla realtà nuova. Interface Studi sulla realtà nuova	consider the visual quality of AR in music performance interaction, visual feedbacks, interface behavior, and gestural quality of virtual bodies also have the potential to carry an expressive visual component that can be developed and composed in time as much as the sonic dimension.
EmoFindAR: Evaluation of a mobile multiplayer augmented reality game for primary school children (Lopez-Faicán, L., and Jaen, J., 2020) (Paper 13)	children	mobile augmented reality without markers	Action-adventure games	competitive and collaborative	mobile augmented reality without markers as the technology	to implement a multiplayer game scenario that can be used to improve socialization, communication skills, and emotional intelligence in primary school children. study addresses the usability of two gameplay styles, and their impact on users’ communication, and motivation: competitive vs collaborative play. EmoFindAR	both game modes are intrinsically satisfactory for children triggering positive emotions such as enthusiasm, enjoyment, and curiosity that improve the participants’ mood and help increase the degree of involvement. Moreover, we observed that the collaborative game version has a greater impact on emotional affection, social interaction, and interest.

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