Participatory Design Method to Unfold Educational Game Design Issues: A Systematic Review of Trends and Outcome

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Abstract— **There are countless of educational game and serious games on the shelf ready to be commercialized. However, at one point the effectiveness of the game in assisting students or children in learning are still questionable. Designing the right design for the game, which emphasizes the users in it, requires particular method and process. The use of participatory design (PD) as a method in designing an educational games is much pertinent to this issue. Hence, this study aims to systematically review the literature on participatory design method for designing educational games by identifying its trends in range of ten years and investigates the process applied to reach the research outcome. Six databases were used in the search: ACM Digital Library, IEEE Xplore, Emerald Insight, Science Direct, Scopus, Springer, Taylor and Francis, and Web of Science. The search identified 4387 papers, among them, 4234 were excluded and 153 remains for further selection process. The selection process later cease to 26 papers being evaluated. The selection incorporated all papers, which focused directly on the participatory design process contributing in educational game design and development. Overall, studies lacked a strong link between the participatory design processes evaluation and interpretation of game design elements effectiveness in each process. Participatory design method makes a positive impact on educational game design effectiveness. However, existing processes have not been captured the process evaluation that may be needed. Robust research is needed to address the evaluation of participatory design processes and how to identify the effectiveness of game design using PD method.**

Keywords- participatory design; educational game design and development; systematic review.

I. INTRODUCTION

Digital games are seen as potential tools in teaching and learning in a classroom, for example in Malaysia higher education institution [1]. Nevertheless, in primary schools in Malaysia, digital games in education are seen as additional activities that can be done outside of schools hour and need to be monitored by the guardians or parents [2]. Incorporating learning in educational games in digital games in Malaysia's higher education was seen as a success over the years. However design preferences by the primary schools students are not well tailored in the existing educational game. This is due to the gameplay preferences are only available in entertainment game rather than educational game design. On the other hand, game designer and developer designs most of the commercialized games and usually users are not involved in the development phases [3; 4; 5]. Since users are not in the pictures in game design and development, the effectiveness of the game in assisting students and children in learning is still questionable. In identifying method of designing educational game, involving and centralized students or children in the design process, participatory design (PD) method is relevant to this situation. Although there are some other techniques particularly user centered design, or experience design available to design educational game, however PD is much suitable in guiding students and children who has less knowledge in game design and development. In PD, users will be engaged in each PD phases whether inductively or deductively in discovering students or children design preferences by practically designing an educational game prototype mockups [6].

However, there are some further needs in uncovering the PD trends in designing educational games in the past 10 years to determine how PD method is evolve and extended in applying on particular design issues especially in reducing the game design effectiveness problem and what are the outcomes finalized and contributed in educational game design. Therefore, in this study, we will; 1) systematic literature review method; 2) identify the trends and outcome of PD used in solving educational game design issues whether its presenting the processes or its extended methods by synthesize it into several comparisons; and 3) we will discuss systematic results comprehensively from the results presented.

II. SYSTEMATIC REVIEW

In systematic review process, we will use six databases namely ACM Digital Library, IEEE Xplore, Emerald Insight,

Science Direct, Scopus, Springer, Taylor and Francis, and Web of Science. Using specific search strings on participatory design method in designing an educational game. From the Boolean search strings, resulting into 4387 papers relevant. However, after specified into a few criteria of relevant case on participatory design in game, paper publication years range of 2009 to 2018 and are an open access can be downloaded. It was then identified that ACM Digital Library gained 47 papers; IEEE Xplore gained 11 papers; Emerald Insight gained 24 papers; Science Direct 36 papers; Scopus gained 22 papers; Springer gained 9 papers; Taylor and Francis gained 12 papers; and Web of Science gained 4 papers. Based on the reference of previous study using systematic literature review (SLR) process [7; 8; 9], we depicted in Fig. 1 our own systematic review to suit our studies in participatory design and educational game design. Hence, we staggered the SLR process into five phases. The first process was done earlier, which were searching and download papers from six databases and placed it in one main folder in Mendeley. The second process is identification, where a few specific criteria that was mentioned earlier, were applied during the search and therefore resulting total of 165 papers relevant to the criteria.
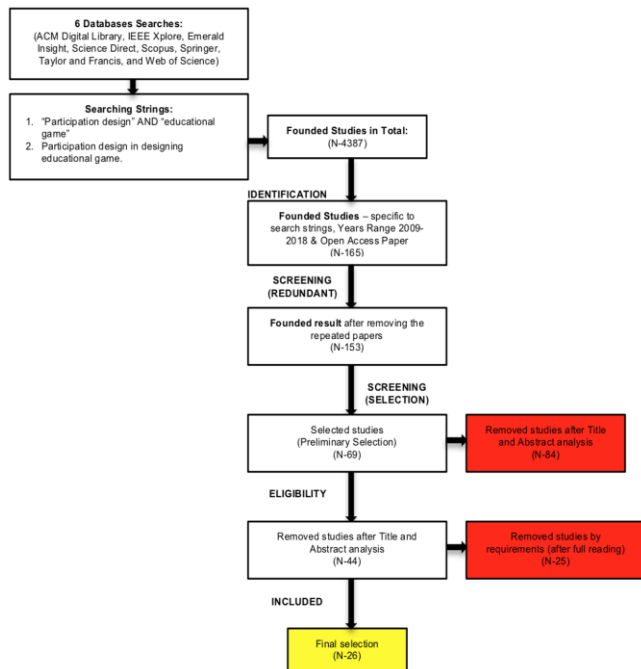

Figure 1. Systematic Literature Review of Participatory Design in Educational Game – Years Range 2009 – 2018 [7; 8; 9]

Using Mendeley desktop software, these 165 papers were placed in a folder known as second process, that is identification process. Next, these 165 papers were then being screened and removed if there's any repeated papers. Hence, 12 papers were identified as repeated or redundant. The 153 papers were then being copied and placed in the third folder of screening for repeated and removed papers. In

this folder, we screened the papers in order to remove the studies after title and abstract analysis. It was then identified 84 papers are not relevant and being removed, which resulting to 69 papers selected and copied to the fourth folder of preliminary selection. In this this folder, we then start the process of eligibility which was done by identifying requirements of participatory design in educational game especially in PD process and studies that involve students or children. Only 44 studies were selected and placed for the final folder which is inclusion that is to reject irrelevant studies of 25 papers and to include the final 26 papers based on the content and comprehensive on the PD process framing on how it was successfully produce an effectiveness of an educational game. The final 26 papers were selected based on its theme on participatory design and framing on the process or stages that have been done in designing educational game. Some other relative terms use is serious game in a few identified papers. These 26 papers later will be analyzed on its trends and PD outcome in educational game design. Discussion will be done to identify issues in game design of 10 years range of PD studies in the selected papers.

III. RESULTS

For this review, 26 papers are identifed that is focused directly on participatory design, mainly in designing educational game for students and children. This study focuses on identifying theme and trends from ten years range of 2009 to 2018, by identifying the games design issues mostly solved using PD method and outcome achieve from the studies. This section will be staggered into three stages which are; 1) trends of PD in educational games; 2) game design issues and how PD was intensively use in the process; 3) PD outcomes from the selected papers.

A. Trends of PD in Educational Games

Fig. 2 depict the SLR done in the previous section, which shows the frequency of 26 selected PD papers in designing educational game which was being published in the range of 10 years period (2009-2018). Based on the open access paper downloaded from the six databases, it was found that PD in educational game was mostly published in the year of 2017. Among the six papers published in 2017, three of the papers focused on designing serious game for students [10; 11; 12], while the other three educational game for children emphasize on game design with playful and usability intervention using PD [7], [13;14].

Paper found in 2009 is on interface design issues [15], while paper found in 2010 are more towards game designer outcome and learning experience [16;17]. Paper found in 2011 are discussing on how PD is used to identify design factors, analysis on player roles and game design framework [18; 19; 20]. However, in 2012 there are a few papers discussing on PD in game design requirements studies and game design approach [21; 22; 23].
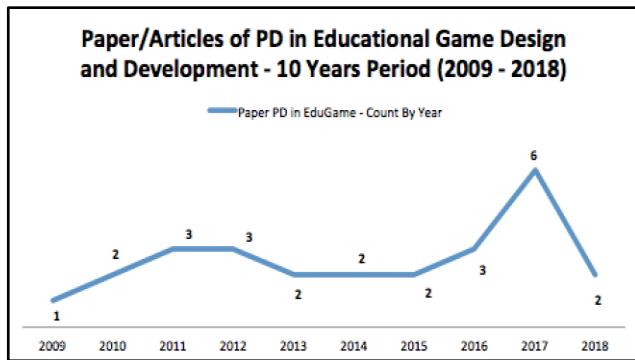
Figure 2. Paper/Article of PD in Educational Game involving students/childrens in 10 Years period (2009-2018)

In 2013, only two papers discuss on PD use in developing game and identifying playability issues [24;25]. Again, in 2014 and 2015 the same discussion raised on how PD was used in game development [26; 27; 28; 29]. In 2016, three papers were found to discuss the usage of PD in game design and testing, analyzing game requirements and personalized game engine [30; 31; 32]. As discussed earlier, 2017 gained more published papers on PD in educational game. In the year of 2018 two papers were found discussing a lot on PD used in designing game and designing a concept for game user interface [33;34].

Besides the papers published frequency in each year, it was also identified that only five papers represent studies in developing countries; Malaysia, Ecuador, South Africa, Colombia and Brazil. The other 21 papers represented studies in developed countries such as Japan, Singapore, Canada, Sweden, UK, USA, Portugal, Greece, Netherland, Austria, Italy, Belgium and Spain. Most of the respondents are range from students and children, and a few of respondents are identified as down syndrome, autism spectrum disorder, hyperactivity disorder, visual impaired, learning disabilities or intellectual disabilities and attention deficit.

B. Educational Game Design Issues

The selected papers shows how they apply PD method in educational design, thus in this section we highlighted most of game design issues that has been solved using PD method. Most of educational game design issues are the effectiveness of the game in assisting students and children in learning [7], [14; 15; 16], [24] [26], [31], [34]. The effectiveness in educational game is related to the students and children game experience that is include fun, enjoyment, feedback and collaboration, which most of the commercialized educational game are not aware of these elements. Some of the educational game also lacks of requirements and pedagogical content, therefore leads to testing using prototype game-based.

Some other issues are identifying game design requirements especially for disable students or children [13], [22], [26], [29], [30], [32]. Educational game on-the shelf is not ideally personalized for the students or children with

special needs. Therefore, designing in PD, which help these students or children and designers to understand requirements or needs for game usability.

C. PD & Outcomes – Summary of the Included Studies

Identifying PD method and how it support the final outcome for game design issues are illustrated as in Table I.

TABLE I. SUMMARY OF THE INCLUDED STUDIES

1st Author (Year)	PD Method in Designing Educational Game	
	PD Method	Outcomes
W. Yue (2009)	Involving students in post and pre test of game interface.	Identify game interface usability effectiveness.
H. Duh (2010)	Workshop and focus group to identify game requirements.	Integrate student's game suggestion on final product.
Q. Li (2010)	Daily camp activities creating and testing hands-on game.	Learning experience through digital game building.
A. Taylor (2011)	Training sessions, observation and interview.	Designing different player roles in serious game.
A. Antle (2011)	Observation on touch tracking issues & on-site testing.	Identified key design features for tabletop game.
G. Triantafyllakos (2011)	Experiment on game board & ideation during gameplay.	Designing a web-learning platform using game board.
H. Lukosch (2012)	Expert design the game criteria and tested by users.	3D authentic virtual training environment.
L. Anthony (2012)	STEM outreach workshop, hands-on activities.	Prototypes and design ideas.
M. Mira (2012)	iThink a web based design collaboration (PD) tools	Identify requirements for board game and prototypes.
C. Moser (2013)	Workshop – Concept thinking, personas, storyboards.	Low fidelity prototyping – using Lego & materials.
J. Tan (2013)	Eploratory playtesting, Evaluation and PD phases.	Game artifacts.
L. Benton (2014)	Idea generation, design development & refinement.	Paper based template of game elements.
T. Nakadai (2014)	Perform simulation and interview session.	Evaluation of Shotoku Taishi Game (Language play game)
S. Parsons (2015)	Conceptual approach & illustration in practice.	Virtual reality environment for children with ASD.
A. Alves (2015)	Concept, design & execution, verification & validation.	Game Prototype.
B. Bossavit (2016)	Ideation, decision making & player roles.	Testing digital educational game.
M. Nouwen (2016)	Exploratory interviews and Concept sketch.	Obtained design requirements for educational music games.

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1st Author (Year)	PD Method in Designing Educational Game	
	PD Method	*Outcomes*
M. Buzzi (2016)	Preliminary of pilot test after development of prototype.	Personalized game engine.
R. Ismail (2017)	Framing on PD processes available.	Final PD process framework for educational game design.
N. Robb (2017)	Posters making using materials & questionnaires.	Multisensory design technique. Interactive posters design.
P. Pons (2017)	Semiformal interviews, drawings & questionnaires.	Game storyboards.
E.L. Lemoyne (2017)	Workshop – ideation process, requirements & review.	Maximizing pedagogical impact of the game.
L. Guaman (2017)	Design prototype & testing.	Graphic interface of educational board game.
L. Bunt (2017)	Character based & gameplay inquiry, user interface design.	Game elements conceptualized for prototype development.
F. Baradaran (2018)	Observation, presentation, feedback & interviews.	Framework on Participation.
U. Quindio (2018)	Conceptual design and game elements in paper prototype.	Paper Prototype of User Interface.

Finally, the analysis of the 26 selected papers discussed on PD in educational game was analyzed on 1) its trends (published by year and countries); 2) game design issues solve using PD; 3) types of respondents; 4) design method and processes; and 5) the purposes of PD in educational game and the final product. Fig. 3 depicts the summary of the analysis.
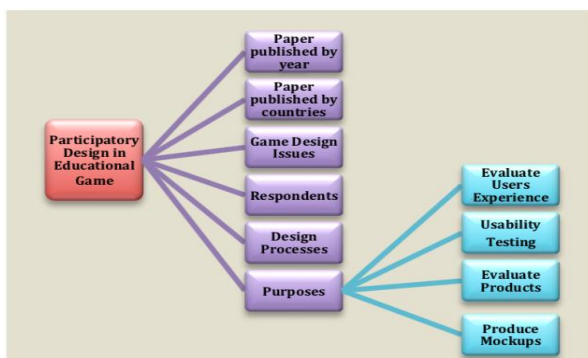

Figure 3. Identification of PD method in solving game design issues from the selected SLR Paper/Article of PD in Educational Game involving students/children.

IV. DISCUSSION

Based on the trends analysis, it was found that PD method was use intensively in designing educational game with majority users are students and children over the 10 years. There are six PD papers in educational game were actively published in the year of 2017, where prototypes are rapidly designed and developed. The issues of game design components, effectiveness and intervention of fun and enjoyment in game are mostly concerned the users and researchers. However, there are only five case studies of PD in educational game in developing countries compared to developed countries. Hence, we can deduct that a few of factors may be involved such as cultures, policy and technology in teaching and learning approach is still developing, which need more studies in this areas. Somehow, an application of PD in solving educational game design issues in these developing countries as a case study can be considered as a beginning to explore the potential of PD, and it can be expanded, adapt to the fullest benefits to the expanded community and industry. Since students and children are still at the beginner in designing the educational game, some guidance in PD such as focusing on its process is seen as important to assist the students and children in design process. However few studies uncover on the suitable PD processes in assisting students and children designing educational game especially the cases relevant to developing countries.

The game design issues analyzed from the selected papers show that effectiveness of the game is frequent in educational game. Some interventions, which include fun, enjoyment, feedback and collaboration, are needed in educational game. Some other issues on identifying game components, design requirements or elements are also raise especially when it relates to the new technology or new event, there are more anticipated elements and some needed to be personalized by the users. New technology advances in the market, may have its own flaws especially when users playing educational game using the device. User experience evaluation, usability testing and prototyping somehow can overcome these issues. This is where participatory design comes to picture. PD in solving game design issues has its own flexible ways of execute the solution by its processes. Since PD focuses on designers cooperating directly with focused users throughout the design and development process. This is where the users are empowered to make decisions about the design as a part of the team.

The final summary of the PD in educational game outcomes, emphasize on PD methods and what is the final outcome from each papers. Although different of case studies identified, however the outcome have almost similarity, which is improvement of the game design issues whether it was delivered as prototype or mockups. A few of studies also emphasize on developing PD or game design framework. A few of studies also framing how PD can identify users requirements for educational game and deliberately increasing educational effectiveness. However, there are lacks of connection in evaluation of PD processes or phases on during game design. Therefore, a robust research to address the evaluation of PD processes in designing educational game. Studies on which PD processes suitable in addressing game design issues are also seem important in expanding various types of flexible processes in PD.

V. CONCLUSION

Based on this review, PD is a suitable method in solving educational game design issues particularly when it is related to students and children type of users. However, the existing PD studies didn't capture on how its processes being evaluated during game design phases. Vigorous studies are needed to address the evaluation on PD processes in designing educational game. This includes identifying the suitable PD process and to which game design issues is suitable to be applied with. Some other consideration such as PD tools and participants can be included.

ACKNOWLEDGMENT

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