Learning Analytics for Children's using Augmented Reality Games

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Abstract: *Data science approaches, which are increasingly used in virtually every sector, can be applied to the quantity of information collected from children's interactions with augmented reality (AR) games. Data science tools can significantly improve AR game evaluation and help teachers and institutions to make evidence-based decisions. The collection, analysis, and visualisation of player interactions with AR games is referred to as game learning analytics (GLA). The main purpose of this study is to evaluate the effectiveness of children's performances in AR games by using learning analytics (LA). The data acquired from these analytics can be used to improve AR games, better comprehend player behaviours and strategies, and improve player assessment. To examine the benefits of these technologies, the methods that can be used to implement LA for children in AR games are presented in this paper. The findings suggest that LA provides significant benefits to children while also assisting educators in evaluating students based on their game involvement.*

Keywords: *Augmented Reality (AR), Education Games, Game learning analytics (GLA), Learning analytics (LA), Serious games (SGs)*

1. INTRODUCTION

Augmented Reality (AR) is an emerging technology that combines the real world with virtual objects and operates in the real world (Ibáñez & Delgado-Kloos, 2018). It can be used for both entertainment and education (Eishita et al., 2015). AR in games have emerged as a promising way to improve the learning experience for students born in the digital age (Li et al., 2022). AR is a recent technology trend that is becoming more common in a variety of application fields. By developing applications that are suitable for children, AR has the potential to develop a successful solution to help kids overcome their challenges (Manisha et al., 2019). AR can now be widely used in education without the need for expensive additional devices. This technological innovation has increased the efficiency of AR recognition in games in pedagogical settings. The positive benefits of AR technology on children's learning have also been identified in the development of skills and knowledge, augmentation of learning experiences, and improvement of collaborative learning (Li et al., 2022). AR could provide a more tangible presentation of what are frequently abstract events, as well as more effectively convey spatial and temporal ideas (Koutromanos et al., 2015). As a result, AR Games are one of the solutions for making learning more interesting and knowledge rich. It makes it easier for students to acquire, process, and remember information.

However, there are concerns about how we can assess students' performance in an AR game. After the learning process with AR games, a measuring tool or performance indicator is used to validate the results. It was discovered that an analytical tool is required to virtually store all the data, and analyse the results in accordance with the institutional requirements. Learning Analytics (LA) is an analytic tool for measuring student performance and forecasting student interest. LA is a new area of study that appears as a link between educator data and student data. LA can also provide information about decision making in order to better understand and optimise the learning process (Agus & Mohamad Samuri, 2018). Big data has been introduced to support data storage for many sectors such as business, social media, science, and telecommunication in order to improve performance, refine marketing strategy, satisfy customer needs, and engage in customer

relationships. This is not an exception in the education sector, where extensive data analysis of students' learning profiles is required and should be context specific. As a result, a new discipline known as LA emerged. LA emerged as a result of the rapid development of educational technology in 21st-century classrooms, combined with educators' conscious efforts to improve their formal and informal educational practices. LA is gaining popularity due to its enormous potential to improve teaching and learning practices(Christopoulos et al., 2020). By predicting learning outcomes, this technology allows educators and instructors to better understand their children's needs and potentials.

The main aim of this study is to evaluate the effectiveness of children's performances in AR games since there is a lack of previous studies on LA for children's AR games. Additionally , this study also to identify the pedagogical approach for immersive learning to engage students in education games by using AR games. There are four main elements that go into a feasibility study which can be implemented in this topic: technical feasibility, financial feasibility, operational feasibility, and economic feasibility as discussed in the following section. A feasibility study is a method of determining the viability of any given in the development of AR games for children.

1.1 FEASIBILITY ANALYSIS

A feasibility study is a method of determining whether or not a project plan has a chance of success. A feasibility study assesses the practicality of our project plan in order to determine whether or not we can proceed with the project. A learning analytics AR gamefeasibility study is a formal project proposal used to obtain internal or external funding and resources for the development of AR games. It is intended to assess the proposed project's business and technical potential/problems, i.e., can we make it, and if so, can we make it profitably. Following the study, the AR game project is either continued or cancelled. Because conducting an AR game feasibility study takes time (and, money), it should only be done for promising augmented reality game concepts (Agus & Mohamad Samuri, 2018).

1.1.1 TECHNICAL FEASIBILITY

In technical feasibility, current resources, including hardware and software, as well as required technology, are needed in order to develop a project. Learning analytics software or tools for AR games is technically possible in terms of hardware because it can be readily constructed in any corei5 and corei7 CPUs.

1.1.2 OPERATIONAL FEASIBILITY

The degree of supplying service to needs is examined in operational feasibility, as well as how easy the product will be managed and maintained after deployment. The LA for AR game is operationally feasible since it fits the majority of children's educational needs as well as their level of pleasure, enthusiasm, and attentiveness.

1.1.3 ECONOMIC FEASIBILITY

The cost and benefit of the project must be considered in economic feasibility. It comprises a detailed analysis of the project's development costs, which includes all essential costs for final development such as hardware and software resources, design and development costs, and operations costs, among other things. When it comes to hardware costs, learning analytics for AR games software is affordable because it can be made easily on any corei5 or corei7 processor.

2. METHODS

This section discusses how to implement LA as well as design guidelines for AR games for children. The implementation of LA methods is typically associated with web-based platforms. There are a few strategies or guidelines to implement LA using AR games. These strategies could help educators, researchers, and policymakers to gather large data sets in order to analyse the potential of AR applications in combination with LA models. One of the techniques that can be implemented in LA games that is used by instructors in delivering their lessons is instructional strategies. Effective

instructional strategies encourage students to participate actively in the learning process. The instructional strategies that can be used in order to apply LA are discussed below.

A design framework that can be widely adopted for designing, developing, and implementing AR supported teaching for trainees and practitioners who want to apply their theoretical knowledge to better learning through interactive settings must be proposed (Kazanidis et al., 2021). First, instructional designers should be trained on how to use appropriate AR software and hardware. Second, application developers and learning technologists should investigate design solutions for the use of AR technology in "hands-on" learning practices. On top of that, the software or system that has been designed must be easy to use in order for AR games to be taken seriously in education as assessment tools. Third, policymakers should not overlook the socio-cognitive and cultural implications of using interactive AR applications in conjunction with LA to inform trainees and practitioners about their performance and outcomes (Kazanidis et al., 2021).

Another technique is by improving the design and implementation of a diverse range of games in various educational contexts (Calvo-Morata et al., 2019). For anticipating player game progression, statistical learning models such as neural networks can be used. Predictable variables include, for example, the player's input to various activities and the time at which the player will stop playing

(Niemelä et al., 2020). Combining both near real-time and offline game LA, as well as stealth assessment for games, it may be feasible to leverage their use in classroom settings in real-time, making their use easier for teachers (Ashmawy et al., 2019). Figure 1 illustrates one approach to implementing LA for children using AR games. Students/children will interact and learn by adopting mobile AR technology with the application of educational content in the education field as well as pedagogy approach. All player data will be transferred to the GLA database, where it can be sent/requested by educators to analyse the success of children in education through the use of AR games.

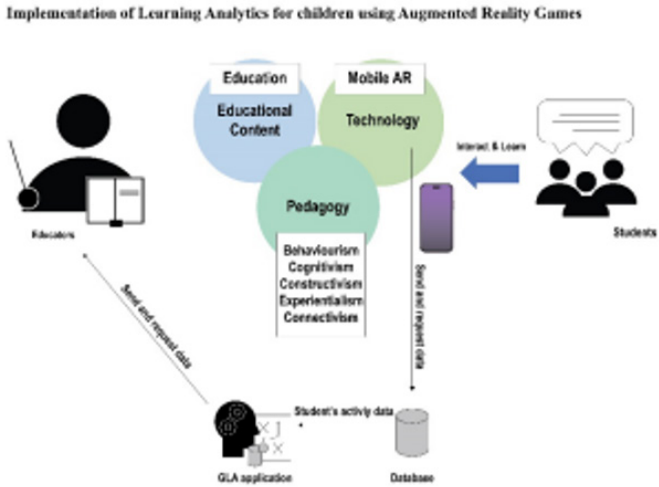

Fig. 1 Implementation of LA for Children using AR Games

3. RESULTS AND EXPECTED OUTCOMES

This section presents the benefits of the implementation of LA for children using AR games. Based on our review, there are a huge number of benefits while performing LA such as: 1) when students developed intrinsic play, their cognitive thinking and practical skills (Kazanidis et al., 2021), emotional, and behavioral engagement was low, but when they developed extrinsic play, their engagement increased

(Aguilar-Cruz, 2022), 2) GLA serves to predict students' engagement with a serious games (SGs) in marginalized settings (Aguilar-Cruz, 2022). Some of the opportunities provided by LA in game-based learning include the importance of systematising the process through the use of standards and game independent analyses and visualisations, as well as the various techniques (visualisations, data mining models) that can be used to yield meaningful information to better understand learner actions and results in SGs (Alonso-Fernández et al., 2022).

The game design must be improved by incorporating new technologies and tools. Thus, by implementing LA metrics, there is a tremendous potential to track the activities of the players and game LA data can simplify children's use of this technology in classrooms. In addition, LA can help educators evaluate students based on their game interaction (Calvo-Morata et al., 2019).

Various uses of GLA data for games will be gathered: to validate the game design, verifying that design choices were adequate for its goals (e.g. gameplay time, difficulty level); to prove that all game target users can achieve the expected outcomes; to test additional hypotheses expected by educators or researchers; to provide visual feedback while games are in play to follow the intervention; or to predict learning results (Alonso-Fernández, Cano, et al., 2019). Data science techniques can significantly improve game evaluation and help teachers and institutions to make evidence-based decisions (Alonso-Fernández, Calvo-Morata, et al., 2019).

The real-world experiment of educational subjects with AR games will be undertaken in this proposed study using AR games mobile. The data will subsequently be collected and submitted to the GLA application. The usage of GLA can be useful in predicting a student's grade level or performance, simplifying the deployment of educational games in schools, predicting student knowledge, and validating the success of educational subjects in AR games. Figure 2 illustrates an overview of the LA framework for AR games.

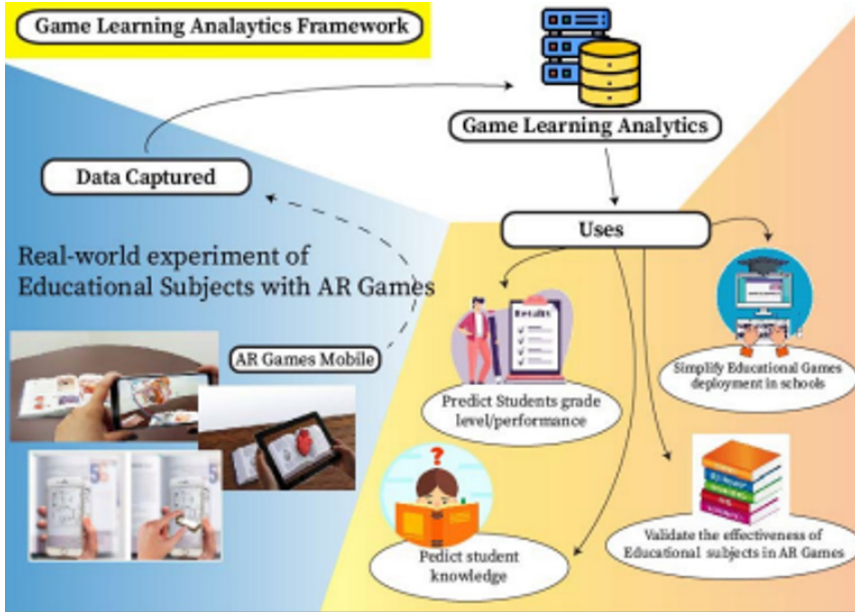

Fig. 2 Game Learning Analytics Framework

4. DISCUSSION

It is believed that LA data retrieved from SGs is critical for providing insight into students' activities while playing and simplifying educators' use of games in the classroom (Calvo-Morata et al., 2019). We describe GLA in order to advocate the use and deployment of SGs in the classroom as learning tools (Alonso-Fernández, Cano, et al., 2019). Significant age and gender differences in interests, skills, achievement, and development through efforts can also be revealed by the LA application (Zapata-Caceres & Martin-Barroso, 2021).

The information derived from the use of data science techniques to interaction data from educational games can both reduce costs and complexity by simplifying game design and development, as well as measure games' actual impact, making the benefits of using games clearer to all stakeholders (Alonso-Fernández, Calvo-Morata, et al., 2019). It is hoped that GLA becomes one of the keys to assisting educators in the use of SGs in the classroom.

5. LIMITATION OR CHALLENGES

Even if a game fits all of the requirements for classroom use, educators may not see its applicability as clear. As instructors, they may be unfamiliar with the technology utilised in the game and may lack confidence in the game's deployment (Calvo-Morata et al., 2019).

In terms of persistence, significantly different behaviours were observed in the face of the challenge, which can help us adjust the different learning methodologies to each age group and gender, adapting the way we provide reinforcement and rewards, especially for boys in the more complex challenges and for girls starting at the age of 5 years (Zapata-Caceres & Martin-Barroso, 2021). Regardless of educational level or subject, instructional designers continue to face a wide range of constraints and limitations when implementing laboratory exercises, experiments, and practice-based learning tasks (Kazanidis et al., 2021). One challenge in establishing computerised learning support is the variety of skill learning amongst players. In addition to that, individual player performance must be analysed using appropriate methods (Niemelä et al., 2020).

6. CONCLUSION

The conceptual design can help educators, instructors, and scholars' study potential links and complexities of educational practices by taking into account the diversity of instructional contexts, accessible resources, and educational activity design characteristics. By integrating alternate instructional and assessment methodologies, the incorporation of LA methods can improve the education continuum.

Teachers may also require training so that they are provided with resources to assist them when implementing the game, as well as providing guidelines on what educators and students must do when the game is in play.

The data analysis could yield insights into the motivation to learn to programme among young players of various ages and genders, as well as insights into the effects of rewards based on player characteristics.

Future research should investigate the effect of modifying the degree of agency during game play based on multichannel data generated from individual learners that depend on a variety of factors such as prior knowledge, background such as major, race, age, etc., proportion of time fixating and interacting with game elements related to scientific thinking, efficacy in using scientific-thinking skills and developing competency to guide individualised game- learning analytics.

7. CO-AUTHOR CONTRIBUTION

The authors affirmed that there is no conflict of interest in this article. Author1 carried out the field work, prepared the literature review and overlook read through the writeup of the whole article. Author1 and Author3 conceived of the presented idea, while Author2 and Author3 encouraged Author1 to investigate the related topic and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

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