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RESEARCH ARTICLE

Evaluation of educational applications in natural sciences

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Abstract: In this paper, a variety of mobile, tablet or desktop educational applications designed to teach physics concepts to 3- to 5-year-old preschoolers are presented and evaluated. The primary purpose was to investigate these applications' effect on kindergarten children and their interest in effectively learning physics concepts. The REVEAC application evaluation tool was used to evaluate the applications, which evaluates the educational content, design, functionality and technical characteristics of the application.

Keywords: educational applications, natural sciences, kindergarten, gamification

1 Introduction

Digital technologies play a crucial role in creating a functional, engaging, and innovative learning environment for children (Papadakis & Kalogiannakis, 2019). In fact, according to Berson and Berson (2010), it is emphasized that children who work with digital technologies enhance their mental abilities and creativity, allow the world to expand around them and at the same time enter social environments beyond time and space (Papadakis, 2022). On the other hand, Blackwell et al. (2014) underline the importance of supporting teachers in the use of digital technology, learning experiences and technology on the promotion and strengthening of teacher qualifications as a necessary condition for teacher specialization and training as well as self-confidence of the teacher in the application and use of digital technologies (Tzagkaraki et al., 2021). It refers to a change in the attitude of the current teacher, with a clear tendency for their active involvement in the learning process (Kikilias et al., 2009).

Of course, despite the multiple benefits of digital technologies, as one can reasonably imagine, multiple risks also lurk. More specifically, it is pointed out that if digital technologies are used unrestrictedly and carelessly, they may affect children's developmental needs (Kalogiannakis & Papadakis, 2017).

More specifically, concerning the natural sciences, namely physics, chemistry, and biology, it is argued that these should be taught in kindergarten, and this is based on several reasons (Eshach & Fried, 2005). They promote children's curiosity and develop positive attitudes towards the sciences through their exposure to the understanding of scientific content and concepts of science while at the same time cultivating scientific thinking and broadening their horizons, using various methods of acquiring knowledge (Papadakis et al., 2021).

The natural sciences can be taught in numerous ways, e.g., through relaxing and fun activities and exercises related to playing, painting, discussing, watching the teacher's demonstrations, listening to stories, *etc*. (Papadakis & Orfanakis, 2018).

The integration of technology into teaching is a powerful tool for enhancing student learning and promoting development in the areas of literacy, mathematics, and science, leading to better academic results compared to the simple use of traditional teaching methods (Drigas & Kokkalia, 2014; Clark, 2013)

1.1 The use of ICT in the educational process

Student education has evolved, and Information and Communication Technology (ICT) has revolutionized the educational scenario, potentially benefited student learning and reducing the achievement gap significantly (Papadakis, 2018). In early childhood education, ICT can include computer hardware and software, digital cameras, the Internet, telecommunications tools, programmable games, and many other devices and resources (Kalogiannakis & Papadakis, 2020). Bibliographically, it is argued that it is essential to integrate ICT already in preschool education, as, through its use, new learning opportunities are offered. Nevertheless, in general, an interest develops in the entire educational sector for developing and integrating ICT in educational policy, curriculum, and practice (Kastriti et al., 2022).

Well-known digital devices are tablets, iPads, and other technology devices, which in many schools in modern day-to-day life are used in combination with ICT for teaching (Nikolopoulou, 2021). Interestingly, in England in 2014, over 70% of primary and secondary schools had tablet devices in their classrooms. Two years later, 900,000 tablets were expected to circulate in schools (Drigas & Kokkalia, 2016). This is a fact that highlights, on the one hand, the necessity for modernization, on the one hand, the transition to a technological society which becomes capable of promoting knowledge beyond traditional forms of teaching (Barianos et al., 2022).

Impressive and remarkable is the fact that children as young as two years old can use the iPad regardless of their characteristics (Lynch & Redpath, 2014), while according to research by Beschorner & Hutchison (2015), it is claimed that young students can navigate the iPad independently. If children cannot use educational technology effectively, they cannot learn through it (Bratitsis, 2018). Even children as young as five may struggle to complete an activity using the mouse. In contrast, Aziz et al. (2013) research show that all children four years of age and older can use the seven common gestures, such as click, drag and drop, slide, pinch, spread, rotate, rotate and move (Papadakis et al., 2017). The rapid influx of interactive smart screen devices presents a particular challenge to the early childhood community (Foti, 2021).

Of course, at this point, one must note that the simple integration of ICT in kindergartens is not enough (Kapaniaris & Zampetoglou, 2021). Instead of familiarizing kindergarten teachers with the necessary equipment, their integration is in such a way that children learn creatively about natural phenomena and encounter science in general (Higgins, 2003).

The question at this point is how teachers can integrate digital devices effectively and create new learning opportunities. The rapid development of digital technology has affected education (Chaldi & Mantzanidou, 2021). Children are faced with numerous opportunities to interact with it, which opens up a lively discussion about technology and early childhood education (Mertala & Koivula, 2020). Regarding digital devices, according to Aldhafeeri et al. (2016), teachers face challenges in their implementation and use in the educational context. Even arguing that digital devices have limited opportunities in a game-based pedagogical context, as they limit children from being creative, active and interacting with other children (Tallou, 2022).

Additionally, Schriever (2020) pointed out that digital technologies have a more complex relationship. Even if kindergarten teachers have a more solid knowledge of ICT and pedagogical application, they tend not to use it. At this point, considering Edwards and Bird (2017), it is argued that the application of digital technologies in kindergarten is not a new phenomenon. On the contrary, it has always been challenging. On the one hand, it highlights the great difficulty of preschool teachers to develop their skills in the context of digital technologies in play-based approaches such as kindergarten.

On the other hand, the impact of ICT on the development and learning process of children in practice is often not fully understood (Dong& Newman, 2016). In addition, UNESCO published a detailed report, arguing that since children are exposed to digital technology early in life, it is easy to show positive and negative influences (Papadakis, & Kalogiannakis, 2017). Therefore, an action plan regarding the implementation of ICT should be guided by the impact on children, which children have to use ICT in their play on their terms and educational goals (Kerckaert et al., 2015).

From the above, an innovative approach is needed to connect the pedagogy of play with the use of technologies and Preschool teachers (Mantilla & Edwards, 2019).

1.2 Gamification and educational applications

The term explored in this paper is gamification, which focuses on extracting the basic principles of games and the question of whether an educational experience can be reshaped to build on these principles. Additionally, here games allow mistakes to be made with minimal consequences, as experimentation, exploration and discovery are encouraged. At the same time, children are encouraged to acquire an alternative way of thinking, see problems from a different perspective, going through periods of intense activity and relative inactivity so that players can pause and reflect on the tasks they have completed.

Therefore, gamification integrates game elements and thinking into activities, stimulating, and promoting learning. Furthermore, it enables the acquisition of autonomy by establishing challenges for children to overcome. It also promotes digital literacy, i.e., the application of game mechanics to schoolwork through ICT, an aspect that motivates students and increases their participation (Jiménez et al., 2019).

Science education is integral to 21st-century education, but many issues still need to be addressed. One of the most critical problems facing science education is the creation of negative emotions and experiences. It is difficult for students to understand science lessons resulting in increased dropout and dropout rates (Mellado et al., 2014). Teachers' lack of interest, insufficient knowledge of relevant content, lack of pedagogy related to science teaching and a

negative experience can also be transferred to their students (Mellado et al., 2014). Additionally, improving how students investigate and understand phenomena and concepts while promoting active and scientific thinking is critical (Slykhuis et al., 2011).

The advantages of using touch devices include the opportunities provided to enhance young children's understanding of abstract concepts through the presentation of dynamic representations, opportunities for embodied learning and the inclusion of interactive elements. Additionally, according to Yusop & Razak (2014), mobile devices enhance the acquisition of knowledge using visual, auditory, or kinesthetic means.

On the other hand, like most digital learning technologies, they have both advantages and disadvantages. Regarding gamification, there are various problems associated with these learning technologies, such as the prohibitive cost of software development, teacher training, and support materials for teachers (Teo et al., 2015). In addition, poor game environment design, such as complex instructions or ad hoc use of game elements and mechanics, such as increased levels of difficulty or overly complex graphics, are inhibitory factors for learning while reducing student motivation and performance (Markopoulos et al., 2015).

At this point, however, one must underline the often-inappropriate utilization of these means. Today's digital market is full of applications that are promoted as educational but have little or no pedagogical value because they are often made with limited input from educators or development experts (see Figure 1). On the other hand, the unavailability of some tools presented in the relevant literature for parents, caregivers and educators of young children cannot be avoided, as they are stored in copyrighted digital repositories and databases. Furthermore, additional concerns arise regarding their appropriateness, the time required to complete an assessment, *etc.* On the other hand, freely available tools are considered outdated and inadequate in terms of their depth and scientific value. The low quality of most educational apps targeting preschoolers highlights the need for a tool to help parents and educators evaluate self-proclaimed educational apps for their actual value.

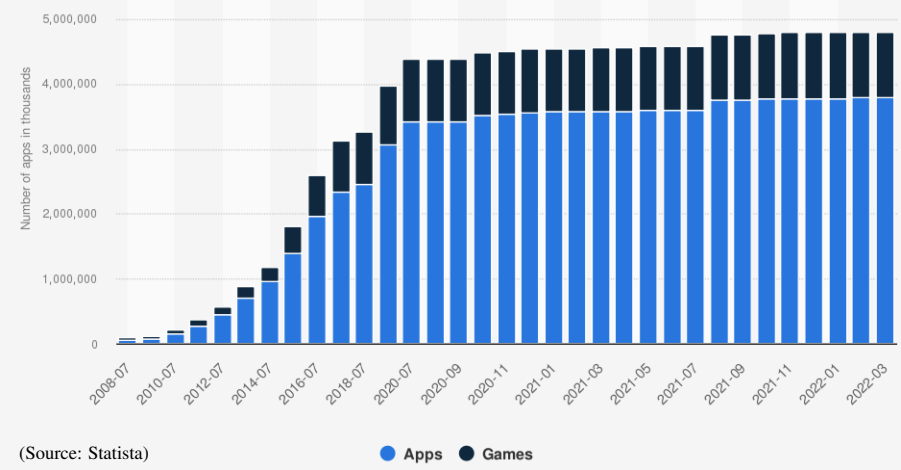


Figure 1 The number of apps available on the Apple App Store from 2008 to 2020

2 Methodology

The impetus for authoring this paper was created through the above investigation of the bibliographic review and considering the questions and concerns arising from the suitability, availability, and potential benefits of educational applications. The research aimed at apps for preschool children, i.e., children from 3 to 5 years old learning physics concepts.

The research questions are as follows:

(1) Do the apps available receive the same rating from users as an app rating system?

(2) Is user rating (stars in online stores) related to a subjective rating system for the sample apps?

(3) Can these applications be considered suitable and effective for the purpose for which they were designed based on their evaluation?

The research sample consisted of 15 randomly sampled Android and Windows applications (see Figure 2). The evaluation data was collected using a scientific tool, the rubric published by Papadakis et al.(2016) in the article, "Designing and creating an instructional application rubric for early childhood educators."

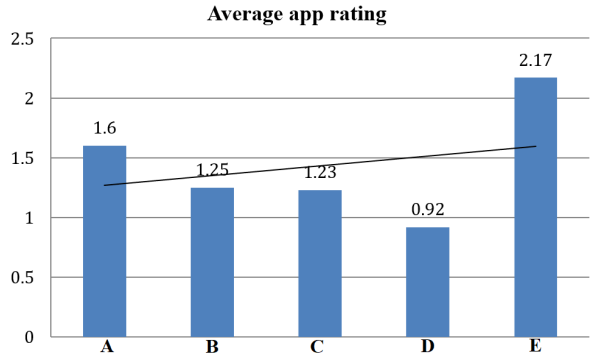
Figure 2 Some applications evaluated by the researcher

The apps were classified into three categories: game apps for mobile or desktop, interactive e-story books, and mobile app creation.

3 Results

The analysis showed that only 6.7% of the sample was in the form of an e-story. At the same time, the applications reproduced stories in electronic form. They did not use the most proper opportunities offered by modern communication and information technologies without offering any interactive capabilities. Also, the applications were based on practice activities, in the form of questions, with the consequence of not promoting critical thinking but enhancing machine learning. No added applications aim to develop a learning environment in which children are motivated and able to learn (Noorhidawati et al., 2015).

Of the 15 apps evaluated, only four apps scored higher than the average rubric score but had below-average scores in error correction/feedback and learning provision (see Figure 3).



A: Educational content; B: Design; C: Functionality; D: Technical Characteristics; E: Final Score

Figure 3 Mean application score for the rubric and the four individual sections

Next, it was investigated whether the rating of each app by its users, as reflected in the Google star rating system, is in line with the percentage of the app recorded by the rating rubric. An app's Google Play store rating ranges from 1 to 5. Converting the rubric score to the five-point scale revealed a considerable difference between each app's objective (rubric) and subjective (users) score.

In addition, in most app reviews, shallow scores were found, with a relatively low two-star rating, due to their design and development.

4 Conclusions

It is observed that most of the educational applications evaluated in this study did not have the best score based on the rubric used. Thus, developers must improve their educational applications in all areas, both in educational content and in each application's design, functionality, and technical characteristics. Regarding the usefulness of educational applications in the classroom and at home, most of the applications analyzed prepare children to have some rudimentary foundations in specific areas (reading, writing, arithmetic, music) without promoting knowledge and learning creatively productively.

For this reason, the need to create digital applications is strongly emerging, intending to promote learning maximally, whether teachers or parents carry it out. This requires the contribution of the creators and designers of applications themselves to study and upgrade their

applications so that preschool children can learn while having fun and achieve the ultimate goals of acquiring basic skills and abilities by integrating into the school environment and starting their immediate training.

In addition, it is essential to emphasize the value of personalizing learning, through activities that involve the contribution of technology, with the fundamental premise that they allow children to express themselves creatively and that can promote the developmental benefit of confidence.

In summary, it becomes clear that children need opportunities to participate in activities and exercises, on the one hand, which promote their development, and on the other hand, are related beyond traditional teaching methods. Reference is made to the necessity of providing freedom to children to become independent, take the initiative, try new applications that promote their knowledge and gradually acquire a complete sense of identity, strengthening their self-confidence and self-esteem (Kay, 2018).

In conclusion, it is found that in modern society, in the year 2022, the modernization of traditional with digital teaching is required. Preschool children, it is argued, can adapt to digital tools, and learn to efficiently operate tablets and smartphones (Patelarou et al., 2022). The choice of the proper application by teachers and parents becomes extremely important if one considers the effect it can have on the child and the possible benefits and risks involved. Additionally, it is imperative as it stands out among many apps, promoting science learning and the broader development of preschoolers.

5 Discussion

The present bibliographic review and the ongoing research revealed a gap between educational applications and student benefits. As it becomes clear, interdisciplinary collaboration between many disciplines is required to create applications that constructively advance knowledge about the Natural Sciences. It is found that it is not enough to create an entertainment application but instead an application that actively involves the child in learning and does not simply promote mechanization. In addition, it becomes imperative to anachronize existing applications due to the significant mismatch between the objective and subjective evaluation of applications. So that children and teenagers, creatively and productively, can receive help from their use.

6 Limitations and future proposals

The results of this research concern the investigation of the 15 applications mentioned above, so it becomes clear that the results cannot be generalized to all applications available to children and teenagers. First, it is essential to emphasize that further investigation and interest in evaluating already existing applications is required to evaluate them and establish possible benefits in acquiring students' knowledge. Additionally, it is suggested to create applications that do not simply consist of closed or multiple-choice questions; instead, it is crucial that they actively involve the user and promote the development of their critical thinking. A future suggestion would be for educational applications to involve as many of the user's senses as possible so that the application is not dull. At the same time, the user expands his cognitive field. At the same time, such an application could be enhanced by using augmented reality through special applications that allow the user to be taught differently beyond the traditional one. In addition, it is suggested that the applications are not purely entertainment, as found in this research (93.3% of the applications). Instead, new educational applications should be created where teachers, competent advisors, and parents can interact and jointly propose corresponding means of creating such an educational application.

Conflicts of interest

The author declares that they have no conflict of interest.

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