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PAPER

Essential Features for Mobile Applications to Assist Early Childhood Educators

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ABSTRACT

The integration of early childhood applications is increasingly common. However, in this process, educators often use academic apps from Apple and Android stores, believing they will enhance children's training. However, most of these apps, not designed by preschool educators, fail to enhance the training processes in early childhood education. This paper aims to identify the essential features those mobile applications must possess to enhance childhood education processes. To achieve this, we conducted a qualitative study with a descriptive scope and involved teachers of childhood education from the Universidad de La Sabana in the development of the mobile application. It is also based on the Mobile-D agile development methodology. The results have enabled the development of an intuitive mobile application for early childhood children, which strengthens children's development of cognitive, body, communicative, and aesthetic dimensions and identifies the essential elements that mobile applications should have in early childhood. The findings indicate that it is critical to involve early childhood education teachers in the development of mobile applications and that mobile applications must strike a balance between entertainment and educational content, as well as strengthen cognitive processes rather than disciplinary content.

KEYWORDS

educational technology, educational app, early childhood educator, early childhood education

1 INTRODUCTION

The contemporary world is currently experiencing a pivotal moment in its history, where the intertwined dynamics of culture and technology have profoundly reshaped how individuals interact with each other, perceive reality, and define their identities [1]. As societies adapt to an increasingly digital landscape, citizens are acquiring essential competencies and skills necessary for effective participation [2]. The advent of generative AI systems has further accelerated this transformative process [3].

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Educational institutions at all levels, from primary to higher education, are undergoing significant transformations [3], driven by the integration of generative AI into their educational frameworks. However, the impact of these changes on early childhood education appears less pronounced. This is due to differing perspectives among academics, teacher training institutions, and organizations focused on children's well-being regarding the appropriate role of technology at these developmental stages [4].

While there is growing support for integrating technology and digital tools into preschool education, proponents emphasize the importance of aligning these initiatives with clear educational objectives [4, 5, 6]. Nonetheless, insights from the Fred Rogers Center underscore the need to consider multiple factors such as children's ages, screen exposure duration, developmental stages, and socio-cultural contexts to mitigate potential disparities.

In addition to these considerations, it is imperative to consider the observations submitted by institutions such as the American Academy of Pediatrics and numerous academics on the repercussions of children's involvement with mobile devices during the COVID-19 pandemic [7]. These repercussions include noticeable disturbances in parent-child interactions, attention intervals, cognitive development, and executive function [7]. In addition, they extend to disturbances in behavioral patterns, changes in attitudes, and complications related to language use [8].

All of the above shows that although the current dynamics of society ensure that the integration of technology in early education is increasing, this integration must be carried out with a clear pedagogical intention that responds to the nature of preschool education, balancing moments of physical activity, peer interaction, and moments of digital interaction that favor cognitive development, attention, and executive functions, and allowing the teacher to integrate them into the curriculum. However, a literature review highlights that early childhood educators commonly utilize various digital technologies such as specialized software [9], e-books, digital tablets [10], robots [11], online resources [12], and mobile devices [9] to enrich the learning process. These technologies are favored for their user-friendliness [13], enabling natural and intuitive interaction that bypasses complex setup procedures, and offering access to a wide array of mobile applications beneficial to teachers [13]. Nevertheless, many of these resources are primarily designed for classroom activities, limiting flexibility for teachers to integrate them into their pedagogical approaches. This is significant because the use of technology in classrooms directly impacts teachers' knowledge, attitudes, and digital competencies, as emphasized by multiple authors [4, 8, 14]. Therefore, to better integrate educational apps into early education, it is crucial to design them with the specific needs of early childhood education and the digital competencies of teachers in mind.

However, early childhood educators face challenges when attempting to incorporate mobile applications into their teaching practices. Many applications labeled as educational in app stores such as the Apple Store or the Play Store are oriented towards entertainment and lack educational design principles necessary for early childhood development [14]. Despite being categorized as educational, these apps often fail to demonstrate their effectiveness or contribution to learning outcomes [15].

Given these findings, it is evident that developing suitable applications for child development is essential. Such applications empower teachers to create technology-based learning strategies that are appropriate for young children. Therefore, this study aims to identify the essential elements and features those mobile applications should possess to meet the specific needs of early childhood education. By providing teachers with tools that align with how children naturally

learn at this age, this study aims to guide scholars in improving the successful integration of technology in early childhood education.

2 LITERATURE REVIEW

The literature research was conducted to examine how mobile applications have been incorporated into preschool education. What are the obstacles and requirements you are currently facing? Mobile applications in preschool education serve several functions, including enhancing reading skills, promoting good eating habits, and gathering behavioral data in classrooms [16, 17, 18, 19]. However, if we concentrate only on the training procedures, we can see that mobile applications are utilized to encourage the advancement of socio-emotional, cognitive, physical, linguistic, and mathematical aspects [16, 17, 18], as well as the development of computational thinking, coding, and STEM activities [11, 14, 15].

Initially, research is primarily concerned with the impact of incorporating mobile applications into children's social interaction. This integration of applications with collaborative learning strategies encourages social interactions among children [19]. Collaborative approaches, in turn, enhance commitment, promote inclusion, and improve problem-solving skills [20]. Furthermore, engaging with peers serves as a source of motivation. Initially, there is research that specifically examines the impact of incorporating mobile applications on children's social contact. Research suggests that incorporating educational programs that encourage collaboration might effectively promote social relationships among youngsters [19]. This mutual dedication fosters inclusivity and enhances problem-solving abilities [20]. Furthermore, the interaction between peers serves as a source of motivation for children and promotes a greater level of involvement in their shared learning experiences [19, 20]. Nevertheless, all research emphasizes that mobile applications enable children to feel driven, but their utilization necessitates a pedagogical design that focuses on collaboration in order to foster social contact among children.

Similarly, the utilization of mobile applications that prioritize gamified learning methodologies, specifically built with a distinct educational purpose to enhance the contemplation, identification, and regulation of children's emotions [21]. Several products labeled as "educational" in stores often have a significant emphasis on play and might potentially lead to addictive behaviors and emotional challenges in children [14, 21]. Hence, it is crucial to collaborate with parents to ensure that they effectively utilize mobile applications at home, thereby preventing potential emotional challenges in children [14, 21]. In order to enhance the pedagogical design of these applications, it is important to strike a balance between the playful and educational elements, as suggested by Meyer et al. [17].

In this regard, Meyer et al. [17] emphasize the need for educational applications adhering to the following four essential principles in order to be classified as instructional: Pillar 1: Active learning; Pillar 2: Engagement in the learning process; Pillar 3 focuses on meaningful learning; while Pillar 4 emphasizes social interaction. After conducting a thorough analysis of over 100 educational applications available on Android and Apple stores, the researchers determined that 58% of these apps might be categorized as low quality based on their evaluation using the criteria listed above. It is highly recommended that all developers in the industry incorporate cognitive and developmental experts in childhood learning in order to create applications that align better with children's learning processes and cater to the various aspects of childhood development.

Furthermore, educational applications have demonstrated their significance in enhancing children's cognitive development [15, 19, 20, 23]. They serve as valuable tools for children facing learning difficulties, physical disabilities, or attention-related disorders such as attention deficit hyperactivity disorder (ADHD). These applications help children improve their focus, impulse control, and manage hyperactivity [23]. Similarly, they promote mathematical cognition by dispelling negative perceptions associated with math through engaging activities. Consequently, children experience increased motivation, develop a deeper understanding of mathematical concepts, and derive enjoyment from learning mathematics [24]. However, it is important to note that in some cases, integrating mobile applications may not lead to significant improvements in math learning [25]. Additionally, significant challenges have been identified when using multitouch capabilities with preschool children [25].

Similarly, these applications demonstrate significant benefits in supporting language development. Research reveals that children exhibit enhanced creativity in communication [26, 27], particularly when engaging with gamified environments featuring augmented reality [28]. This is especially advantageous for children facing challenges with vocabulary, as it enables them to communicate using visual representations and symbols. Moreover, these applications empower children to create various forms of expressive content, nurturing their creativity [25, 26, 27]. They also facilitate interaction among children with speech and language impairments, helping to prevent feelings of isolation [29, 30]. However, caution is necessary regarding screen time duration, as these applications can be highly engaging, potentially discouraging children from stopping use [27, 28]. Additionally, prolonged screen time has been associated with childhood obesity [22]. To mitigate these risks, experts recommend innovative application designs that promote physical activity, teamwork, and the development of fine motor skills [20, 22].

The researchers stress the importance of considering the pedagogical knowledge and beliefs of teachers when integrating technology into childhood education [31]. This is particularly crucial when incorporating emerging technologies such as mobile devices, as teachers need to identify and comprehend the various methods of integrating such technology into the classroom [32]. In order for a teacher to include technology into primary education, it is crucial for them to acknowledge the existence of an educational requirement that can be enhanced through the incorporation of technology [31]. In addition, the manner in which the teacher incorporates technology is influenced by their attitudes towards technology, which are determined by four elements identified by Gjelaj et al. [32]. These aspects include the teacher's prior experience, the availability of digital technology, their professional growth, and their personal beliefs about technology. It is crucial to recognize that most of these challenges arise due to the absence of digital technology education for recent graduates and that the technology currently accessible for early education was not specifically created for this objective.

In conclusion, the literature evaluation unequivocally demonstrates that the utilization of educational applications promotes the advancement of learning as well as the cognitive, co-communicative, and motor aspects. However, it also indicates that apps are not specifically created to address the many requirements and demands of early childhood education. Furthermore, it emphasizes the importance of involving educators in the design and development of the app to ensure a harmonious blend of entertainment and educational value. It also stresses the need to assess the appropriateness of interaction processes for the target age group, discourage multitouch actions, and evaluate the educational potential of the apps prior to their

implementation in training programs [30]. Likewise, when aiming to create technology for these age groups, it is crucial to attentively consider the input of teachers and explore methods to seamlessly include technology into their educational principles and strategies for classroom integration. Therefore, this project aims to build and validate a mobile application that addresses these features by actively integrating instructors in its design and testing.

3 METHODOLOGY

This qualitative study focused on identifying essential features for a mobile application tailored to early childhood education. Conducted in three phases, the research began with a focus group of subject specialists to outline key application features. The second phase involved designing and developing the application using the Mobile-D approach, known for its agile development capabilities in educational contexts [33, 34, 35]. The methodology spans exploration, initialization, production, stabilization, and system testing stages.

Importantly, the developed application targets educators rather than students. To ensure alignment with stakeholder needs, a collaborative approach was employed. The development team actively engaged pre-service early childhood teachers throughout the Mobile-D process, gathering feedback and suggestions on integration into educational practices.

3.1 Participants

The research sample consisted of 19 pre-service teachers from last semesters of early childhood education at the Universidad de La Sabana.

3.2 Instruments

1. Semi-structured interview: Prior to beginning the application design process, a semi-structured interview was conducted with early childhood educators. The purpose of this interview was to identify the various aspects that should be considered for the design and development of the mobile application, based on their classroom practice.
2. Survey to evaluate the app: This instrument was utilized to verify the design of the mobile application as well as assess its potential impact on the advancement of early childhood education dimensions and ascertain the various methods through which the application could be incorporated into children's training processes. An interdisciplinary team including two educational technology specialists, two early childhood education specialists, an instructional designer, and a graphic designer was responsible for designing the survey. The validation process involved the assessment of specialists in the fields of childhood education and educational technology.
3. Focus group to experts: After completing the design process of the application, a focus group was conducted with two experts in educational technology and three experts in childhood education to verify and approve the pedagogical and technological design of the app, as intended for its development.

3.3 Data collection procedures

Data collection occurred at multiple stages throughout this study endeavor. Initially, in the first phase before application development commenced, semi-structured interviews were conducted with five experts in children's education. These interviews aimed to identify key factors crucial for the application's design.

In the second phase, after the application design was completed, a focus group was convened with the same five experts from the initial interviews. The purpose of this group was to validate the application design and suggest any necessary revisions.

Moving to the third phase, preschool students engaged with the mobile application, followed by a survey to gather data on the application's design, its perceived benefits, and potential methods for integrating it into early childhood education.

Upon completion of the application's design process, a final focus group was conducted. This group included two specialists in educational technology and three specialists in childhood education. Their role was to review and approve both the pedagogical and technological aspects of the application as originally intended for its development.

3.4 Data analysis

The data analysis was conducted in two stages. Firstly, the qualitative data collected through the instruments were analyzed using the Atlas ti v.13. The data were categorized, and conclusions were drawn through the process of triangulation. It is worth noting that all participant information was encrypted to ensure their anonymity. The Excel program was utilized to analyze the quantitative data due to the descriptive nature of the study. This limitation of the research prevented the use of variable crises, but the primary objective was to analyze the collected data on the usability of the mobile application in a descriptive manner.

3.5 App develop procedure

The mobile application was created with the Mobile-D methodology. This process comprises five distinct phases: exploration, initiation, production, stabilization, and system testing [33]. The choice of this methodology was deliberate, as it has the ability to facilitate agile development in the field of mobile applications [34] and has been demonstrated to aid in the design and development of interactive applications in educational environments [35].

Exploration. This phase is the most important phase of the entire production process because it is dedicated to establishing the project plan and defining the scope and functional and nonfunctional requirements of the project. For these, three main moments are defined: stakeholder establishment, scope definition, and project establishment.

The stakeholders of the project are the users of the application (early childhood pre-service teachers) and the research groups involved in the development and the early childhood education program of the Universidad de La Sabana.

The project was established after conducting interviews with stakeholders. The requirements were identified and are shown in Table 1.

Table 1. Requirements

ID	Description
R001	The application must be compatible with any mobile device that uses Android OS version 9 or higher.
R002	The application should allow early childhood teachers to develop activities both in and out of the classroom.
R003	The application should respond to the natural way in which children learn between the ages of 3 and 5.
R004	The application should be intuitive because users have little experience in handling mobile applications.
R005	The application should be based on exploratory learning.
R006	The application must communicate with the NFC system to allow interaction with physical elements.

Initialization. In this phase, all the resources needed to develop the project were prepared, including hardware, software, and team training. In this case, the hardware is of great importance because the application communicates with an NFC system and allows the recognition of physical objects. The project architecture and navigation flow were also defined.

The project architecture and development of the app were performed in layers. The user interacts with the presentation layer to log in and participate in the developed video game, whose narrative, functionalities, and contents are established in the business layer. Within this layer, the logical component of the app is responsible for providing the content, videos, resources, and activities proposed to encourage the development of children's thought processes through exploration and communicates with the data layer so that the application can interact with the NFC communication system, which is responsible for recognizing the physical elements, as shown in Figure 1.

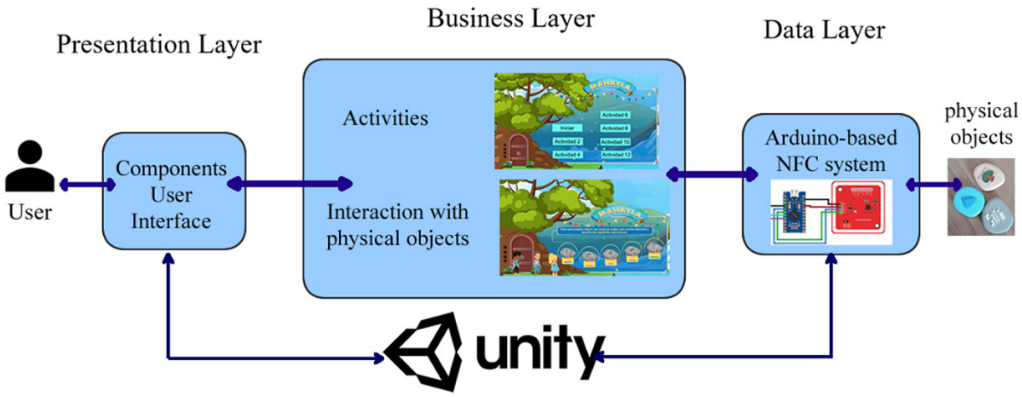

Fig. 1. Project architecture adapted from [33, 34]

Navigability: The navigation flow starts with the teachers' access to the application when they enter their account details. From there, they are taken to the main menu, where they have access to different parts of the video game narrative. To make it easier, the videogame allows students to go back to the main menu from any activity and from the main menu to enter the peer activities, so that the teacher can integrate a particular activity she needs to work on before or after the class session into her training process. The navigation of the application is described in more detail in the results section.

Production. In this phase, the development of both the application and its interfaces began. The process began with a review of the different disciplinary and pedagogical aspects that the app should contain to enable the development of children's thinking processes through exploratory learning. Subsequently, it was determined that the best solution was to develop a video game, so the narrative of the game and the storyboard were created in Word, as shown in Figure 2. The narrative can be seen in Figure 2a and the activities in the game in Figure 2b.

a)

One summer morning Santi and his friends were playing football in the park, Nico kicked the ball, and it flew very high, so high that it soon left the football pitch and rolled into the nearby forest. Vale said to his friends let's go look for it and the three of them ran off in search of their ball to continue playing.

They ran downhill through the park, looking at all the places where they could play until they finally managed to retrieve the ball. But they were very tired, so tired that they didn't know if they could make it back up the hill they had come down. They took the road nearby and walked to some buildings.

When they arrived, Santi told them that he was very thirsty, he wanted something cold and fresh, then Nico told him I know, a lemon popsicle and they all tasted each other, and started to look where they sold lemon popsicles.

Act1: It's your chance, help your little friends find the place where they sell lemon popsicles, thanks!

When they arrived at the ice cream shop, they asked for three lemon popsicles. But the owner of the ice cream shop said there were none. They asked why there were no lemon popsicles?

The owner told them that something was wrong at Aqualia because they were getting all kinds of popsicles except lemon. The restless children asked how could they go to Aqualia?

b)

Act2: can you guess in which order the runes should go inside the tree and find out what will happen?	So that you can put the runes in order, pay close attention and decipher the following riddles: 1. When you touch me, I can pass through your fingers and sometimes you drink a little of me. 2. I am yellow like the sun and warm like the sun. 3. I am light, and I can pass through your cheeks. 4. I have only two lines, wavy. 5.I represent the green of your planet, earth.	The idea is for the children to place the runes in a specific order as a sequence.

1.Aqualia	2. Vesubio	3. Alisio	4. Pangea	5. Mahayla

Fig. 2. Initial storyboard of the mobile application

Next, we developed interfaces for different sections of the app, as shown in Figure 3.

Fig. 3. Presentation layer interfaces

Finally, all business layer services were produced, as shown in Figure 4.

Fig. 4. Business layer services

Stabilization. In this phase, adjustments and integration of the app modules were made, stabilizing the correct functioning. Figure 5 shows the Visual Studio software code used to select the appropriate spacecraft for travel.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

0 references
public class scr_ctrl_nave : MonoBehaviour
{
    0 references
    float speed = 1.4f;
    3 references
    public static float tiempointro;
    0 references
    void Start()
    {
        tiempointro = 14f;
    }
        0 references
        void Update()
    {
        if (tiempointro > 3f)
        {
            tiempointro -= Time.deltaTime;
        }
        else
        {
            SceneManager.LoadScene("actividad 4");
        }
    }
}
```

Fig. 5. Code for select the correct spacecraft

Test. During this phase, the system undergoes rigorous testing and necessary repairs. The primary goal is to ensure the system's availability in a stable and fully operational state. This phase is dedicated to confirming that the application aligns with the pre-established functional requirements, ensuring that these coordinated requirements are met for the correct functioning of the system for end users (the teachers). This involves scrutinizing the system components and conducting comprehensive functional tests for each developed module.

4 RESULTS

The application was utilized by a total of 19 pre-service teachers enrolled in the Children's Education program at the University of La Sabana, as previously mentioned. Participants who used the application were required to fill out a survey to assess the application's usability, its suitability for integration into childhood education, and to decide the specific times and methods for integrating the application into classroom practice for child education. Ultimately, it became feasible to discern the key components necessary for effectively integrating a mobile application into preschool education.

4.1 General features that the app should have according to experts

The semi-structured interview with early childhood education specialists revealed that for successful integration of mobile applications into early childhood education, the application must possess the following characteristics:

1. It should enable early childhood educators to create activities for both inside and outside the classroom.
2. Should be designed to align with the innate learning processes of children aged three to five.
3. Should be user-friendly as users have limited familiarity with mobile applications.
4. Should be grounded in experiential learning.
5. Images should employ a minimalistic approach, utilizing solid colors and avoiding intricate details, to ensure clear comprehension by children. Similarly, the instructions should be provided in both written and auditory formats, allowing the youngster to repeat them as many times as desired.

4.2 Evaluation of application by pre-service teachers

Following their use of the mobile application, the pre-service teachers carried out an evaluation of the application using a survey specifically designed for this purpose. The results acquired are displayed in a sequential manner and are divided into two sections. The initial section encompasses the outcomes pertaining to the visual elements of the application, whereas the subsequent section centers on the educational aspect of the application. Figure 6 displays nine statements that were made regarding various features of the tool, specifically its UI and academic usability.

UI components. The initial assessment evaluated the suitability of colors used in the application for different age groups of children. A significant majority of students (94.4%) agreed with this assessment, while a single student (5.6% of the sample) disagreed, suggesting that Figure 4 could use distinct colors for each displayed rune.

Regarding the importance of the illustrations in the application, the majority of students (83.3%) agreed. One student remained neutral, and two students (11.1% of the total) disagreed, citing that the graphics should have more depth and suggesting that the application should be in 3D. They argued that children today are accustomed to interacting with three-dimensional environments. However, the application was designed and developed in a two-dimensional (2D) format.

The statement that garnered the most disagreement among students was whether the graphical interface of the application enhanced children's engagement. About 38.9% agreed, 27.8% disagreed, and 33.3% neither agreed nor disagreed. Some students mentioned a need for faster reading times with the NFC system, noting a perceived delay of five seconds between each reading when placing physical objects. Additionally, there were comments about certain objects being too small. However, these dimensions were intentionally chosen to accommodate the tactile abilities of children aged four to six, considering the size of their fingers. Some students also emphasized the importance of providing clearer instructions for the activities in the app to enhance comprehension among children.

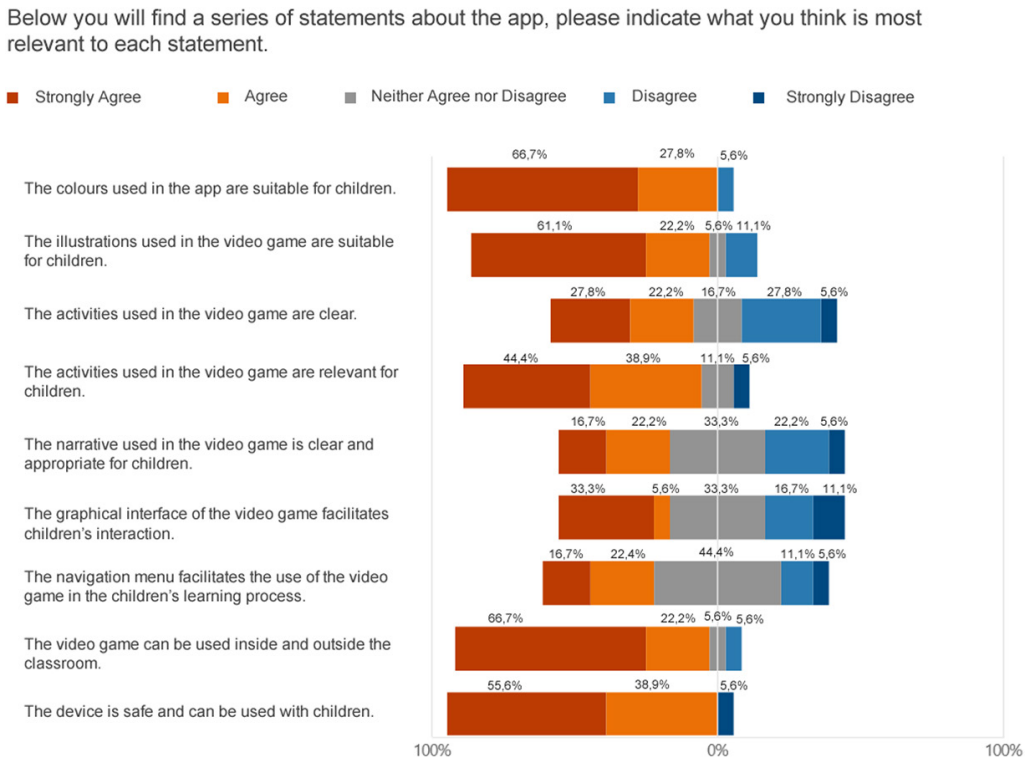

Fig. 6. Code for select the correct spacecraft

Academic components. Regarding the statement about the clarity of activities in the app, 50% of surveyed students agreed that they were easily understandable for children, while 16.7% neither agreed nor disagreed, and 33.3% disagreed. Those who disagreed cited insufficient detail in certain activities, which made them challenging for children to interpret without assistance from a teacher. There were also requests for increased audio volume, although it was explained to participants that volumes couldn't be excessively high to protect children's auditory systems.

However, a significant majority (83.3%) of students agreed that the activities used in the app were relevant for children. This finding is crucial for the research as any technical issues hindering the process can be addressed in the app's subsequent versions. Nevertheless, if the core aspect of the proposal, namely the

exploration-based activities, were to be more structured, it might necessitate a redesign of the application. Only one student (5.6% of the total) expressed disagreement, suggesting that activities should include more detailed explanations based on responses from open-ended questions.

Two additional statements assessed the application's utility beyond the classroom and its suitability for children. Regarding the first statement, 89.9% of students believed the application could enhance training procedures beyond the classroom setting. Conversely, only one student (5.6%) disagreed. Regarding safety, 94.4% of students agreed that the application was safe for pupils, with just one dissenting student.

While some students expressed support for enhancing the application's usability and graphical interface, the majority concurred with various assertions about the software. Moreover, the next section will highlight numerous applications of the software in early childhood education instruction.

4.3 How to integrate the application into early education

In order to ascertain the optimal age for implementing the mobile app in early childhood education, kids were queried regarding its most suitable age range. 79% of respondents stated that the proper age to use the program is between five and six years. This suggests that the application is suitable for use from kindergarten to transition, as depicted in Figure 7.

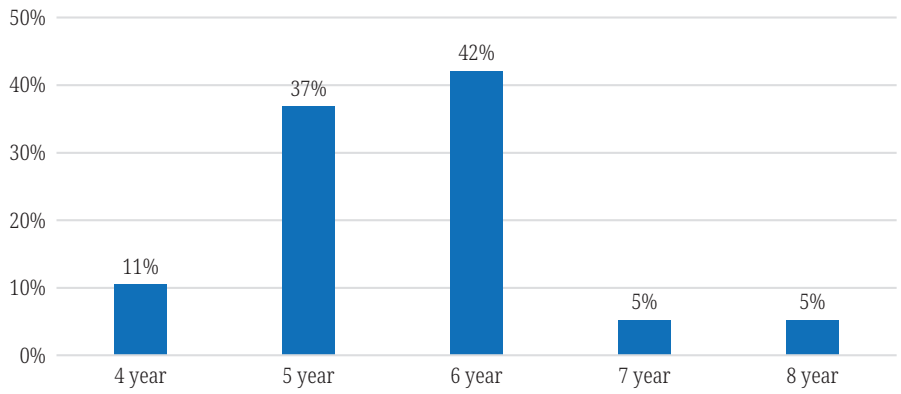

Fig. 7. Recommended age to use the game

When asked about the grade levels suitable for integrating the application, responses varied: 11% specified kindergarten, 85% favored transition, and only 5% mentioned prekindergarten. However, when specifically questioned about the application's feasibility in first grade, only one student (5%) expressed skepticism, while the remaining 95% indicated that it could be used effectively if it included more intricate narratives promoting critical thinking and collaboration. They also emphasized the importance of teacher supervision and integration into instructional plans.

Regarding the application's suitability for children with unique educational needs, 58% of respondents deemed it not feasible, while 42% believed it could be viable with specific modifications to ensure safe use within this demographic.

In another survey question, students were asked about the dimensions of child development that could be enhanced through the application. Responses included 5.6% for the aesthetic dimension, 16.7% for the socio-affective dimension, and 22.2% for the communicative dimension. Some students suggested that integrating

external activities aligned with the application's themes and challenges would be essential to foster growth in communicative, socio-affective, and aesthetic aspects. Similarly, there was a suggestion to incorporate activities of varying complexity to engage children and stimulate their intellectual abilities effectively.

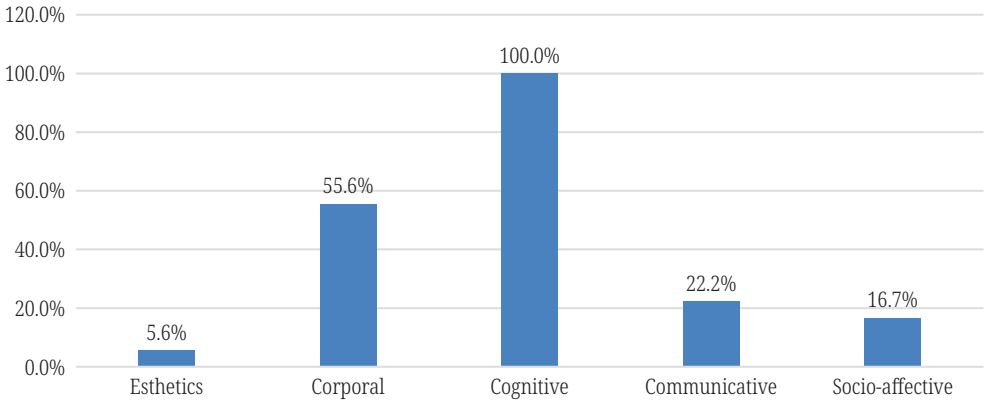

Fig. 8. Dimensions of child development that the mobile application contributes

Ultimately, the researchers inquired about the potential utilization of the program by early education teachers. The students indicated that early education teachers can utilize the application to facilitate collaborative work, regulate emotions, optimize time management, adhere to instructions, cultivate problem-solving and decision-making abilities, participate in sequential mathematical operations, introduce reading, establish connections between information, and encourage concrete thinking.

4.4 Features for a mobile application in early education

According to the research findings, it was feasible to ascertain those mobile applications aiming to be incorporated into early childhood education must possess the attributes outlined in Table 2.

Table 2. Essential features in early childhood apps

Features	Description
Balance between fun and learning	It is important to ensure that the application maintains a harmonious equilibrium between the elements of play and the educational activities.
More cognitive processes than disciplinary content	Direct your attention on the aspects of growth and progress. The application should prioritize the promotion of at least two aspects of child development, specifically cognitive, corporal, communicative, socio-affective and esthetic dimensions.
Keep it simple but fun	It is vital to ensure that the activities are comprehensible to the kids without requiring the teacher's assistance. This is crucial at their age as it promotes the development of their autonomy. Additionally, it is essential to ensure that the activities are enjoyable, considering their young age.
Inside and outside the classroom	It is important to ensure that the activities in the mobile app make full use of the device's portability and allow teachers to conduct them both inside and outside the classroom. Additionally, it is crucial to focus on activities that promote motor development, which is particularly important at this age.
Process centered exploration	It is crucial for children to engage in exploration as part of their educational process, as it aligns with their natural learning tendencies at this stage. By discovering and reflecting on their capabilities, children develop self-confidence.

5 DISCUSSION

The primary objective of this study was to identify the essential features, components, and tasks necessary for a mobile application to support early childhood education effectively. This was achieved through a methodological approach involving disciplinary experts and pre-service teachers. By incorporating stakeholders' perspectives, the study aimed to enhance the educational processes in early childhood education through mobile technology.

This study was pivotal as it facilitated the identification of key features crucial for integrating a mobile application into early education. While existing literature showcases successful examples of mobile app integration in early learning [22, 23, 24, 27], there remains a lack of clarity on the specific characteristics required for effective implementation.

Recognizing the importance of stakeholder involvement, the study adopted the Mobile-D agile development methodology. This approach enabled stakeholders to participate in decision-making and the creation of multiple prototypes [33, 34, 35], facilitating the identification of essential elements and traits necessary for the application.

Moreover, aligning with recommendations from literature [22, 25, 26, 28, 30, 36], the study emphasized the involvement of pedagogical specialists in the development process. This ensures authenticity and consistency in educational value [22, 25, 27], balancing enjoyment with learning [14, 21, 22, 37]. Importantly, the study highlighted the unique contribution of pre-service teachers in application development. Unlike experienced teachers, pre-service teachers bring innovative ideas and concepts, motivated by their anticipation of using these applications post-graduation. This enthusiasm enhances their dedication to creating applications better suited for children's needs.

Furthermore, this project has made a significant contribution by highlighting the benefits of integrating developers into the entire development process. This integration has resulted in developers developing empathy with educators and becoming more attuned to their needs. As a result, the development process has been expedited, and an application has been designed that seamlessly integrates into the transition class. This application is tailored to the actual requirements of teachers and can be utilized regardless of their individual learning strategies. Developers must prioritize empathy towards stakeholders and ensure that clients feel actively involved in the process. This is crucial because, unlike other educational developments mentioned in the literature [9, 12, 13, 18, 20], children of this age are highly perceptive to the form and aesthetics of the resources they interact with.

Nevertheless, the research findings demonstrate that teachers' comprehension and incorporation of digital educational resources vary greatly. This diversity is evident even when they are involved in the creation and advancement of a mobile application. When evaluated by different teachers, the application reveals unmet needs. This is because each teacher has their own understanding of how to use ICTs for learning and teaching, as discussed by various authors in the literature [12, 17, 18, 19, 20, 21, 24, 26, 28, 30, 37].

Ultimately, as stated in the conclusion of the results section, this study proposes that for a mobile application to effectively cater to the requirements of childhood education, it should strive to achieve a harmonious equilibrium between entertainment and educational value. Greater emphasis is placed on cognitive processes rather than disciplinary content. Ensure that it is both uncomplicated and enjoyable, permitting its utilization within and outside the confines of the classroom, and most importantly, facilitating an investigation that is focused on the process.

6 CONCLUSION

According to the literature, many mobile applications designed for early childhood education claim to be educational but often prioritize entertainment over promoting knowledge acquisition and child development. Studies have proposed suggestions for improving these applications by involving experts in childhood pedagogy.

The objective of this project was to identify essential elements that should be incorporated into mobile applications to enhance various aspects of early childhood education. Initial findings affirmed existing literature, highlighting the critical role of early childhood education teachers in the design, development, and validation of such applications. Contrary to previous research, this study found that involving pre-service teachers is equally, if not more, crucial due to their innovative ideas and active engagement with instructors during practical work.

Furthermore, the study revealed that enhancing multiple aspects of child development simultaneously is achievable but requires a focus on cognitive processes rather than just knowledge and skill acquisition, as commonly emphasized in the literature.

A significant challenge encountered during the application's design and development phase was conveying the importance of pre-service teacher involvement to the development team. Developers initially struggled to grasp why students had varying perspectives on application design and relevant activities. This challenge was addressed through interactive sessions that fostered mutual understanding between developers and students.

Despite its contributions, the study acknowledges a limitation in needing further investigation into its outcomes. This includes applying the identified features to develop other mobile applications and involving additional teachers and developers to generalize the findings. Continued research is necessary to ensure educational content aligns with critical early childhood education processes and effectively develops self-regulation skills for digital screen usage across different age groups.

In conclusion, this study significantly contributes to the literature by identifying essential features that any mobile application targeting childhood education should possess. It underscores the importance of involving pre-service teachers in the design and development process to enhance the educational effectiveness of such applications.

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