Evaluation of digital applications in learning and interactivity of young children

Avaliação de aplicativos digitais no aprendizado e interatividade na primeiríssima infância

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Abstract

Introduction: Early childhood (0 to 36 months of age) is a crucial period for a child's physical, cognitive and social development, being a decisive moment for the foundations of learning and social interaction. **Objective:** To evaluate the interactivity, age-appropriateness, learning potential, and motivational appeal of free games and apps for children in early childhood. **Methods:** This is a cross-sectional, descriptive study that observed the following steps: search and selection of free apps available on Google Play®; use by children aged 24 to 36 months attending public daycare centers; participant observation and evaluation by two independent researchers, according to the following criteria: interactivity, learning, appropriateness, and results. A form was created for the analysis to assess the aforementioned criteria, with response options on a Likert scale from 0 ("not at all") to 3 ("quite a bit") for each criterion. Scores were calculated with a maximum value of 1.00, with 0.60 being the minimum appropriate value. **Results:** Twenty apps were found, and 7 were selected based on the established criteria. The average score was 0.74 for learning (0.59–0.84), 0.82 for interactivity (0.41–0.95), 0.78 for adequacy (0.53–0.90), and 0.81 for outcomes (0.47–0.96). **Conclusion:** Just over 2/3 of the seven free-access applications performed well on the criteria, revealing potential for use in research and by educators and parents.

Keywords: Mobile applications. Digital media. Interactive multimedia. Child development. Child.

Resumo

Introdução: *A primeiríssima infância (0 a 36 meses de idade) é período crucial para o desenvolvimento físico, cognitivo e social da criança, sendo um momento decisivo para as bases do aprendizado e da interação social.* ***Objetivo:*** *Avaliar a interatividade, a adequação para a faixa etária, o potencial de aprendizado e o apelo motivacional de jogos e aplicativos de acesso gratuito para crianças na primeiríssima infância.* ***Métodos:*** *Trata-se de um estudo transversal, descritivo, que seguiu as seguintes etapas: busca e seleção dos aplicativos gratuitos disponíveis no Google Play®; utilização por crianças de 24 a 36 meses de idade frequentadoras de creches públicas; observação participante e avaliação, por dois pesquisadores independentes, conforme os critérios de interatividade, aprendizado, adequação e resultados. Para análise, produziu-se um formulário avaliando os critérios citados, com opções de resposta em escala Likert de 0 ("nada") a 3 ("bastante") para cada critério. Foram calculados os escores com valor máximo de 1,00, sendo 0,60 o valor mínimo apropriado.* ***Resultados:*** *De acordo com os critérios estabelecidos, foram selecionados 7 dos 20 aplicativos encontrados. O escore médio foi de 0,74 no aprendizado (0,59–0,84), 0,82 em interatividade (0,41–0,95), 0,78 em adequação (0,53–0,90) e 0,81 nos resultados (0,47–0,96).* ***Conclusão:*** *Pouco mais de 2/3 dos sete aplicativos de acesso gratuito apresentaram bons resultados quanto aos critérios, revelando potencial para uso em pesquisas e por educadores e pais.*

Palavras-chave: *Aplicativos móveis. Mídia digital. Multimídia interativa. Desenvolvimento infantil. Criança.*

Introduction

The childhood earliest stage , from 0 to 36 months of age, is a crucial period for physical, cognitive, and social development, representing a decisive moment for the foundations of learning and social interaction.[1] During this phase, children are strongly influenced by their family environment, educational practices and, in recent years, the growing use of digital media, which has significantly altered play and learning habits.[2]

Recommendations from organizations such as the World Health Organization (WHO) and the Brazilian Society of Pediatrics (SBP) emphasize the need for caution: for children under 2 years of age, screen exposure should be completely avoided, while for those between 2 and 5 years old screen time should not exceed one hour per day, always with quality content and adult mediation.[3,4]

Technology has become an increasingly present component in children's daily lives, with the rise in the use of devices such as smartphones, tablets, and video games, while traditional play activities have declined.[5,6] Paradoxically, research indicates that many families are unaware of these guidelines or face difficulties in implementing them, resulting in early and prolonged exposure associated with risks such as speech delays, sleep problems, and reduced face-to-face interaction.[7,8]

Children of the 21st century, referred to as "digital natives," are immersed in a technological environment from a very early age and show great ease in interacting with digital devices.[9] However, excessive screen use raises concerns about its impact on social, motor, and cognitive development. Studies show that many children exceed the recommended screen time, which may impair social interaction skills, creativity, and other developmental areas.[10,11] Still, when used intentionally and in a balanced way, digital media can complement concrete experiences if they meet quality criteria and are supervised.[12]

To understand the role of digital media, it is first necessary to define the term "media," which is the plural of "medium" and refers to the means of communication used to disseminate and convey information.[13] Media can be classified into traditional media, such as radio, television, and books, which involve more passive interaction where the audience receives information; and digital media, which differ by enabling active interaction, allowing everyone to be both senders and receivers simultaneously through decentralized and dynamic digital platforms.[14]

Although digital media can have positive effects, such as stimulating creativity, learning, and cognitive development, inappropriate or excessive use may cause harm, especially regarding social interaction and the child's imaginative capacity.[4,15] Careful selection of applications with clear educational objectives, limited usage time, and promotion of active child participation, rather than passive consumption are essential to support child development. The use of digital media in early childhood should be mediated by adults, prioritizing content that encourages interaction, meaningful learning, and the child's engagement in the process.[16]

To achieve the goal of promoting developmental gains, applications must first be age-appropriate, have learning potential, and spark the child's interest in digital interaction.[17] It is essential to protect early childhood from inappropriate digital stimuli, especially given the significant increase in technology presence in children's daily lives.[18] In this context, it is important to understand the applications quality aimed at this age group, paying attention to associated risks and the compatibility of content with physical, cognitive, and social development.

Thus, the objective of the current study is to evaluate the interactivity, age-appropriateness, learning potential, and motivational appeal of free games and applications designed for children in early childhood. The research aims to contribute to the conscious and pedagogical use of digital technologies, offering guidance for educators, parents, and researchers in the careful selection of digital resources focused on child development.

Methods

This is a cross-sectional, exploratory study approved by the Ethics Committee of the Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM) under protocol number CAAE: 29490420.9.0000.5108. Prior to the procedures, informed consent was obtained from the children's legal guardians. The study included 15 children aged between 24 and 36 months.

The sample of evaluated applications consisted of games and apps with visual and auditory stimuli that offered challenging activities appropriate to child development. Games available on the online app stores Google Play and App Store were selected, compatible with the Samsung A7 tablet operating system, Android version 11.0. The search terms used were "games for children," "children's game," "children's game 2 years," and "children's game 3 years." Applications requiring monetary payment or those not suitable for the studied age group were excluded.

The study followed these steps: (1) search and selection of applications; (2) evaluation of applications by the researchers; (3) use of applications by the children. For data collection, the participant observation technique was used, with two researchers individually accompanying 15 children aged 24 to 36 months who had no prior experience with the tested applications and no diagnosis of neuropsychomotor delay.

All interactions occurred exclusively under the supervision of the researchers, who provided standardized instructions on how to use the applications. The children interacted with each application in a controlled environment, without the option of free use. The applications were independently evaluated by the two researchers based on the following criteria: (1) Interactivity: critical thinking, active participation, decision-making; (2) Learning: activities that potentially stimulate cognitive development, fine motor skills, receptive language, expressive language, and social-emotional development; (3) Appropriateness: to age, developmental stage, and multiple domains; (4) Outcomes: challenging but non-frustrating activities that provide feedback.[17]

Each criterion was scored on a Likert scale from 0 to 3 (0 = none; 1 = very little; 2 = somewhat; 3 = a lot), based on specific behaviors observed during the child's interaction with the applications, such as vocalizations related to the content (e.g., attempts to verbalize sounds or words during the game), persistence in challenges (such as completing visual patterns or matching figures), or signs of frustration (such as reactions to motor difficulties or lack of clear feedback). For each application, a specific questionnaire was developed to assess multiple dimensions of the child's performance and experience, including receptive language (ability to understand game commands and identify figures in context), expressive language (spontaneous verbalization attempts), cognitive aspects (following instructions, matching figures, completing patterns, and making decisions), fine motor skills (such as using a finger to draw, drag objects, or connect dots), engagement (active participation and stimulation of thinking), and game appropriateness (such as age-appropriate vocabulary, challenge level, clarity of feedback, and absence of frustration). Questions such as "Did the child understand the game commands?" or "Was the game challenging but not frustrating?" guided the observations, ensuring a comprehensive and systematic evaluation. To ensure reliability, the researchers recorded observations independently, followed by a concordance calculation (Kappa index > 0.8), and the data were analyzed considering consistency across the evaluated criteria.

For each application, scores were calculated for the criteria of learning, interactivity, appropriateness, and outcomes, with a maximum value of 1.00 for each axis. The total score was obtained by the arithmetic mean of the scores for these four criteria.

A minimum total score of 0.6 (60% of the maximum value) was considered adequate, a criterion aligned with educational technology evaluation standards that associate this range with the minimum required effectiveness.[18] Data were organized in Microsoft Excel and later transferred to SPSS software (version 20.01) for descriptive analysis, including measures of central tendency (mean, median) and measures of dispersion (minimum and maximum).

Results

In the first stage, 20 applications were identified, of which 7 were selected for the study due to their age-appropriateness and free availability.

The applications used were as follows: Application A focuses on stimulating receptive language, cognitive skills, and visuomotor abilities.[19] Application B is aimed at stimulating children's fine motor skills through activities such as coloring animal drawings.[20] Application C proposes the association of identical or similar figures, stimulating the cognitive, linguistic, and fine motor domains of children.[21] Application D offers various games and puzzles essential for learning shapes, colors, the alphabet, numbers, and vocabulary.[22] Application E is designed to stimulate multiple domains of child development, with activities that allow children to learn while having fun.[23] Application F includes activities that stimulate cognitive and fine motor skills through puzzles and coloring tasks.[24] Finally, Application G is a musical app that encourages children to play and explore different instrument sounds.[25]

In the second stage, the applications were evaluated according to the criteria of description, domains, interactivity, learning, appropriateness, and outcomes. Based on the specific questionnaires for each application, scores were generated to assess the applications in terms of learning, interactivity, appropriateness, and outcomes (Figure 1).

Figure 1 - Evaluation of the applications in terms of learning, interactivity, appropriateness, and outcomes.

Regarding learning, that is, activities that potentially stimulated cognitive development, fine motor skills, receptive language, expressive language, and social-emotional abilities, App A received the highest score (0.84). In terms of interactivity, meaning whether the application encouraged critical thinking, active participation, and decision-making, App C achieved the highest score (0.92). The applications that received the highest ratings for appropriateness considering age, developmental stage, and multiple domains were Apps B and G, both scoring 0.90. As for outcomes, in other words, challenging but non-frustrating activities that provided feedback, App D obtained the highest score (0.96), while App F had the lowest score (0.47). Regarding the overall evaluation score, App A achieved the highest total score (0.87) among the seven selected applications (Figure 2).

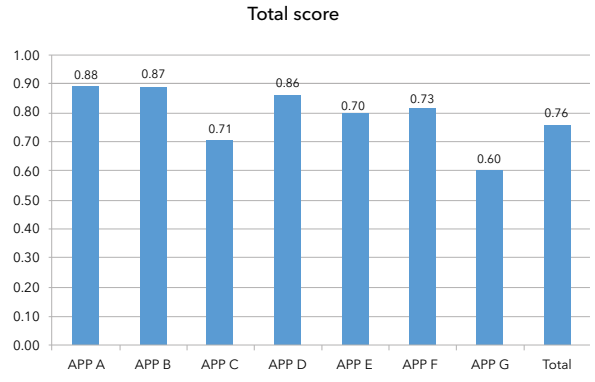

Figure 2 - Total evaluation score of the applications based on the criteria of learning, interactivity, appropriateness, and outcomes.

Discussion

In the current study, seven freely accessible applications were evaluated based on the criteria of interactivity, learning, appropriateness, and outcomes, demonstrating potential for use with children in early childhood. These criteria were also examined in a systematic review that investigated 35 interventions involving children under 6 years old playing with interactive applications, showing beneficial effects on learning in several studies, especially in mathematics for typically developing children.[17]

It is noteworthy that interactivity, meaning active use, was a requirement for inclusion in the review, as it is well known that the way applications are used directly influences the child's participation and engagement. Furthermore, research suggests that interactivity and content may be more important factors to consider than simply "screen time," which can be either active or passive, reinforcing the importance of the quality of interactive media use by young children.[26]

In this study, App A stood out in the learning criterion, which may be explained by its specific features and versatility, as each game is adaptive, meaning it adjusts to the child's exact level of difficulty.[27]

App C received the highest score in terms of interactivity, which refers to the potential of a medium to allow the user to exert influence over the content or form of mediated communication.[28] One possible explanation lies in the auditory model of the action the child must follow, provided by the application. This represents a positive aspect, as the accessibility mode offers a narrated preview of the screen, helping the user identify the elements present and acquire information about the next steps to proceed in the game.[29] Moreover, studies highlight that an important aspect of interaction is how the child engages with the screen elements. In most applications, it is necessary to tap and drag items to respond.[30] In the present study, App C encouraged the child to think about where each card should be placed, along with the image on the card and the voice in the app pronouncing, for example, the name of each animal.

Regarding appropriateness, the application must be suitable for the child's age and the proposed activity, bearing in mind that activities should be neither too easy nor too difficult, so as not to become discouraging and to effectively promote learning.[31] In this regard, Apps B and G received the highest scores, which can be attributed to their interactive visual features, key elements for the success of an application aimed at children.[32] As for outcomes, appropriate feedback should be one of the priorities in system design to ensure users understand what to do after completing tasks.[33] In early childhood education, feedback plays an essential role in creating a positive and welcoming learning environment. This feedback should be encouraging, even in the face of errors, as it helps strengthen self-esteem and prevents feelings of frustration or discouragement.[34]

In this sense, App D stood out, as it provides constructive responses in both correct and incorrect situations, promoting child engagement and supporting cognitive and emotional development. Upon completing a game, a victory sound is played, and celebratory objects such as gifts appear on the screen; conversely, when a mistake occurs, the application emits a denial sound.[29]

App A received the highest score among the seven selected and is presumed to be the one that most effectively promoted learning, interactivity, appropriateness, and outcomes. However, to ensure quality screen use by children, beyond the analyzed criteria, it is essential to consider other aspects such as content quality and the nature of interactions provided by digital media, which can significantly influence child development. Additionally, active mediation by parents or caregivers, through guidance and supervision of technology use, can enhance the benefits for children, highlighting the importance of balanced and conscious screen use within the family context.[35]

Why, then, recommend and use App A? This can be justified by the fact that the application has the greatest potential to provide stimuli for cognitive development, fine motor skills, receptive language, expressive language, and social-emotional growth, through drag-and-drop or touch-and-move interactions.[36] Studies emphasize that App A supports motor learning through the drawing of geometric shapes and enhances emotional development through the discovery of different facial expres-sions, in addition to teaching numbers, colors, and puzzles aimed at improving cognitive development.[37] Furthermore, the application enables child interaction with the games, as participation is active and encourages, for example, thinking about where to place a specific object. In terms of age appropriateness, it allows the selection of games at the exact level of difficulty suitable for the child's developmental stage.[38] As the level increases, it is assumed that the child already possesses cognitive skills to differentiate specific elements, requiring the ability to distinguish images and quantities, as well as make associations.[39] Regarding outcomes, the application provides feedback at each completed stage of the game, through applause, positive signals, and praise from the app's character ("Well done! Fantastic!"). Moreover, the application received high scores across all study outcomes, justifying its classification as the most suitable for promoting learning and interactivity in children aged two to three years.

The main limitation of this study is related to the small number of children involved in the research and the difficulty in discussing the findings due to the lack of studies with the same objective and a similar target population. Additionally, the descriptive nature of the study limited the possibility of comparing results with other existing research. On the other hand, one of the contributions of this study lies in the selection of applications that may serve as a basis for future research, such as randomized controlled clinical trials. It also serves as a guide for parents, caregivers, and educators to become informed about free-access digital media that are appropriate for stimulating child development.

The present study highlighted the potential of digital applications as pedagogical tools for children in early childhood, emphasizing the importance of criteria such as interactivity, learning, appropriateness, and outcomes in the selection of these resources. Although limitations such as sample size and the exploratory nature of the research reduce the generalizability of the findings, the results provide valuable insights for parents, educators, and researchers. The detailed analysis of the applications revealed that, when carefully selected and used with appropriate supervision, these tools have the potential to promote children's cognitive, motor, and socio-emotional development. Therefore, it is essential that future research expands the understanding of the impact of digital technologies on child development, exploring different contexts and populations to establish guidelines that optimize the pedagogical use of digital media.

Conclusion

Among the applications evaluated in the study and recommended for children aged 2 to 3 years, 85% demonstrated learning, interactivity, and outcomes with scores above 0.6, and 71% showed appropriateness with scores above 0.6. These findings reveal the potential of the applications to stimulate children's critical thinking, active participation, and decision-making, as well as to enhance child development.

On average, the evaluated applications presented 74% in learning, 82% in interactivity, 78% in appropriateness, 81% in outcomes, and a total score of 76%. App A was the highest-rated, with a total score of 88%, followed by App B, with 87%. The selection of applications aimed at promoting learning and interactivity in children

should be incorporated into the daily routines of parents and caregivers, given that the use of such applications has become a regular part of children's everyday lives.

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Authors' contributions

EDMC was responsible for the study design, development of the research project, data collection and analysis, manuscript writing, and critical content review. RLSM contributed to data collection, statistical analysis, critical content review, and interpretation of the data. JNS participated in the study design, assisted with data analysis, and made substantive contributions to the manuscript revision, focusing on the literature review and discussion of the results. MFRL and LBC assisted with data collection, results interpretation, and manuscript revision. All authors approved the final version.

Data availability statement

Research data is not available.

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