Usability Guidelines for Children's Educational Mobile Applications

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Abstract

The increasing demand for educational applications has led to a competitive market for mobile devices, resulting in an increased supply of these products. This situation has raised concerns regarding the appropriateness of these applications in terms of usability and educational features. In light of this, the objective of this research was to analyze and contribute to the development of mobile applications targeting preschool-age children. The snowballing technique was employed, along with a questionnaire directed at parents and guardians of children who use mobile applications. Through this research, inadequacies in terms of usability and pedagogical requirements were identified. Based on these findings, a set of usability guidelines was developed with the aim of improving the development of future mobile applications.

Keywords: guidelines, usability, educational mobile apps

Resumo

A alta demanda por aplicativos educacionais têm aquecido o mercado de dispositivos móveis e causado um crescimento na oferta destes produtos, levantando questionamentos referentes ao quão adequado são estes aplicativos no quesito de usabilidade e funcionalidades educativas. Neste intuito, esta pesquisa buscou analisar e contribuir com o desenvolvimento de aplicativos móveis destinados ao público infantil em idade pré-escolar por meio da realização da técnica de snowballing e da aplicação de um questionário direcionado aos pais e responsáveis por crianças que utilizam aplicativos móveis, onde foi possível constatar a inadequações em aspectos de usabilidade e em requisitos pedagógicos. A partir dessa análise, foi elaborado um conjunto de diretrizes de usabilidade com a finalidade de contribuir no desenvolvimento de aplicativos móveis futuros.

Palavras-chave: diretrizes, usabilidade, aplicativos móveis educacionais

Introduction

In recent years, there has been a significant increase in the demand for educational and entertainment content that caters to the digital interaction needs of children who are considered digital natives. This surge has led to a booming market for children's app development. However, the appropriateness of these products for their target audience and their educational purposes has been a subject of questioning in various research studies.

According to Papadakis et al. (2020), researchers widely agree that developers are capitalizing on the growing demand for educational software, aiming to profit without necessarily understanding the end users and their specific needs. This problem,

as highlighted by Papadakis et al. (2020), also brings attention to the application of usability aspects tailored to children and raises concerns about the quality of the user experience for children during app usage.

Recognizing the scarcity of mediation models and frameworks specifically designed for analyzing the usability of children's educational software, this study aims to provide a set of recommendations to support the development of educational mobile applications that consider the characteristics of preschool children aged between 2 and 6 years.

Usability in Educational Mobile Applications for Children

Nielsen (1994) defines usability as the degree to which users can effectively and efficiently use an application to accomplish specific tasks. Usability is closely associated with several key attributes, including user satisfaction, ease of learning and remembering software usage, error handling, and the efficiency of software usage.

The implementation of usability is greatly enhanced by utilizing golden rules or general principles, commonly known as usability guidelines. These guidelines not only provide design recommendations during the development process but also serve as a foundation for critical analysis of decisions (Dix et al., 2003). They offer valuable guidance to designers in improving the usability of their products or services, ultimately enabling the creation of user-friendly experiences when they are followed.

Afrid (2014) emphasizes that both usability and user experience play crucial roles in the development of successful apps. When it comes to educational mobile apps for children, specific challenges arise, including the necessity for child-friendly interfaces that are suitable for their cognitive abilities.

However, it is worth noting that there is still a limited availability of mediation models and frameworks tailored for these mobile apps (Afrid, 2014). D'Carlo et al. (2016) as cited in Abreu et al. (2020, p. 46) highlight the insufficiency of heuristics addressing specific usability aspects for different software domains, particularly for educational mobile apps. This further underscores the importance of dedicating attention to this pertinent field of knowledge.

Applied Methodology

The methodology employed in this study incorporated two significant approaches: the utilization of a snowball sampling technique to access recent studies in the field and the administration of a questionnaire targeted at parents and guardians of children aged between 2 and 6 years, who are users of these products.

The snowballing technique is a systematic literature review method (Wohlin, 2014) that enables the identification of relevant documents, which are subsequently used for a more comprehensive study. For this study, specific criteria were established, including the exclusive use of Google Scholar with the search term "ux children apps" to find the most recent and highly evaluated studies related to user experience, children, and mobile apps.

The initial search yielded 51 articles for the initial portfolio, which were subjected to cut-off criteria analysis. The criteria included publication within the last 5 years, peer-reviewed status, and scientific relevance, with articles published in English or Portuguese.

To evaluate these criteria, the titles and abstracts of the articles were read in order to understand their relevance to the research theme. After reading the selected papers, a backward snowballing by analyzing the articles references, as well as forward snowballing by evaluating articles that cited the initial articles. This process resulted in a portfolio of 33 articles (Table 1) that represents the state of the art in this research field.

Following the snowballing method, a questionnaire[1] was administered to parents and guardians of children aged between 2 and 6 years to assess their perceptions of children's usability experiences in mobile applications.

The questionnaire, titled "Usability Research in Educational Apps for Children," was created using the Google Forms tool and consisted of three pages: the first page presented the Informed Consent Form (ICF)[2], the second page collected information about the participant and their consumption profile, and the third page addressed usability aspects of the educational mobile apps used by the children under their care.

The questionnaire comprised fifteen questions aimed at analyzing quantitative aspects related to the consumption and evaluation profile of the guardians, along with two open-ended questions focusing on the guardians' perceptions and expectations regarding qualitative aspects of the study.

Abreu et al.'s (2020) research on usability heuristics for educational mobile applications, as well as the Usability Requirements and Pedagogical Requirements developed by An et al. (2013), served as important references for this study in designing the questionnaire.

The prerequisites for validating participation in the questionnaire were defined as follows: a) being a parent or guardian of at least one child aged between 2 and 6 years, b) residing in Brazil, and c) agreeing to the Informed Consent Form at the beginning of the questionnaire. If any of these prerequisites were not met, the responses provided by the participants were invalidated, i.e., excluded from the analysis. Between June 6 and 22, 2022, a total of 57 responses were collected, out of which 50 were deemed valid for the survey due to the incompatibility of 7 of the participants who claimed not to have children within the required age range.

Table 1. Results of the Snowball method

Topics	Reference
Usability and Pedagogical Requirements Assessments	Wöbbekind, Lea, Thomas Mandl, and Christa Womser-Hacker. (2021)
	Hussain, Azham, et al. (2019)
	Kaur, Kiranjeet, Khairul Shafee Kalid, and Savita K. Sugathan. (2019)
	Mohamad, Normala, and Nor Laily Hashim. (2021)
	Abreu, Caio Almeida,et al. (2018)
	Eltalhi, Saria, et al. (2021)
	Tahir, Rabail, and Alf Inge Wang. (2019)
	Dias, Patrícia, and Rita Brito. (2021)
	Brito, Rita, and Patrícia Dias. (2020)

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[1] Link to access the questionnaire: https://forms.gle/dvbwhVg6gnGwJmjZ

[2] Link to the ICF: Pesquisa de Usabilidade em Apps Educacionais Infantis (TCLE).pdf

	Papadakis, Stamatios, et al. (2020)
	Callaghan, Melissa N., and Stephanie M. Reich. (2018)
	Khlaif, Zuheir N., et al. (2019)
	Branco, Karina da Silva Castelo, et al. (2020)
	Lindgren, Chris. (2020)
	Laranjeiro, Dionísia. (2021)
	Vaiopoulou, Julie, et al. (2021)
Heuristics and Usability Guidelines	Kumar, Bimal Aklesh, and Munil Shiva Goundar. (2019)
	Kumar, Bimal Aklesh, Munil Shiva Goundar, and Sailesh Saras Chand. (2019)
	Jamaldeen, F. Fazeena et al. (2018)
	Kumar, Bimal Aklesh, Munil Shiva Goundar, and Sailesh Saras Chand. (2020)
	Eltalhi, Saria, et al. (2021)
	Vieira, Estela Aparecida Oliveira, Aleph Campos da SILVEIRA, and Ronei Ximenes Martins. (2019)
	Yanez-Gomez, Rosa, et al. (2019)
	Tsvyatkova, Damyanka, and Cristiano Storni. (2019)
	Abreu, Caio Almeida, Jean CS Rosa, and Ecivaldo de Souza Matos. (2020)
Systematic Reviews	Papadakis, Stamatios. (2020)
	Molina, Odiel E. et al. (2022)
	Herodotou, Christothea. (2018)
	Missen, Malik M. Saad, et al. (2019)
	Estrada-Molina, Odiel, Dieter Reynaldo Fuentes-Cancell, and Anaibis Alvarez Morales. (2022)
	Moreno, Hilda B. R. et al. (2018)
	Vásquez-Carbonell, Mauricio. (2021)
	Kumar, Bimal Aklesh, and Priya Mohite. (2018)

Data analysis and discussion

The results of the initial questions, which focused on the participants' personal information, indicate that 56% of parents reported the predominant use of Smart TVs in their family's daily life, followed by 38% who mentioned smartphones, 6% for tablets, and 2% for computers/notebooks. Interestingly, no votes were recorded for the use of gaming consoles such as PlayStation, Xbox, or Nintendo.

The purpose of including these questions in the questionnaire was primarily to understand the consumption profile within the Brazilian context. The data collected suggest a significant prevalence of smart TVs and smartphones as the primary electronic devices used by preschool-aged children. This consumption profile differs from the findings presented by Brito and Dias (2020, p.4) in their research focused on a similar target group—parents and guardians of children up to 8 years old residing in Portugal—where "smartphones and laptops are mainly used by parents, while consoles and tablets are the typical devices for children."

Regarding the frequency of daily smartphone and tablet usage, 46% of parents

reported that their child uses these devices for up to 1 hour per day. Additionally, 20% mentioned a usage duration between 30 and 60 minutes, 26% indicated less than 30 minutes, 28% stated that their child uses the devices for 1 to 2 hours daily, followed by 16% who reported a usage duration between 2 and 3 hours, and a minority of 10% stated that their children use the devices for more than 3 hours on a daily basis.

In contrast to daily usage patterns for smartphones and tablets, the usage patterns for Smart TVs differ. According to the responses, 42% of parents stated that their children spend more than 2 hours per day using Smart TVs, while 32% indicated a usage duration between 1 and 2 hours, and 26% reported less than 1 hour of usage. This observation suggests that despite the increasing demand for educational mobile apps, parents and guardians still find web versions of these apps or specific content for Smart TVs more appealing or convenient.

Regarding the usability aspects of mobile applications during the installation process, 50% of respondents stated that they are never prompted for assistance, 34% mentioned occasional requests for help, and 16% reported frequent requests for assistance. This data may reflect the level of freedom children have in accessing app stores.

When asked about the need to modify application settings, 30% of parents stated that they had never provided assistance, while 50% mentioned occasional assistance, and 20% reported frequent assistance. Regarding the interpretation of game rules within the apps, 42% of parents indicated that they were never asked for assistance, 38% mentioned occasional assistance, and the remaining 20% reported frequent requests for help. This difficulty in interpreting instructions, language, images, and text present in the apps is further reflected in the fact that 74% of parents reported needing to assist their children with some frequency, while only 26% stated that they have never had to intervene.

Regarding the search for content within the apps, 58% of parents reported that they are sometimes asked for assistance, while 28% stated that this request is frequent. Only 14% of parents mentioned that they have never assisted in the search for specific content.

Parents were also asked to evaluate usability aspects in the applications based on their children's age group. For this purpose, nine Usability Requirements presented in the study by An et al. (2013) apud Abreu et al. (2020) were listed, and questions were formulated to gain a better understanding of how these requirements are implemented, or not, in the development of these mobile applications.

Regarding the adequacy of language in the interfaces and content of the mobile apps, 54% of parents considered it not very adequate, while 40% evaluated it as adequate, and only 6% found it inadequate. These findings align with the responses regarding the need for intervention in understanding texts and images in the applications, where 60% of parents observed that the adequacy does not meet the expected parameters for content intended for a children's audience.

In terms of content attractiveness in the apps, 52% of respondents rated it as adequate, 42% mentioned little adequacy, and 6% considered it inadequate for the children's age group. The playfulness of the apps was considered adequate by 48% of respondents, while 12% found it inadequate, and 40% observed little adequacy.

Regarding the stimuli for autonomy present in the apps, 40% of parents stated that they are appropriate for the child's age, while 44% considered them not very appropriate, and 16% found them inappropriate. In evaluations regarding the level of

interactivity, 32% considered it adequate, while 68% deemed it as little adequate or inadequate, which is significant for the attractiveness and engagement of users in this age group.

The data obtained regarding the perceptions of stimulating creativity in the applications align with the previous findings. 40% of respondents considered it adequate, while 60% found it to be little or inadequate for the age group of the users.
In terms of response time for actions and the possibility of repeating steps without exhaustion, 32% evaluated it as adequate, while 54% perceived little adequacy and 14% considered it inadequate.

One area that received less approval was the clarity of rules, with only 26% of parents rating it as adequate. On the other hand, 58% found it not very adequate, and 16% considered it inadequate. This aspect relates to the demands of concentration required according to the target audience.

Regarding the demands of concentration, 38% of parents deemed it adequate, 54% found it to be not very adequate, and 8% evaluated it as inadequate for their child's age.

Moving on to the pedagogical requirements present in the apps, when asked about the coherence of the content and its contextualization to the proposed educational level, 44% of parents considered it adequate, 54% found it not very adequate, and 2% deemed it inadequate.

Regarding the level of difficulty and the ability to advance in phases and depth enabled by the apps, 48% stated it was adequate, 46% found it not very adequate, and 6% considered it inadequate. This analysis is interesting when compared to the didactic evaluation present in the apps, with 56% perceiving little adequacy, 38% evaluating it as adequate, and 6% deeming it inadequate.

In terms of providing feedback to the user and the possibility of correction, 70% of parents found it to be little adequate, 24% considered it adequate, and 6% perceived it as inadequate. This data aligns with the evaluation of the use of stimuli and rewards in the applications, with 72% indicating little adequacy, 22% perceiving adequacy, and 6% finding it inadequate.

When asked about the adequacy of the content to the child's daily life and its relevance in their education as part of society, only 26% of parents considered it adequate, while 74% found little or no adequacy in this requirement in the applications.

In the responses to the open questions, some criticisms emerged regarding the lack of stimulus for physical activities and interpersonal relationships. Some parents viewed the apps as merely a pastime. One parent mentioned that "learning in relation to apps, at this stage of life, is much more linked to the management of use than with the content itself."

When discussing what they look for in educational apps, parents emphasized content that complements school learning, teaches other languages, and fosters their child's creativity. They also expressed the desire for activities appropriate for the age group, parental control features, a single payment option without advertisements or in-app purchases. Parents highlighted the importance of content that does not promote violence, unconscious consumption practices, or unhealthy behaviors.

These responses demonstrate the interest in mobile applications as tools that can enhance learning, provide valuable content, and align with positive values and practices. However, there is also a recognition of the limited availability of high-quality options in the market.

Usability Guidelines for Children's Educational Mobile Apps

The usability guidelines serve as rules or instructions for designers to ensure a high level of usability in app development. They provide guidance on creating interactive, usable, and impressive user interfaces. The articles identified through the snowball sampling method, which focused on usability for children, offered valuable insights for the formulation of seven usability guidelines specifically tailored to preschool-age children.

These guidelines were developed based on the usability and pedagogical requirements presented by Abreu et al. (2020). By considering these heuristics, the guidelines aimed to address the specific needs and considerations of designing mobile applications for young children.

Guidelines related to Language:

1. Give preference to the use of texts linked to illustrative images;
2. Use short, clear texts with high-case fonts;
3. Use simple, common, everyday terms to facilitate understanding;
4. Make use of clear images that are present in children's daily lives;
5. Prioritize the use of voice commands to text boxes in search boxes;
6. Establish a standardized layout (fonts, letters, colors...).

Guidelines related to the Didactics of the Content

1. Present the tasks as challenges;
2. Ensure that the objective of each action remains clear and visible;
3. Present constant feedback regarding the user's evolution;
4. Provide evolution in the complexity of the challenges proposed in the tasks;
5. Link the tasks to everyday activities;
6. Make use of concrete examples, which do not require abstraction for resolution;
7. Try to contextualize the content addressed to the user's previous knowledge.

Guidelines related to Autonomy

1. Enable the user to act in the adaptation and development of tasks;
2. Implement the definition of the degree of difficulty of tasks;
3. Provide actions to stimulate free expression;
4. Make use of feedback during the completion of tasks;
5. Implement the visualization of the user's progress;
6. Generate tasks that stimulate decision making.

Guidelines related to Interactivity

1. Enable the creation of user characters and profiles;
2. Implement registration and sharing options;
3. Promote user development in a ranking board;
4. Promote proposals for integration of its content with other users;

5. Provide spaces for evolving user feedback.

Guidelines related to Creativity

1. Create spaces for content creation and manipulation;
2. Make it possible to record tasks;
3. Provide a stimulating environment through the use of colors and hidden elements;
4. Enable the creation of tasks and challenges;
5. Promote more than one way to accomplish a given task;

Guidelines related to Response Actions

1. Promote a longer response time for the user in the first interactions;
2. Make use of stimuli that demand simple answers;
3. Decrease the response time according to the user's evolution;
4. Use visual, auditory, and kinesthetic stimuli when interacting with the user;
5. Provide clear, short, and exemplified instructions;

Guidelines for Rule Clarity

1. Make use of images and sounds when explaining the rules and instructions for use;
2. Use symbols and colors to indicate what is prohibited and encouraged;
3. Keep access to tutorials and information visible at all times;
4. Present the instructions in a practical, playful and interactive way;
5. Generate a characteristic layout pattern for instructional information;

Final Considerations

The research aimed to address the high demand for educational mobile applications that provide meaningful learning experiences for preschool children while ensuring quality usability. Through exploratory studies and analysis of usability aspects reported by parents, the research identified gaps and potentials in the field of usability for children. This led to the development of usability guidelines to support the creation of user-friendly applications and to expand existing guidelines.

To ensure the effectiveness of these guidelines, validation by experts in usability and mobile application development is crucial. The research acknowledges the modest sample size obtained through the questionnaire administered to parents and guardians, indicating an opportunity for further study.

The work of researchers such as Kumar et al. (2019), Abreu et al. (2020), Palaiologou (2016), and Papadakis (2020) enriches the narrative of the research. It emphasizes the importance of Child-Computer Interaction research but criticizes the lack of effective application of its findings in the industry.

Dialogues surrounding the use of mobile applications in early childhood often focus on screen time rather than the content children engage with. Brito & Dias (2020) argue that simply swiping a finger on touchscreen devices does not equate to a

full understanding of how they work or the implications of such practices.

Deepening the knowledge in this growing field is essential for the development of high-quality educational mobile applications that effectively contribute to education. It involves updating traditional learning methods and promoting new ways of teaching and learning.

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