USABILITY TESTING APPLIED TO GRAPHICAL AND VR APPLICATIONS IN AN ACADEMIC ENVIRONMENT

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Abstract

This article explores usability testing in the context of graphic and virtual reality (VR) applications in academic settings, emphasizing its importance for optimizing user experience. Usability testing assesses how easily and effectively users can interact with an application, being crucial for improving the design and functionality of digital products. The study compares user perceptions of the usability of graphical applications versus VR applications, using data collected through a questionnaire addressed to students. The results reveal significant differences in how users perceive ease of use, satisfaction, and efficiency between the two types of applications, highlighting the unique challenges and potential of VR applications in education.

Keywords: Usability testing, Virtual reality, User management systems, Technology-based improvement

JEL Classification: M15

1. Introduction

In recent years, graphics applications and virtual reality (VR) technology have become increasingly present in various fields, from entertainment and education to medicine and engineering. These technologies provide immersive interactive experiences, allowing users to explore virtual environments and interact with digital elements in a more intuitive and natural way. In the academic environment, graphics applications and VR are used for

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simulations, complex visualizations and hands-on training, contributing to more effective and engaging learning.

A key aspect in the development of these applications is usability testing, which evaluates how easily and efficiently users can interact with a system. Good usability ensures a smooth experience, reducing user frustration and optimizing the learning process or their productivity. Especially in the case of virtual reality, where interaction differs significantly from that with traditional applications, usability testing becomes crucial for identifying specific challenges and improving interface design. By comparing user perceptions of the usability of classic and VR graphics applications, valuable insights can be gained into how these technologies can be optimized to meet user needs.

As technology evolves, user expectations regarding the interface and functionality of digital applications are becoming increasingly high. A well-designed interface must be intuitive, efficient, and accessible, reducing the time required for learning and adaptation. Especially in the case of virtual reality, where users interact through gestures, movement, and specialized controllers, the experience can vary considerably depending on the interface design and the level of comfort offered. Therefore, usability testing plays a key role in optimizing the user experience, contributing to the development of more intuitive and efficient applications, both in academia and in other fields.

2. Graphics applications and VR applications

Graphics applications are software designed for creating, editing, and manipulating visual elements, such as images, illustrations, 3D models, or digital interfaces. They play an essential role in a wide range of fields, facilitating design, simulation, and visualization processes [1].

One of the main areas of application is the academic one, where tools like MATLAB, Blender or EndNote Visual are used for modeling, graphical visualization and data organization. MATLAB is recognized for its data processing and simulation capabilities, which are frequently used in engineering and exact sciences. On the other hand, Blender is an open-source solution for 3D modeling and animation, used in education and research for creating complex visual models [2].

In the medical field, graphics applications are essential for medical imaging analysis and anatomical simulations. 3D Slicer and Mimics are relevant examples of software that allow the visualization of anatomical structures and facilitate computer-assisted surgical interventions. These tools contribute significantly to the training of healthcare professionals and the accurate diagnosis of patients [3].

The entertainment industry also relies heavily on graphics applications for creating visual content. Unity, Adobe Photoshop, and Illustrator are among the most widely used programs for game development, image editing, and graphic design. Unity is a game engine used for developing interactive experiences, including virtual and augmented reality. Adobe

Photoshop and Illustrator are standards in graphics editing, being widely used by designers and visual artists [4].

Therefore, graphic applications represent an essential tool in multiple fields, contributing to the improvement of the creative process, research and education. The continuous evolution of these technologies allows the development of increasingly efficient solutions, adapted to the needs of users [5].

Virtual reality is a technology that creates a three-dimensional digital simulation of an environment, allowing the user to interact with this space in a more realistic way. This experience is made possible by equipment such as VR headsets, motion controllers, and sometimes even body sensors. The main goal of VR is immersion, that is, the feeling that the user is physically present in the virtual world, although they are in a real space [6].

One of the most valuable uses of virtual reality is in education. For example, students can explore the human body in detail in an interactive way or visit archaeological sites without leaving the classroom. VR is also used in professional training, such as training pilots, doctors, or workers in hazardous environments, by providing controlled and safe scenarios for practice [7].

In medicine, virtual reality is used for both therapeutic and educational purposes. VR exposure therapy is applied in the treatment of disorders such as phobia, PTSD or anxiety. Surgeons can also simulate interventions before performing them, improving the accuracy and safety of medical procedures [8].

Video games were among the first industries to adopt VR on a large scale. Through this technology, gamers have access to interactive experiences in which body movements influence the action in the game. In addition, VR is used in cinema, where viewers can experience interactive films, becoming part of the story.

In addition to education, health and entertainment, VR is also making its way into architecture, tourism, industrial design and psychology. For example, architects can present interactive 3D models of buildings to clients before they are built. In tourism, visitors can virtually explore tourist destinations around the world. These applications increase efficiency and creativity in design and decision-making processes.

3. Usability testing

Testing, in a broad sense, is the process of verifying whether a product, system, or service functions according to established requirements. This can occur in any field – from education, where testing means assessing knowledge, to the software industry, where testing involves identifying errors and validating the functionality of applications. Essentially, testing plays an essential role in ensuring quality, reducing risks, and increasing trust in the final product. It is performed either manually, by people who interact directly with the product, or automatically, with the help of software tools that simulate user behavior. Testing is not just about finding defects, but also about validating that the product meets the real needs of users, that it is safe, efficient, and easy to use. A good practice is for testing to be integrated throughout the development of a product, not just at the end, to prevent major problems before they become costly or difficult to fix.

Testing is of several types through functional testing, performance testing, security testing, compatibility testing, regression testing, automated testing and usability testing.

Functional testing checks whether the application or system does exactly what it is supposed to do, according to specifications. Buttons, forms, functions, etc. are tested. Performance testing evaluates how well the system behaves under road, whether it is fast, stable and efficient when used intensively or by many users. Security testing deals with identifying vulnerabilities, to prevent unauthorized access or data loss.

Compatibility testing checks whether the product works correctly on different devices, operating systems, browsers or versions. Regression testing ensures that recent changes (bug fixes or new features) have not broken things that worked well before. Automated testing is performed using programs or scripts that run tests automatically, streamlining the process.

Usability testing is the process of evaluating how easily and effectively a user can interact with a product, system, or digital interface. The goal of this testing is not only to identify design errors, but also to understand the behavior and expectations of real users. By observing how they navigate and perform specific tasks, designers and developers can adjust the product so that the experience is intuitive and enjoyable. Testing is usually done with a small group of users but strategically selected to cover different types of use.

This method is essential in the development of applications, websites or software, as it highlights accessibility and functionality issues early on that could affect end-user satisfaction. More than a technical check, usability testing involves empathy – that is, putting yourself in the user's shoes to understand what obstacles they might encounter. The results are then used to refine the product and create solutions that are better suited to the real needs of the target audience.

Usability testing begins with establishing clear objectives: what exactly you want to evaluate in terms of user experience. Typically, you choose a few essential tasks that users need to complete, such as filling out a form, finding information, or placing an order. It is important that the scenarios reflect real-world situations so that the test results are relevant. Before the test, participants are recruited who are representatives of the target audience, i.e. people who might be among the future users of the product.

Testing sessions take place in a controlled setting, either physical or online, where participants are asked to navigate the product and express their thoughts out loud. During this time, the team of observers notes what actions the users take, where they get confused, what mistakes they repeat, and how they react emotionally. It is important that the testers do not intervene or guide the participant but only observe. Tools that record the screen, mouse movements, or gaze (eye-tracking) can also be used for more detailed analysis.

After the tests are completed, the data is centralized and analyzed to extract useful conclusions. Patterns are looked for: frequently encountered problems, frustrations, or unintuitive steps. Based on this information, recommendations are made to improve the design or interaction flow. Usability testing is usually not done just once but is repeated after each major release of the product, to ensure the most fluid and satisfying experience for end users.

Usability testing brings multiple benefits, starting with the early identification of issues that would otherwise negatively affect the user experience. By directly observing how people interact with a product, the development team can better understand the real needs and expectations of users, not just what was assumed during the design phase. This understanding leads to concrete improvements to the interface, which makes the product more intuitive, more efficient, and more enjoyable to use. In addition, usability testing helps reduce costs in the long run, because problems solved early are much cheaper than those corrected after launch. At the same time, a well-optimized product from a usability perspective increases user satisfaction, loyalty, and even conversions, in the case of commercial sites.

4. The comparative approach – Research method

The main object of this research is to test the usability of graphic and virtual reality applications in the educational context, with a focus on improving the user experience. In an era where technology is becoming increasingly present in the learning process, it is essential to understand how these applications are perceived and used by pupils and students. Usability, defined as the ease with which a user can interact efficiently and satisfactorily with a system, is an essential criterion for the success of any interactive application. In the case of educational applications based on virtual reality, good usability can significantly contribute to active learning, user involvement and information retention. Thus, evaluating the user experience is not just a technical stage, but a crucial step for optimizing the educational process through innovative digital means.

To analyze students' perceptions of the usability of these applications, the questionnaire method was used - known in the specialized literature as the survey method. This research method is quantitative and involves the systematic collection of data through a standardized instrument, namely the questionnaire, which includes closed and/or open questions. The questionnaire is an effective method of obtaining information from a large number of respondents in a relatively short time, while also offering the possibility of analyzing the answers in an objective and comparable way.

The questionnaire method is frequently used in social sciences, including educational research, because it allows for direct insights from real users. In the present context, this tool provided a clear picture of how students interact with graphical and VR applications, what difficulties they encounter, what elements they find useful, and how they perceive the impact of these technologies on their own learning. Thus, the data obtained through this method contributes to a deeper understanding of how technology can be adapted and improved to better support the educational process.

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The other three sections focused on direct user experience. The second part tracked how the participant interacted with the traditional graphical application, while the third part analyzed the interaction in the VR environment. The questions were designed to capture the perceived level of difficulty, the degree of involvement, but also the preferences of the users. The last section, focused on learning and improvement, targeted how the participants felt they had progressed or adapted during the use of the applications. Together, these four components help us understand not only which application is more effective, but also why it is perceived that way and for whom, providing a complete picture of the user experience.

A total of 70 students were involved in this research, who voluntarily completed the questionnaire developed to evaluate the usability of graphic and virtual reality applications in the academic field. The diversity of those who responded is important because the perception of technology, the degree of familiarity with new digital tools and the way of interacting with them can vary depending on gender, which can influence the way the usability of the analyzed applications is perceived. The sample was made up of students from various study programs, most of them enrolled in fields with a technological or creative component, such as computer science, multimedia, graphic design or digital communication, fields in which the use of graphic and VR applications has an increasing practical relevance.

It is essential to mention that although all 70 students fully completed the general section of the questionnaire, only 44 of them also responded to the part dedicated to virtual reality applications. The other 26 respondents stated that they had no previous contact with such applications and, therefore, could not provide relevant feedback in this regard. This aspect highlights an important reality regarding the degree of penetration of VR technology in the academic environment – namely, that, despite its educational potential, virtual reality is not yet widely or uniformly used among students. The lack of direct experience with VR applications limits the ability to effectively assess their usability, but, at the same time, highlights the opportunity to expand access to these technologies for educational purposes. Thus, the results obtained from the 44 respondents who actually interacted with VR applications will be analyzed separately, in order to provide a clearer picture of their experience and perceptions in relation to the usability of these innovative tools. Below in Figure 1 we see the distribution of those who responded according to their gender.

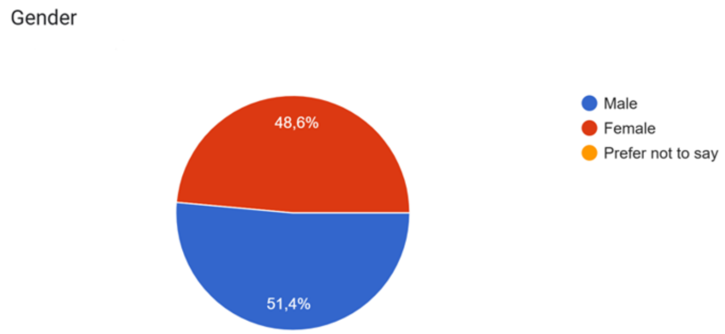

Figure 1. Gender of the respondents

The analysis of the demographic and academic profile of the respondents reveals that the majority of the students who participated in this research are in their third year of undergraduate studies. They are followed, in number, by fourth-year students and, to a lesser extent, by students enrolled in master's programs. This structure reflects an increased interest in the field of graphic applications and emerging technologies, especially among students in advanced stages of their academic career, when contact with complex technological applications becomes more frequent and more applied within the study programs.

Regarding the field of study, approximately 80% of respondents are enrolled in bachelor's or master's programs in Computer Science, while the remaining 20% come from the field of Electronics. This distribution confirms the increased relevance of the researched topic for students in technical and scientific fields, especially for those who are already familiar with advanced notions of programming, digital interfaces and interactive technologies, such as those used in virtual reality.

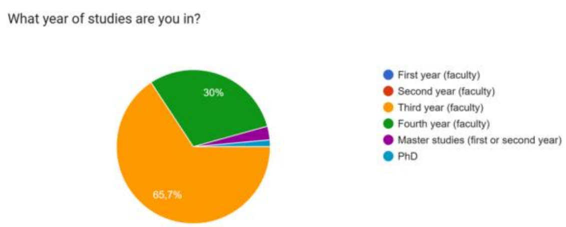

Figure 2. Year of study

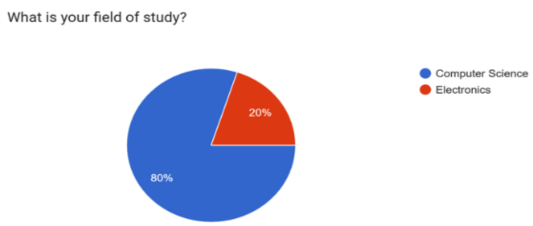

Figure 3. Field of study

The first aspect investigated in the questionnaire concerned the level of confidence that users feel in relation to the use of graphical and virtual reality applications. This dimension is essential in assessing usability, since the level of confidence directly influences the willingness of users to interact with the technology, as well as their ability to integrate it into academic or professional activities. According to the responses received, in the case of graphical applications, most respondents indicated a moderate level of confidence. This suggests that, although these types of applications are relatively familiar and frequently used in the academic environment, students still experience certain reservations or limitations in their advanced or efficient use. The average level of confidence can be attributed to the complexity of certain functionalities or insufficient technical training to fully exploit the potential of these tools.

In contrast, the results show that with regard to virtual reality applications, a higher proportion of students show an increased level of confidence in their use. Although the number of those who responded to this section was lower, the data obtained highlighted a positive attitude and a greater openness towards new immersive technologies. This high level of confidence can be explained both by the perception of novelty and attractiveness associated with VR applications, and by the fact that the interactive and intuitive experience offered by these applications contributes to a more accessible use, even in the absence of in-depth technical training. In this sense, virtual reality seems to offer a friendlier and more captivating environment for users, which can be a significant advantage in the process of integrating these technologies into educational activities.

Another important aspect analyzed in the research was the scope of applicability of graphic applications compared to that of virtual reality applications. According to the answers provided by the students, graphic applications are used mainly for academic purposes. They are integrated into learning activities, in the implementation of university projects and in the development of technical skills specific to the field of study. Familiarity with such applications, as well as their functional role in the educational process, contributes to this clear orientation towards the academic environment. In contrast, virtual reality applications are perceived and used, to a great extent, for recreational purposes, being associated with fun, free exploration and playful experiences. This contrast between the two categories of applications highlights a clear differentiation in the students' perception of the main purpose of each technology, but also an untapped potential of virtual reality in the educational space.

Regarding the equipment used to run and test these applications, the general trend identified among respondents is the orientation towards the use of personal computers. Most students consider this to be the most accessible and easy-to-use device for interacting with both graphical and VR applications. This can be explained by the high level of familiarity with the desktop environment, but also by the fact that most applications of this type are developed or optimized to be run on such platforms. Also, using a computer allows better control over the interfaces and functionalities of the applications, providing a more predictable and, implicitly, more comfortable experience for the user.

When it comes to virtual reality equipment, such as 3D glasses or VR headsets, the data collected indicates a clear differentiation between the two types of applications analyzed. Thus, in the case of graphic applications, the use of these equipment is practically non-existent. Students did not feel the need or did not have the opportunity to use such devices in the interaction with graphic applications, which can be justified by the two-dimensional or conventional nature of these applications. On the other hand, regarding virtual reality applications, 3D glasses are often used and, according to the responses, are perceived as easy to use. This positive perception indicates a good integration of these equipment into the VR experience, contributing to the creation of a natural and fluid interaction with the digital environment.

However, the same cannot be said for the use of VR headsets, which, although often used in testing virtual reality applications, are perceived as difficult to use. Many respondents reported challenges in handling this type of equipment, either due to weight, discomfort, or the complexity of the settings required for optimal operation. This difficulty in using VR headsets can represent a significant barrier to the widespread adoption of virtual reality in educational settings, where efficiency and accessibility are essential factors.

In a related vein, the level of difficulty experienced by users in navigating VR applications is perceived as higher than in the case of graphical applications. This can be attributed to the additional equipment required for using VR, which involves not only familiarizing oneself with the application interface but also adapting to a new way of sensory and spatial interaction. In contrast, graphical applications offer a more linear and predictable user experience, which contributes to easier navigation and a shorter learning curve. This difference highlights the need to improve the interfaces and equipment used in virtual reality, in order to increase the accessibility and efficiency of these technologies, especially in an educational context.

One of the key aspects investigated in the research was the identification of sources of difficulty in using graphics and virtual reality applications, as well as the main problems encountered by users. Regarding graphics applications, respondents frequently indicated the lack of knowledge necessary for the effective use of these tools. This difficulty is aggravated by an incomplete understanding of the requirements or tasks, which affects the ability of students to use the applications autonomously. Also, the complexity of the interface is a major source of frustration: the existence of a large number of functions and menus, the lack of an intuitive interface structure (UI/UX), as well as the absence of clear visual elements to guide the user contribute to the decrease in the level of comfort in use. In addition, many students highlighted the lack of dedicated practice hours within the study programs, which considerably limits the chance to become familiar with these applications in a controlled teaching environment.

Regarding virtual reality applications, the difficulties encountered are both technical and practical. Most often, respondents mentioned the lack of access to the necessary equipment – such as VR headsets or 3D glasses – as the main barrier to the effective use of VR applications. Even in cases where the equipment is available, other sources of discomfort include the need for constant movement in space, which can become tiring, and an inadequate placement of graphical interface elements in the user's field of view, which significantly complicates interaction. Similar to the situation with graphical applications, in the case of VR, respondents also report the lack of well-structured practice sessions within the university, thus suggesting an increased need to integrate these technologies into the curriculum to reduce uncertainties and technical barriers.

In addition to general difficulties, participants reported a number of recurring technical issues encountered during testing of both types of applications. These include frequent application crashes, difficult movement of interface elements, and errors when using multiple monitors simultaneously. Application construction errors – such as bugs or coding deficiencies – were also reported, which are difficult to identify and fix by the average user. A notable aspect is the difficulty of interaction between the different elements of the application, especially in the case of those developed in three-dimensional environments, where synchronization and coordination of components is a major challenge. These technical issues, combined with equipment limitations and lack of practical training, outline a complex picture of the obstacles that must be overcome for an effective and accessible use of graphics and VR technologies in the educational environment.

A relevant factor in the analysis of the perceived difficulty in using graphical and virtual reality applications is the level of programming knowledge of the participants. According to the data obtained, a significant number of students – more precisely, 65 out of 70 – declare that they have knowledge in programming graphical applications. This suggests that theoretical and practical familiarity with the development of graphical applications directly contributes to a lower level of difficulty in using them. On the other hand, only 8 students mentioned that they have programming knowledge specific to virtual reality applications, which indicates a much narrower area of competence in this field. This significant disproportion can explain, to a large extent, the differences in the perception of difficulty and in the level of confidence in using the two types of technologies.

At the same time, a recurring theme in the students' responses is the lack of sufficient hours of practice within university study programs, especially regarding virtual reality applications. Many participants consider that the current training offered by the faculty is insufficient to facilitate a thorough understanding and effective use of these technologies. In the absence of constant and guided exposure in the laboratories, students face difficulties both in using the applications and in learning how to develop them. Thus, the data highlights a clear need for curricular adaptation, which would include a greater number of hours dedicated to emerging interactive technologies, in order to better prepare students for the current demands of the IT and engineering fields.

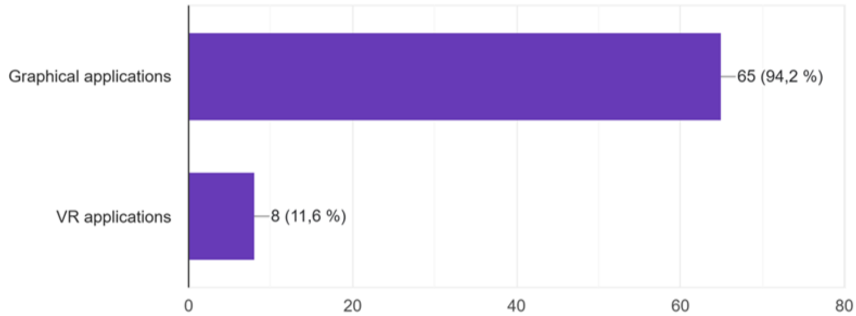

Figure 4. Programming knowledge field

The conclusions of this study highlight a clear preference of students for interacting with graphical applications, to the detriment of those based on virtual reality. This orientation is significantly determined by the degree of familiarity that participants have with graphical applications, acquired through repeated exposures within academic or extracurricular activities. Familiarity with a certain type of technology contributes to reducing the perceived level of difficulty, increases user confidence and favors a positive attitude towards exploration and deepening. In contrast, virtual reality applications, less present in the educational path of students, are perceived as being more difficult to use, both due to lack of experience and technical barriers associated with the use of specific equipment.

At the same time, the research results highlight a structural problem of current academic training in the field of interactive technologies: the insufficiency of practical hours and didactic content focused on new emerging technologies, especially those related to virtual reality. Many students expressed their desire to delve deeper into more advanced concepts, especially regarding the development and use of VR applications. This openness indicates an intrinsic motivation for learning, but also a clear opportunity for higher education institutions to adapt their study programs to reflect the rapid dynamics of the technology industry. In this context, expanding practical training and including modules dedicated to virtual reality could significantly contribute to the development of relevant and up-to-date skills among students, facilitating a more natural and efficient integration of these technologies into the educational process.

5. Conclusions

Usability testing is proving to be a fundamental tool in the applied research process, especially in the context of analyzing user interaction with graphical and virtual reality applications. This method allows not only the collection of objective data on user behaviors and preferences but also provides an in-depth understanding of the difficulties encountered in the actual use of the applications. In this case, the use of a questionnaire as the main research tool facilitated the obtaining of direct and specific feedback, contributing to the identification of relevant trends in the way students perceive and interact with the two types of technologies analyzed.

The survey clearly highlighted key aspects related to the user experience (UX), as well as the efficiency and structure of the user interface (UI). In particular, the responses provided by the participants highlighted the need for significant improvements in the design of VR application interfaces. Users mentioned difficulties in navigation, inadequate positioning of UI elements in three-dimensional space, as well as a lack of coherence in relation to their functional expectations. These observations indicate that, unlike traditional graphical applications – which benefit from years of interface refinement and established design patterns – VR applications are still in a process of maturation in terms of ergonomics and intuitiveness of interaction. Thus, usability testing becomes not only an evaluation tool, but also an essential stage in the iterative process of developing interactive applications.

In addition, the study's conclusions provide valuable directions for improving the educational framework in which these applications are used. The information obtained can contribute to the development of more effective educational methods and applications, capable of better responding to the real needs of students. Integrating usability testing results into the curriculum design process could lead to better adaptation of educational content, by optimizing the interfaces of applications used in education and by increasing accessibility to emerging technologies. In this sense, usability testing is not only a technical tool, but becomes a link between technology, design and pedagogy, supporting innovation in education and facilitating a more efficient and user-centered learning experience.

Given the results obtained, future studies could explore in depth the technical and pedagogical aspects of the use of VR applications in education, as well as how the progressive integration of these technologies influences the learning process. It would be useful to conduct longitudinal research that would track the evolution of students' skills over time, depending on exposure to and interaction with graphical versus immersive environments. Also, controlled experiments can be developed to compare the impact of different interface models and educational scenarios on the understanding and retention of information. Another valuable direction would be to investigate how specific training on VR equipment, supported by an appropriate curriculum, can reduce perceived difficulties and increase users' confidence in these technologies. In general, expanding research in this area can significantly contribute to optimizing the design process of interactive educational applications and adapting them more effectively to the current needs of the digital generation.

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