

Challenges and Solutions of Human-Computer Interaction in the Digital Transformation of Education

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Abstract. The digital transformation of education has become an inevitable trend in global education, which benefits from the rapid development of information technology. Human-computer interaction (HCI) technology has been the main driving force behind this transformation, offering substantial benefits in enhancing teaching efficiency, diversifying teaching approaches, and fostering personalized learning. Through HCI, educational institutions can provide students with more flexible and diverse learning experiences, help teachers understand students' learning progress and needs, and thus develop more precise teaching plans. However, applying HCI in education is difficult and has many challenges. Specifically, problems such as technology maturity, data security, privacy protection, the transformation of educational concepts, teachers' digital teaching ability, students' adaptability differences, and user experience and emotional interaction are particularly prominent. They not only hinder the wide application of HCI in education but also pose obstacles to the overall digital transformation of education. This paper aims to investigate the application status of HCI in the digital transformation of education, identify the challenges it is facing, and suggest potential solutions to provide a valuable reference for the digital transformation of education.

1 Introduction

The digital transformation of education is now a key tactic for China to pave the way for innovative education growth and cultivate fresh strengths in education development [1]. The transformation is not just about the innovation of technology but also about reforming educational philosophy, teaching mode, and learning ways. The application of Human-Computer Interaction (HCI) is the main driving force behind the digital transformation of education. It not only changes the traditional teacher-centered teaching mode but also provides students with a richer and more personalized learning experience, making learning more efficient and interesting.

Challenges will accompany the introduction and application of any technology. The same is true for the application of HCI in education. From a technical perspective, we need to think deeply and come up with solutions to HCI's maturity, data security, privacy protection, and technical compatibility and interoperability. In terms of education, challenges in applying HCI include changes in educational concepts, enhancing digital teaching skills, and varying student adaptability levels. Considering the user's perspective, it is crucial not to overlook optimizing the user experience, enhancing emotional interaction design, and assisting students in using resources effectively. This paper will deeply analyze the challenges HCI encounters in the digital transformation of education from three aspects: technology, education, and users, and it will put forward

countermeasures based on these challenges. We expect this research to offer references and ideas for those involved in the digital transformation of education, encourage more extensive use of HCI in education, and bring fresh energy to the ongoing growth of China's education industry [2].

2 The Application Status of HCI in the Digital Transformation of Education

2.1 Basic Concepts and Classification of HCI

In short, HCI is a subject that focuses on designing, evaluating, and implementing interactive computer systems for people to use. Its core is studying information exchange between humans and computers, covering input, output, and processing. According to different ways of interaction, HCI presents various forms. From the traditional command line interaction to the widely used graphical user interface interaction, and now the multi-channel interaction and virtual reality interaction, all reflect HCI's continuous progress and innovation [3].

Moreover, HCI plays an important role in education. It is widely used in many fields, including intelligent teaching systems, virtual laboratories, and online learning platforms, which bring new vitality to digital transformation.

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2.2 Examples of HCI Applications in Education

2.2.1 Intelligent Teaching Assistant

Intelligent teaching assistant is a great innovation in the digital transformation of education. It uses the powerful ability of artificial intelligence and can deeply analyze students' learning situations, including learning progress, mastery, and difficulties. Based on the above, intelligent teaching assistants can tailor personalized learning plans for students and provide accurate resources and exercises. At the same time, it provides real-time learning feedback to help students understand their learning situation in time and adjust their learning strategies, thus improving learning efficiency. To sum up, the emergence of intelligent teaching assistants reduces teachers' teaching burden and provides students with independent, flexible, and efficient learning methods.

2.2.2 Virtual Reality Learning Environment

Virtual reality learning environments are another important innovation in the digital transformation of education [4]. They use virtual reality technology to create an immersive learning environment for students. In this environment, students learn and practice by immersing themselves in a simulated real-world scene. This type of learning can greatly improve students' learning effects and effectively train students' practical skills. In addition, students can understand abstract knowledge more intuitively and master practical skills in depth, thus laying a solid foundation for future study and career.

2.2.3 Augmented Reality Assisted Teaching

Augmented reality-assisted teaching has brought innovative changes to education. The technology can overlay virtual information onto the environment, making abstract ideas and key points easy to grasp and comprehend. The new teaching approaches have significantly increased students' engagement and enthusiasm for learning. Because of augmented reality technology, students can understand complex concepts more deeply and learn in interaction simultaneously,

making the learning process more vivid and interesting. In summary, augmented reality-assisted teaching enriches teaching methods and creates a more diversified and three-dimensional learning environment for students.

2.2.4 Online Learning Platforms

Online learning platforms have achieved unprecedented flexibility and convenience for modern education. It allows students to access many learning resources anytime and anywhere, whether course videos, e-books, or online exercises on this platform. In addition, students can participate in online discussions, collaborate with other students, and solve problems together. This cross-regional and cross-time learning method breaks the limitations of traditional education and makes learning autonomous and efficient. To sum up, online learning platforms offer students a personalized learning experience and facilitate the sharing and exchange of global educational resources.

3 Challenges of HCI

3.1 Technical Challenges

3.1.1 Lack of Technical Maturity

Although HCI has made impressive progress in recent years, some key technology areas, such as natural language processing and affective computing, still need to fully mature. Technical bottlenecks limit the application effect of HCI in complex educational scenes. For example, immature natural language processing technology may cause intelligent teaching assistants to fail to understand students' questions accurately or give appropriate answers. The defect of affective computing may make the system unable to correctly perceive and respond to students' emotional changes, thus affecting the learning effect. Therefore, improving the maturity of HCI, especially in key technical areas, is an urgent problem that needs to be solved in the current digital transformation of education. Figure 1 shows the mechanism of HCI.

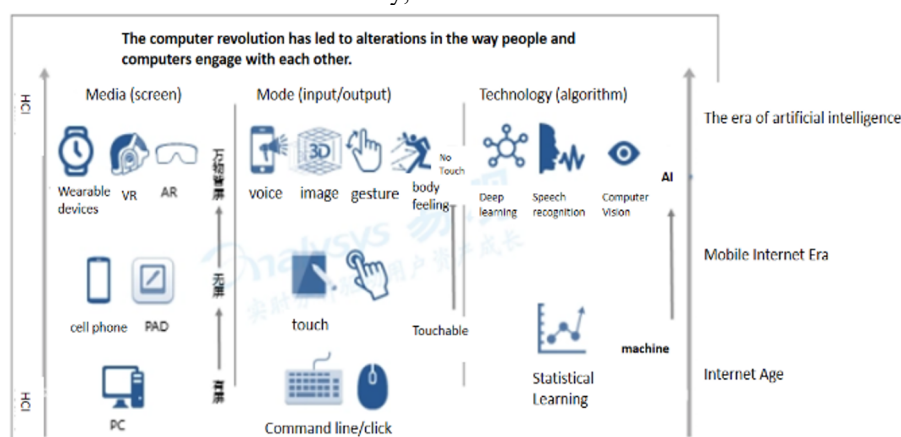


Fig. 1. Human-Computer Interaction

3.1.2 Data Security and Privacy Protection

Applying HCI in education involves a large amount of personal data and privacy information. Ensuring the security and privacy of the data during collection, storage, processing, and use poses a challenging issue that needs to be addressed. Educational institutions must implement a secure data security system and utilize encryption and anonymization techniques to safeguard students' personal information. Additionally, the government and the community should strengthen the supervision and regulation of data security and privacy protection to ensure that the application of HCI in education does not violate students' legitimate rights and interests [5].

3.1.3 Technical Compatibility and Interoperability

The wide application of HCI in education faces problems with technical compatibility and interoperability. The lack of consistency in technical standards and interface specifications among various systems and platforms poses challenges for HCI to smoothly integrate and collaborate across diverse educational settings. Therefore, it increases educational institutions' technical cost and complexity and affects the learning experience and effect. To sum up, promoting the standardization and normalization of HCI and improving the compatibility and interoperability between systems and platforms are the issues that need to be focused on in the current digital transformation of education.

3.2 Challenges in Education

3.2.1 The Transformation of Educational Concept and Mode

The digital transformation in education has brought profound changes in educational concepts and models. Educators should shift their focus from imparting traditional knowledge to prioritizing developing soft skills like creativity and critical thinking. However, there are many challenges in this transformation process, which requires educators to make great efforts and time to adapt to new teaching methods and find effective ways to combine HCI to better achieve teaching goals. The transformation is related to the adjustment of teaching content and the fundamental change of educational concepts. Figure 2 is a digital transformation model.

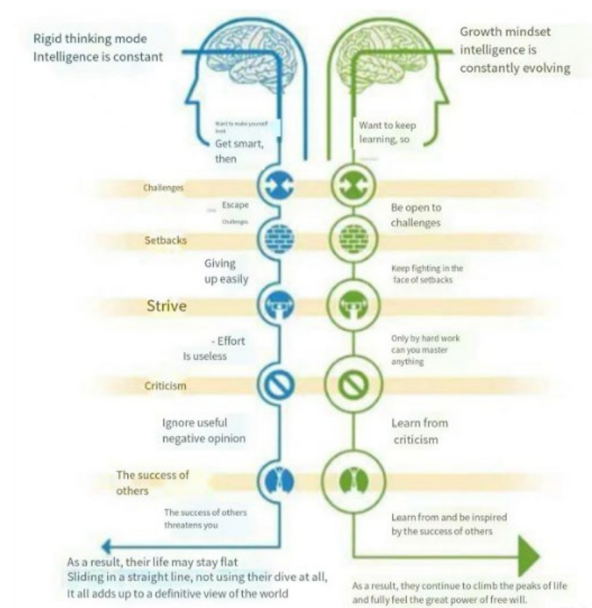


Fig. 2. Education digital transformation model

3.2.2 Teachers' Digital Teaching Capabilities

Teachers are a key part of the digital transformation of education, and their digital teaching ability directly affects the application effect of HCI. However, many teachers have obvious shortcomings in digital teaching and need further improvement in their related skills and knowledge. They should master new teaching tools, be familiar with digital teaching resources, and learn how to effectively combine HCI to innovate teaching approaches.

3.2.3 Differences in Student Adaptability

Students have different learning habits, cognitive styles, and abilities. It is a big problem to make HCI adapt to these differences and provide personalized support for each student. Educators deeply study students' diversified needs and design more flexible and diversified teaching programs to ensure that each student performs the best learning effect with the assistance of HCI.

3.3 User-related Challenges

3.3.1 User Experience and Acceptance

User experience is the key to the success of HCI. Unfriendly interfaces, complex operations, and inadequate feedback will create user resistance and hinder the technology's widespread adoption and application. User experience is particularly important in education because students' acceptance directly affects the learning effect [6]. Therefore, improving the user experience and aligning it with the user's habits and needs is a major challenge.

3.3.2 Lack of Affective Interaction

Compared with traditional human teaching, the human-computer interaction system has obvious shortcomings in affective interaction. The system can't give students emotional support and care like teachers, which may lead students to feel lonely and lack motivation in the learning process. Therefore, how to add emotional interaction elements to HCI to make it more humanistic is a problem that needs to be studied.

3.3.3 Information Overload and Distraction

With the wide application of HCI in education, students may experience information overload and distraction [7]. Distinguishing important content from abundant information and helping students focus is currently a significant challenge that needs to be addressed. Collaboration between educators and technology developers is needed to enhance how information is presented and increase students' learning effectiveness and concentration.

4 Coping Strategies

4.1 Technology-Based Strategy

4.1.1 Strengthen Technological Development and Innovation

To address the problem of insufficient technology maturity, we should increase R&D investment in the HCI field to promote continuous innovation and development of technology. We need to make breakthroughs in key technical fields such as natural language processing and affective computing to improve the intelligent level of human-computer interaction. Researchers introduce more advanced algorithms and models, optimize the experience and effect of human-computer interaction, and make it better meet complex and diverse needs.

4.1.2 Data Security and Privacy Protection Enhancement

Data security and privacy protection are very important in the application of HCI. We should establish a sound data security and privacy protection mechanism and adopt encryption technology and access control to ensure data security. Furthermore, we should create a clear data usage policy, specify the procedures for data collection, storage, and utilization, and build confidence among users regarding data security.

4.1.3 Promote Technical Standardization and Interoperability

To promote the wide application of HCI in education, it is necessary to promote the standardization of technology. Creating consistent technical standards and specifications can reduce the level of technical expertise

required and enhance compatibility across various systems and platforms. Enhancing the interoperability of research among diverse systems and platforms and achieving resource sharing and communication will improve the human-computer interaction experience for educational institutions and students, making it more convenient and efficient.

4.2 Education Strategy

4.2.1 Update Educational Concepts and Models

Educators need to actively update their teaching concepts and models, move away from traditional knowledge transmission, and focus on developing students' soft skills. This means that they need to focus on developing students' innovative and critical thinking abilities to adapt them to society's future development needs. At the same time, it is also very important to strengthen the cultivation of students' AI literacy and digital citizenship literacy, which will help students better understand and apply HCI and become pillars of society.

4.2.2 Improve Teachers' Digital Teaching Ability

To meet the challenge of digital transformation of education, we need to strengthen the training and support for digital teaching. By holding trainings and seminars, we will help teachers master advanced teaching methods and means and improve their digital teaching skills and levels. At the same time, we encourage teachers to actively explore and practice digital teaching modes, develop their characteristic teaching styles, and provide students with a better experience.

4.2.3 Pay Attention to the Adaptability Differences Among Students

In the teaching process, it is necessary to pay attention to students' adaptability differences. Differentiated learning methods and resource support are designed according to different students' learning habits and cognitive differences. Using big data analysis technology, we comprehensively understand students' learning characteristics and needs and tailor their learning programs. Moreover, a diversified evaluation system and feedback mechanism should be established to help students find and correct problems in their studies in time and ensure that everyone can progress with the help of HCI.

4.3 User-Level Strategy

4.3.1 Optimizing User Experience

To improve the application effect of HCI in education, we must pay attention to user experience design. Starting from the interface design and interaction process, we conduct user research and testing to fully

acquire user needs and usage habits. Based on this, we constantly optimize and improve the system function and interface design to ensure easy operation and timely feedback so as to improve user satisfaction and use

effect. A high-quality user experience can greatly enhance the user's acceptance and frequency of use, as shown in Table 1:

Table 1. Data related to "optimizing user experience"

Dimensions	Description
Goal	Improve the application effect of HCI in education, and increase user satisfaction and frequency of use.
Key Factors	1. Interface design: intuitive, easy to use, and catering to user aesthetics. 2. Interaction process: simplify operation and improve operation efficiency. 3. User research and testing: extensively understand user needs and usage habits.
Implementation Strategy	1. Continuous optimization: We continuously optimize system functions and interface design based on user feedback and data analysis. 2. Easy operation: to ensure that the system is easy to operate and reduce the user's learning cost. 3. Timely feedback: provide timely and accurate operation feedback to enhance user perception.
Expected Results	1. Improve user satisfaction: Improve user satisfaction with HCI by optimizing user experience. 2. Increased frequency of use: A high-quality user experience can attract users to use HCI more frequently.
Evaluation Metrics	1. User satisfaction survey: regularly conduct user satisfaction surveys to get the user's satisfaction with the system. 2. Usage frequency statistics: count the usage frequency and evaluate the impact of user experience optimization on usage frequency.

4.3.2 Strengthening Affective Interaction Design

The introduction of affective interaction design is crucial in the human-computer interaction system. We consider adding emoticons and voice interactions to enhance the emotional connection between users and the system. The system simulates the emotional expression of teachers in the real world and gives students emotional support and care. At the same time, we use affective computing technology to analyze and identify users' emotional states and provide them with more intimate and personalized services.

4.3.3 Reasonable Utilization of Resources

One of the key aspects of strengthening guidance and education for students is the establishment of a reasonable learning plan and timetable. This is not just a suggestion, but a necessity to help students manage their time effectively and improve their learning efficiency. In addition, we should strengthen the supervision and feedback mechanism so that students can identify and correct problems in their studies in a timely manner. We encourage students to actively participate in online discussions and collaborative learning to enhance their learning effect and participation. Thus, with the assistance of HCI, students can achieve all-around development.

To sum up, the digital transformation in education is one of the important trends in education, and HCI plays an important role as the core driving force of this transformation. However, there are many challenges in the application of HCI. In response to these challenges, this paper proposes coping strategies from three aspects: technology, education, and users. We put forward measures, including enhancing technological research and development, innovating educational concepts and models, and improving user experience, can effectively tackle these challenges and advance the progress of digital transformation in education. With the continuous development of technology and the expansion of application scenarios, HCI will play a more important role in the education field in the future and actively support the cultivation of high-quality talents with innovative spirit and practical skills.

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5 Conclusion

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