The Impact Mechanism of Interactive Design in Educational Games on Knowledge Transfer Effectiveness

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Abstract: With the rapid development of educational informatization, educational games have gradually become an important tool for improving teaching effectiveness. Educational games combine interactive, entertaining, and situational features, providing new avenues for knowledge transmission. As an important component of educational games, interaction design directly affects learners' learning experience and knowledge acquisition process. This article starts with the interactive design of educational games and systematically explores their specific impact mechanisms on the effectiveness of knowledge transmission. Through theoretical analysis and case studies, it is found that interaction design mainly affects the effectiveness of knowledge transmission from multiple dimensions such as cognition, emotion, and behavior by enhancing learners' participation, stimulating emotional engagement, and promoting knowledge construction ability. In addition, factors such as real-time feedback, task orientation, and multi-sensory interaction in interaction design have a significant promoting effect on learners' learning motivation, focus, and knowledge internalization ability. To further optimize the interactive design of educational games, this article proposes strategies such as strengthening user centered design, integrating multi-sensory interactive technology, providing personalized feedback, and promoting collaborative learning, aiming to maximize the effectiveness of knowledge transfer. The research results not only provide theoretical support for the design and development of educational games, but also provide practical guidance for educators to choose and use educational games and provide reference for promoting the widespread application of educational games and innovative development of educational methods.

1. Introduction

Against the backdrop of rapid development of information technology, digital education models are gradually becoming mainstream, and traditional teaching methods are undergoing profound changes. As an innovative product of educational informatization, educational games break through the limitations of traditional teaching by integrating fun and knowledge, providing learners with a brand-new learning experience. In recent years, educational games have been widely used in fields such as children's education, vocational training, and higher education. Its advantage lies in using game scenarios to stimulate learning interest, while promoting deep absorption and application of knowledge through interactive mechanisms.

Interaction design is an important component of educational games, running through the entire process of game context construction, task design, and feedback mechanisms. Good interaction design can enhance learners' focus, learning motivation, and knowledge acquisition efficiency. However, there are still many problems in the interaction design of current educational games, such as single interaction forms, lagging feedback mechanisms, and lack of targeted task design, which have resulted in suboptimal knowledge transmission effects. In response to these issues, this article explores the specific impact mechanism of interaction design on knowledge transfer effectiveness and proposes optimization strategies to provide theoretical support and practical guidance for the design and practice of educational games.

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2. Theoretical Basis of Educational Games

2.1. Definition and Characteristics of Educational Games

Educational games refer to the process of combining educational content with game elements, utilizing the interactivity, fun, and challenge of games to create an immersive learning environment for learners, thereby achieving knowledge transfer and skill development. Educational games have the following three core characteristics:

2.1.1. Interactivity

Interactivity is one of the core features of educational games, which enhances the practical and applied abilities of knowledge through real-time interaction between learners and game systems. In educational games, learners interact with the system through operations such as clicking, dragging, and selecting. This real-time dynamic interaction not only increases learners' sense of participation, but also helps them better understand the learning content. For example, in language learning games, learners can improve their language abilities by choosing the correct spelling of words or engaging in dialogue with virtual characters. Interactivity transforms learners from passive recipients to active participants, thereby improving learning efficiency [1].

2.1.2. Contextual

Situational refers to the construction of contextualized scenarios related to learning content, which concretizes abstract knowledge and promotes learners' understanding and memory. The situational design in educational games can simulate real-world tasks or problems, making learning content more closely related to practical applications. For example, historical educational games reproduce historical events, allowing learners to perceive the historical context in immersive scenarios, thereby deepening their understanding and memory of the events. Situational design not only facilitates the transmission of knowledge, but also enhances learners' emotional engagement and learning motivation.

2.1.3. Feedback

Feedback is an important mechanism in educational games to promote learning, helping learners correct errors and strengthen correct cognition in a timely manner through immediate feedback. In educational games, feedback can be presented in various forms, such as text prompts, voice feedback, or score evaluations. For example, when learners answer questions incorrectly, games can provide prompt information and explain the correct answer, thereby helping learners deepen their understanding. Instant feedback can not only improve learners' learning efficiency, but also motivate them to continue challenging tasks, achieving continuous accumulation and internalization of knowledge [2].

2.2. The Core Elements of Interaction Design

Interaction design refers to the design of the interaction process between users and systems, with the core goal of enhancing user experience and optimizing the interaction process. The interactive design in educational games mainly includes the following core elements, as shown in Figure 1:

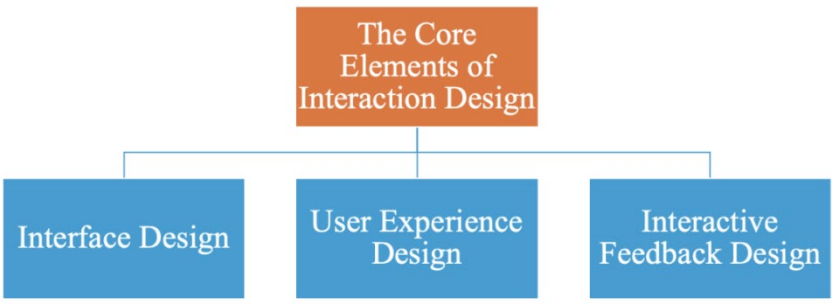

Figure 1: The core elements of interaction design.

2.2.1. Interface Design

Interface design is the foundation of educational game interaction design, and its intuitiveness and ease of use directly affect learners' user experience. A clear and concise interface can effectively reduce learners' cognitive load, allowing them to focus more on knowledge learning and task completion rather than complex operations. For example, by reasonably arranging game function buttons and simplifying navigation processes, learners can quickly get started and focus on learning content. In addition, the color matching and graphic design in the interface should also meet educational purposes, avoiding excessive decoration that interferes with learners' cognitive processing [3].

2.2.2. User Experience Design

User experience design focuses on the integration of multiple senses, enhancing immersion and pleasure in the learning process through multi-dimensional stimuli such as visual, auditory, and tactile senses. Excellent user experience design can enhance the fun and appeal of educational games, thereby stimulating learners' motivation to participate. For example, in a science education game, realistic visual animations, dynamic sound effects, and touch controls can be combined to make learners feel as if they are in a virtual laboratory, enhancing their perception and memory of knowledge.

2.2.3. Interactive Feedback Design

Interactive feedback design is a key factor in enhancing the effectiveness of educational games. Instant and personalized feedback can help learners discover and correct errors faster, consolidating correct knowledge. For example, when a learner completes a math problem, the game can instantly display the correctness of the answer and provide relevant analysis and suggestions. By adjusting feedback content for different learning levels, interactive feedback design can also meet the personalized needs of learners, thereby promoting the deep internalization and transfer of knowledge. This design not only enhances learning effectiveness, but also increases learners' sense of achievement and willingness to continue participating.

2.3. Factors Influencing the Effectiveness of Knowledge Transmission

The effectiveness of knowledge transmission is a key indicator for measuring the effectiveness of interactive design in educational games, which is mainly influenced by the following three aspects, as shown in Figure 2.

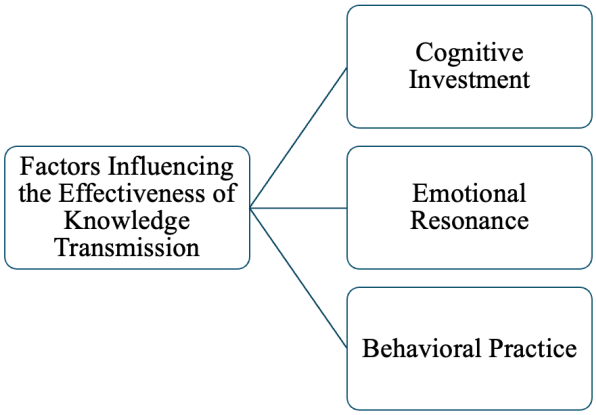

Figure 2. Factors influencing the effectiveness of knowledge transmission.

2.3.1. Cognitive Investment

Cognitive engagement is the manifestation of learners' attention and deep-thinking ability in the process of knowledge transmission, and it is also the foundation for knowledge absorption and transfer. In educational games, high-quality interactive design can attract learners to fully engage and

encourage them to actively engage in knowledge construction and problem-solving. For example, by setting challenging tasks or mind stimulating questions, games can guide learners to engage in logical reasoning, analytical judgment, and creative thinking [4]. The improvement of cognitive investment can not only deepen the understanding of learning content, but also enhance the ability to transfer and apply knowledge in practical situations, making the learning effect more lasting and profound.

2.3.2. Emotional Resonance

Emotional resonance is an important factor in enhancing learning interest and memory effectiveness. Educational games can stimulate learners' emotional engagement through vivid plot design, interesting interactive methods, and motivational task mechanisms. For example, educational and entertaining game scenarios can enable learners to generate positive emotional responses to knowledge content in a pleasant experience, thereby enhancing learning motivation [5]. Meanwhile, emotional resonance can also enhance the connection between learners and educational content, making knowledge easier to internalize and retain over the long term.

2.3.3. Behavioral Practice

Behavioral practice is the process by which learners transform theoretical knowledge into practical abilities through task completion and interactive operations. In educational games, learners can apply their learned knowledge in practice by simulating real-life scenarios or providing task driven interactive designs. For example, simulation business management educational games can allow learners to try operating and making decisions in a virtual market, thereby consolidating theoretical knowledge in practice. Behavioral practice not only helps deepen the memory of knowledge, but also enhances learners' ability to solve practical problems, truly achieving the combination of theory and practice [6].

3. The Impact Mechanism of Interactive Design In Educational Games on Knowledge Transmission Effectiveness

3.1. Enhancing Learner Engagement

Interactive design enhances learners' engagement by providing fun and challenging game content. For example, level design and reward mechanisms can attract learners to continuously engage and increase opportunities for knowledge exposure.

3.2. Stimulating Emotional Engagement

Role playing and scenario simulation in educational games can evoke emotional resonance among learners. Appropriate interactive feedback, such as encouraging evaluations and emotional prompts, can help enhance learners' positive attitudes towards learning content.

3.3. Promoting Knowledge Construction

Interaction design promotes learners to actively explore and construct knowledge through task oriented and problem-solving mechanisms. For example, problem-based learning (PBL) games help learners achieve comprehensive application of knowledge through complex situational design [7].

4. Analysis of Key Factors in Interactive Design of Educational Games

This chapter starts from six key factors: interface, feedback, task, context, collaboration, and data-driven, and deeply analyzes the specific role of educational game interaction design in knowledge transfer effectiveness, providing clear guidance for optimizing educational games, as shown in Figure 3.

Figure 3. Analysis of key factors in interactive design of educational games.

4.1. Interface Design and User Experience

Interface design is the foundation of educational game interaction design and plays an important role in enhancing learners' operational efficiency and cognitive experience. A clear and organized interface can reduce learners' cognitive load and enable them to focus on learning knowledge content. User experience design needs to focus on the smoothness and fun of the game, such as attracting learners' attention through visual guidance, dynamic effects, and color matching, thereby enhancing the effectiveness of knowledge transmission.

4.2. Interactive Feedback Design

Interactive feedback is an essential component of educational games, which can enhance learners' learning outcomes through real-time and personalized feedback. For example, positive feedback (such as point rewards or praise messages) can enhance learners' confidence and learning motivation, while corrective feedback can help learners correct erroneous cognition in a timely manner and promote deep internalization of knowledge [8].

4.3. Game Tasks and Goal Orientation

The task design in educational games needs to be combined with teaching objectives, and through phased goal-oriented tasks, help learners gradually master knowledge. For example, the rationality of task decomposition and the progressive difficulty can guide learners to constantly challenge themselves in the process of completing tasks, achieving mastery and transfer of new knowledge.

4.4. Situational Design and Immersive Experience

Effective situational design can stimulate learners' emotional engagement and provide them with immersive experiences during the learning process. The design methods of virtual situations, role-playing, and story clues can integrate learning content into real or simulated situations, allowing learners to focus more on the correlation between games and learning content, thereby enhancing the effectiveness of knowledge transmission.

4.5. Collaboration and Social Interaction

Collaboration and social interaction design in educational games can enhance knowledge sharing and collaborative learning among learners through group dynamics. Multi person collaborative tasks or competitive game modes can not only increase the fun of learning, but also promote knowledge exchange and teamwork among learners.

4.6. Data-driven Learning Analysis

By collecting and analyzing learners' behavior data in games, educational games can provide personalized learning paths and optimized designs. For example, based on learners' game

performance, dynamically adjusting task difficulty and content push can help learners master knowledge at the most suitable pace, improve learning efficiency and effectiveness.

5. Strategies for Optimizing Interactive Design in Educational Games

The interactive design of educational games is a key link in improving the effectiveness of knowledge transmission. In order to achieve better knowledge transfer effects, designers need to continuously optimize the interactive design of educational games from multiple dimensions such as user experience, technological innovation, feedback mechanisms, and collaborative learning [9].

5.1. Emphasizing User Centered Design

User centered design is the core principle of modern educational game interaction design, with the goal of ensuring that the design process always revolves around the needs and learning objectives of learners. The behavior and experience of learners in educational games have individual differences, and designers should gain a deeper understanding of the characteristics and needs of target users through user research, needs analysis, and learning behavior monitoring. For example, for learners of different age groups, game tasks and interface operation processes of different complexities can be designed to avoid affecting learning effectiveness due to complex operations or monotonous content. Meanwhile, a user-friendly interface and operational logic can reduce learners' cognitive load, allowing them to focus on absorbing and internalizing knowledge.

In addition, the user center design also requires educational games to be able to adapt to different learning environments. For example, educational games on mobile devices require optimization of touch screen interaction and visual presentation, while in desktop game design, mouse and keyboard interaction functions can be added. This flexible design approach can better meet the needs of multi scenario learning.

5.2. Integrating Multi-sensory Interactive Technologies

Learning is a process of multi-sensory participation, and multi-sensory interactive technology can significantly enhance the immersion and knowledge transmission effect of educational games. By integrating sensory stimuli such as vision, hearing, and touch, educational games can provide learners with more vivid and concrete learning experiences. For example, using augmented reality (AR) technology, abstract knowledge can be transformed into three-dimensional images, thereby helping learners understand complex concepts more intuitively.

In terms of auditory design, educational games can stimulate learners' emotional resonance and enhance the fun of learning through background music and voice guidance. Tactile interaction technologies, such as vibration feedback and touch operation, can further enhance learners' engagement and operational experience. Designers can also combine virtual reality (VR) technology to create a fully immersive learning environment for learners, allowing them to construct knowledge in an immersive experience [10].

5.3. Providing Personalized Feedback Mechanism

Personalized feedback is one of the key strategies to enhance the effectiveness of knowledge transmission. Educational games should provide dynamic and personalized feedback to learners through real-time monitoring of their learning behavior and performance data. For example, when learners complete tasks, the system can provide immediate feedback based on their operational status, helping them correct errors or consolidate correct cognition in a timely manner. At the same time, dynamically adjusting the difficulty of the game can provide adapted learning content for learners of different skill levels, avoiding frustration caused by high task difficulty or boredom caused by low difficulty.

In addition, personalized feedback mechanisms can also be achieved through data analysis and artificial intelligence technology. For example, based on learners' behavioral trajectories, educational games can generate personalized learning path recommendations to help learners more efficiently grasp knowledge points. Through emotion computing technology, the system can also perceive

learners' emotional changes, providing encouraging prompts at critical moments to enhance learners' confidence and learning motivation.

5.4. Promoting Collaborative Learning

Collaborative learning is an important way to enhance the effectiveness of knowledge transmission in educational games. Designing educational games that support multi-user collaboration not only enhances interaction among learners, but also cultivates their teamwork and knowledge sharing abilities. For example, educational games can be designed with multiple character tasks that require learners to collaborate and complete goals through division of labor. This form of game not only enhances the fun of learning, but also strengthens the internalization and transfer of knowledge through interaction.

In collaborative learning scenarios, educational games can also utilize social features such as real-time chat, collaboration tools, and leaderboards to enhance communication and competition among learners. These functions can stimulate learners' learning motivation and create a favorable environment for the transmission and sharing of knowledge. In addition, designers can identify key nodes and weak links in collaboration through data analysis, thereby continuously optimizing the game's collaboration mechanism and improving the overall efficiency of team learning.

6. Conclusion and Prospect

This article explores the impact mechanism of interactive design in educational games on the effectiveness of knowledge transmission. Research has found that interactive design in educational games can significantly enhance the effectiveness of knowledge transmission from multiple dimensions by increasing learner engagement, stimulating emotional engagement, and promoting knowledge construction. The core elements of interaction design include user interface design, multi-sensory interaction technology, personalized feedback mechanisms, and collaborative learning support, all of which play important roles in different learning scenarios.

In addition, this article also proposes specific strategies for optimizing the interactive design of educational games, such as emphasizing user centered design, integrating multi-sensory interactive technology, providing personalized feedback mechanisms, and promoting collaborative learning. These strategies provide useful references for the design and practice of educational games, laying a theoretical foundation for further improving the teaching effectiveness of educational games.

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