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Research on "Lightweight" Reconstruction Strategy of Online Learning Space Resources: A Practical Study Oriented to High School Students' Fragmented and Ubiquitous Learning Needs

Yujie Guo
RI ZHAO HAIQU HIGH SCHOOL OF SHANDONG, Rizhao 276817, Shandong, China

Abstract: Under the trend of Education Informatization 2.0 and ubiquitous learning, the mismatch between traditional online learning space resources and high school students' fragmented learning needs has become increasingly prominent. This paper adopts action research, questionnaire survey, and case analysis methods, focusing on how to carry out "lightweight" reconstruction of online learning space resources. The study proposes a "lightweight resource design model" and constructs a three-dimensional strategy framework of "content decomposition - technical optimization - scenario adaptation" based on the investigation of high school students' fragmented learning needs. Practice has proved that this "lightweight" reconstruction strategy effectively improves resource utilization efficiency and learning effects, providing practical references and innovative ideas for the construction of ubiquitous learning resources in high school education.

Keywords: Online learning space; "Lightweight"; Fragmentation; Ubiquitous learning needs

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1. Introduction

1.1. Research background

The Action Plan for Educational Informatization 2.0 issued by the Ministry of Education explicitly emphasizes the importance of co-construction and sharing of resources, aiming to promote in-depth integration of information technology with education and teaching, and build an intelligent education system. Against this backdrop, various regions have actively advanced the construction of educational cloud platforms, and the Rizhao Educational Cloud Platform has emerged as a result. This platform undertakes the important mission of hosting rich educational resources, promoting educational equity, and improving educational quality, providing strong support for the development of regional educational informatization.

The learning scenarios of high school students exhibit obvious fragmented characteristics. Short breaks between classes, commuting time to and from school, and scattered periods at home all constitute their potential learning time. However, traditional online learning resources are mostly in the form of long videos and large texts. In terms of content organization and presentation, these resources are inadequately adapted to the fragmented learning scenarios of high school

students, making it difficult to meet their needs for efficient learning anytime and anywhere[1].

With the widespread popularization of 5G, cloud computing, and intelligent terminals, the technical level has laid a solid foundation for the "lightweight" transformation of online learning space resources. The high-speed network of 5G ensures the rapid transmission of resources; the powerful storage and computing capabilities of cloud computing support large-scale resource management; and the diversification of intelligent terminals requires resources to have broader adaptability. All these factors have created favorable conditions for the development and application of "lightweight" resources[2].

1.2. Problem statement

Currently, online learning space resources face numerous issues. "Content redundancy" makes it difficult for students to quickly locate key information within their limited fragmented time; "slow loading" wastes valuable learning time and reduces learning enthusiasm; and "weak interactivity" leads to students' lack of participation and difficulty in maintaining learning attention. These problems have severely restricted the learning effectiveness of high school students during fragmented time, creating a sharp contradiction with their demand for acquiring effective knowledge anytime and anywhere.

1.3. Research significance

This study aims to optimize the resource supply structure through the "lightweight" reconstruction of online learning space resources, making learning resources more in line with the characteristics of high school students' fragmented and ubiquitous learning, thereby improving the efficiency of ubiquitous learning. Meanwhile, the research results can also provide references for the construction and resource optimization of educational cloud platforms in other regions, promoting the development of educational informatization to a higher level.

2. Core concepts and theoretical foundations

2.1. Concept definition

Lightweight resources are characterized by "micro-granularity, low cognitive load, and high adaptability", and are a form of resources that support quick access across multiple terminals[3]. For example, micro-courses of 5-8 minutes focus on explaining single knowledge points; knowledge cards concisely present core concepts and key information; interactive H5 enhances the learning experience through dynamic interaction design, meeting students' needs for quickly acquiring knowledge in different scenarios.

Fragmented ubiquitous learning refers to the realization of seamless learning in non-continuous time periods and multiple scenarios. It emphasizes that learning resources should be instant, able to provide support at the moment when students have learning needs; at the same time, they should be contextual, pushing learning content adapted to different learning scenarios, thus breaking the time and space constraints of learning.

2.2. Theoretical foundations

Cognitive Load Theory points out that the capacity of human working memory is limited. The design of lightweight resources reduces learners' intrinsic cognitive load by breaking down complex knowledge into micro-granular content, enabling learners to absorb knowledge more efficiently and devote more cognitive resources to the understanding and application of knowledge.

Merrill's First Principles of Instruction emphasizes problem-centered teaching design, promoting learning by presenting problem situations and guiding learners to solve practical problems. In the design of resources in online learning spaces, building problem-oriented task-based micro-resources based on this principle can stimulate students' willingness to learn actively and improve learning effects[4].

The ARCS Motivation Model includes four elements: Attention, Relevance, Confidence, and Satisfaction. By designing light interactive elements in lightweight resources, such as providing immediate feedback on students' learning results and setting up badge rewards, it can attract students' attention, enhance their learning confidence, improve learning satisfaction, and effectively maintain students' learning motivation[5].

3. Investigation and analysis of high school students' demand for fragmented learning

3.1. Research design

Students from Grade 1 to Grade 3 of X High School in Rizhao City were selected as the research objects. A stratified sampling method was adopted to ensure that the sample covered students of different grades, genders, and academic levels, with a total of 500 students selected as the sample.

Data were collected through a combination of questionnaires and interviews. The questionnaire used a Likert 5-point scale, covering aspects such as the distribution of students' fragmented learning time, resource preferences, and learning pain points. Meanwhile, 20 representative students were selected for interviews to gain an in-depth understanding of their actual experiences and needs in the process of fragmented learning.

3.2. Research findings

The survey found that high school students spend an average of about 40 minutes on fragmented learning per day. Among them, morning and evening commuting time accounts for 35%, breaks between classes account for 28%, and bedtime accounts for 22%. These fragmented time periods are relatively scattered but are valuable learning periods that students can utilize.

In terms of resource preferences, short videos rank first with a 78% support rate, followed by graphic summaries (65%) and interactive question banks (53%). However, 89% of students resist long-text resources, indicating that students prefer concise, intuitive, and interactive learning resources.

Students face many pain points in the process of fragmented learning. Slow resource loading, accounting for 62%, seriously affects the learning experience; 48% of students report that the content is disconnected from textbooks, leading to a lack of systematic learning; and 57% mention the absence of personalized recommendations, making it difficult for students to quickly obtain resources that meet their own needs.

4. "Lightweight" reconstruction strategies for online learning space resources

Based on the above research and analysis, a three-dimensional model of "content decomposition - technical optimization - scenario adaptation" is proposed to realize the "lightweight" reconstruction of online learning space resources from multiple dimensions.

4.1. Content dimension: granular and structured reorganization

4.1.1. Knowledge graph deconstruction

In accordance with Technical Specifications for Educational Resource Construction (CELTS-41), the course knowledge points are systematically sorted out to build a knowledge graph. Complex knowledge points are decomposed into 5-8 minute micro-units. Taking "Python loop structures" as an example, it is further divided into 3 micro-courses explaining different types of loop structures, accompanied by 2 checkpoint exercises to help students consolidate knowledge. This enables students to focus on learning a complete small knowledge module within fragmented time.

4.1.2. Interdisciplinary integration

To broaden students' knowledge horizons and cultivate comprehensive literacy, "technology + discipline" themed

resources are designed. For instance, the resource “Analyzing High-Frequency Words in Ancient Poems with Excel” combines Excel application in information technology with the study of ancient Chinese poems, allowing students to integrate and apply interdisciplinary knowledge in solving practical problems.

4.2. Technical dimension: optimization of resource form and interaction

4.2.1. Lightweight format

Following technical standards and specifications, modern technologies such as H5 and SVG vector graphics are adopted to replace traditional PPT/PDF formats. Practical tests show that the new formats reduce resource size by more than 60%, significantly improving the loading speed of resources on different terminals.

4.2.2. Intelligent slicing technology

With the help of Rizhao Cloud Platform’s AI editing tools, existing long video resources are automatically segmented, and each segment is labeled with knowledge points. For example, a complete physics experiment class video is segmented and annotated according to experimental steps and key knowledge points through intelligent slicing technology, allowing students to quickly locate the required content according to their needs and improve learning efficiency.

4.3. Scenario dimension: multi-terminal adaptation and context awareness

4.3.1. Responsive design

CSS media query technology is used to realize responsive design of resources, enabling them to automatically adjust layouts and styles according to the screen sizes of different devices such as mobile phones, tablets, and computers. This ensures that students can have a good learning experience on various terminals.

4.3.2. Context-aware recommendation

Based on LBS (Location-Based Service) technology, scenario-based resources are pushed according to students’ locations. For example, when students are in the school laboratory, the system automatically pushes relevant experimental operation videos, closely integrating learning resources with learning scenarios to enhance the pertinence and practicality of learning.

5. Practical cases: lightweight resource application of Rizhao education cloud platform

5.1. Experimental design

Six classes of Grade 2 senior high school students, totaling 300 students, were selected as the experimental group, using resources reconstructed with the “lightweight” approach for learning; another 300 students were selected as the control group, using traditional resources. The experiment lasted for 3 months, during which the learning performance of both groups was tracked and recorded.

5.2. Typical application scenarios

Fragmented Time Utilization in Morning Reading: English vocabulary animations were pushed to students during fragmented morning reading time. Through vivid and interesting animations, students were helped to memorize words quickly. Data showed that students in the experimental group learned an average of 3.2 words per day, a 27% increase compared with the control group, effectively utilizing fragmented time and improving learning outcomes.

In project-based learning: taking IoT projects as an example, fragmented knowledge points were connected through task cards. For instance, in learning “sensor principles”, micro-lesson chains were used to organically integrate knowledge points such as different types of sensors and their working principles. Students could access the required knowledge at any time during project practice, improving the quality and efficiency of project completion.

5.3. Effect evaluation

5.3.1. Objective data

From the actual operation data of the Rizhao Cloud Platform, the average resource loading time was reduced from 8.3 seconds to 2.1 seconds, significantly improving students' learning experience. The average weekly visit frequency of students increased from 8.5 to 24.6, indicating that "lightweight" resources are more popular among students, and their enthusiasm for learning using fragmented time has significantly increased.

5.3.2. Subjective feedback

Questionnaire surveys showed that 89% of students believed that "lightweight" resources "make it easier to learn in fragmented time"; 73% of teachers reported that "the efficiency of classroom extension has improved", indicating that "lightweight" resources are not only recognized by students but also provide strong support for teachers' teaching.

6. Discussion and reflection

6.1. Implementation challenges

6.1.1. Teacher role transformation

In the process of "lightweight" reconstruction of resources, teachers need to transform from traditional resource developers to "curriculum dismantling designers". This requires teachers to have new teaching design concepts and technical capabilities, such as micro-resource design and interdisciplinary integration. Therefore, strengthening relevant training for teachers is crucial to help them adapt to the role transformation and improve teaching quality.

6.1.2. Platform compatibility

Although new technologies have brought a better learning experience, some old devices cannot support interactive resource formats such as H5. To ensure that all students can learn normally, it is necessary to retain backups of traditional resources, which to some extent increases the complexity of resource management.

6.2. Future prospects

6.2.1. Expanding types of lightweight resources

With the continuous development of technology, AR/VR miniaturized applications can be developed in the future. For example, 3D molecular model interactive resources can be developed to allow students to explore the micro-world more intuitively in a virtual environment, enriching learning experiences and improving learning effects.

6.2.2. Dynamic lightweight mechanism

With the help of advanced learning analytics technology, based on students' attention data (such as eye-tracking), the resource presentation method can be adjusted in real-time. For example, when a student's inattention is detected, the resource content or presentation form can be automatically adjusted to maintain their learning focus, achieving more personalized and intelligent learning support.

In summary, the "lightweight" reconstruction strategy of online learning space resources proposed in this study has achieved significant results in meeting senior high school students' needs for fragmented and ubiquitous learning. However, there are still some challenges in the implementation process. In the future, further exploration and innovation are needed to continuously improve resource construction and application models, providing stronger support for the informatization development of senior high school education.

Disclosure statement

The author declares no conflict of interest.

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