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Evaluation of the Application Effect of Microlearning in Improving Students' Academic Achievements

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Abstract: *This paper explores the effectiveness evaluation of microlearning in improving students' academic performance. As a fragmented and flexible learning approach, microlearning significantly enhances students' learning efficiency, self-directed learning interest, and the depth and breadth of knowledge mastery through concise content delivery and the optimization of personalized learning pathways. By evaluating basic indicators such as academic performance, learning attitudes, learning efficiency, and student engagement, and combining commonly used evaluation tools and methods, the practical application effects of microlearning are analyzed. Case studies show that microlearning has achieved positive results in fundamental subjects, applied disciplines, and interdisciplinary learning. Despite challenges such as technical support and addressing differentiated needs, microlearning will continue to develop in the future, further driving innovations in educational models.*

Keywords: Microlearning; Academic Performance; Learning Efficiency; Personalized Learning; Evaluation

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1. Introduction

With the rapid development of information technology, the education sector has continuously sought innovative learning approaches to improve students' learning efficiency and academic performance. Traditional teaching methods are often constrained by time, space, and individual differences among students, making it difficult to fully meet the learning needs of each student. As a new teaching model, microlearning has rapidly gained widespread attention due to its refined content delivery and flexible learning methods. The core characteristics of microlearning lie in its brevity, personalization, and flexibility, enabling it to effectively address the time constraints and fragmented knowledge demands of modern learners. In contrast to traditional teaching methods, microlearning emphasizes learner autonomy and flexibility, providing customized learning content based on students' needs and interests. By breaking down complex knowledge into smaller units and using short learning sessions, microlearning helps students efficiently absorb and apply knowledge, greatly enhancing learning efficiency and quality. However, the specific effects of microlearning on improving academic performance still need to be verified through scientific evaluation methods. This paper aims to explore the application effectiveness of microlearning across different subjects, analyze its role in improving students' academic performance, and provide an outlook on its future applications, particularly with the continuous advancement of technology, as the

potential of microlearning in personalized education and interdisciplinary teaching will be further realized.

2. Overview of Microlearning

2.1 Definition and Characteristics of Microlearning

Microlearning is a learning approach based on fragmented content, typically delivered through digital technology platforms, with the goal of conveying efficient and precise information in a short amount of time. Its core characteristics include concise content, flexible and controllable learning processes, and strong adaptability to individual needs. Compared to traditional learning models, microlearning provides an efficient learning experience through small, modular content. Each learning unit is brief, typically lasting between 5 and 15 minutes, allowing learners to focus their attention and efficiently absorb information. Microlearning typically relies on multimedia resources (Ariyanti & Seli, 2023), such as short videos, interactive quizzes, and micro-courses, to enhance information absorption and cater to various learning needs. Unlike traditional, long-duration learning, microlearning better aligns with the cognitive habits of modern individuals, enabling students to master specific knowledge points in a short period of time. Furthermore, microlearning supports learning anytime and anywhere, reducing the limitations of time and space and greatly enhancing learning convenience. Students can take advantage of fragmented time for learning, whether on a bus, in a queue, or during a break, using smartphones or other mobile devices. With the help of artificial intelligence and big data analysis, microlearning can provide precise content recommendations, optimize learning paths, and enhance personalized learning capabilities. Its advantages are not only reflected in the improvement of learning efficiency but also in the reduction of cognitive load, allowing students to absorb knowledge more effectively while engaging in high-efficiency input.

2.2 Teaching Model of Microlearning

The teaching model of microlearning is based on the principle of short, efficient learning, primarily relying on mobile devices, social platforms, and online education platforms for delivery. Teachers typically break down course content into independent micro-units, with each unit focusing on a core concept, presented through short videos, animated demonstrations, interactive exercises, etc., to ensure that students can grasp key concepts in a short time. Each micro-unit is concise and information-dense, helping students acquire knowledge efficiently. The microlearning model emphasizes instant feedback, enabling students to receive targeted guidance during the learning process through online assessments, intelligent push notifications, and other methods. Students can quickly assess their grasp of knowledge points and take immediate action to consolidate or supplement their learning. Based on learner behavior data, microlearning platforms can dynamically adjust content recommendations, enhancing personalized learning experiences. The learning data generated by students on the platform helps the system deliver the most suitable content, ensuring each student’s learning path is customized. In practical applications, flipped classrooms, blended learning, and other teaching methods are combined with microlearning to further optimize teaching effectiveness. The flipped classroom model integrates students' autonomous learning with classroom interaction (Jubran, 2024), guiding students to self-learn content before class through micro-courses, with classroom time reserved for discussion, application, and deepening of learning content. Microlearning can also incorporate gamification mechanisms, such as point rewards and challenge tasks, to enhance students' learning motivation, making the learning process more dynamic and engaging. Through reward systems, students can experience instant achievement, motivating them to continuously engage in learning.

2.3 Differences Between Microlearning and Traditional Learning

Microlearning and traditional learning differ significantly in teaching methods, content organization, and learning experiences. Traditional learning typically unfolds in a systematic, linear manner, emphasizing the integrity of the knowledge system and being suitable for in-depth learning and logical deduction. This model is often constrained by time, space, and cognitive load, which can reduce learning efficiency. Course content usually requires extended periods of focused attention to complete, and is often teacher-centered, with less active student participation. In contrast, microlearning is centered on fragmentation and short, efficient sessions, focusing on the immediate acquisition and application of knowledge, making it suitable for learning needs in fast-paced environments. Microlearning relies on technological support to enable personalized recommendations and interactive learning, enhancing learning flexibility, as students can complete tasks anytime and anywhere, free from the constraints of a traditional classroom setting. Microlearning offers richer learning methods, such as interactive tests and dynamic push notifications, to increase student engagement. Traditional learning models, on the other hand, rely more heavily on teacher-led instruction with fixed learning paces, which often fail to accommodate individual differences. Microlearning encourages proactive exploration by providing abundant learning resources through social media and online platforms, allowing students to choose their learning content, whereas traditional learning tends to focus more on classroom lectures and textbook reading, offering a relatively single learning approach. Although both models have their advantages, combining them in modern education can create a more complete learning ecosystem, offering students more comprehensive learning support. By integrating microlearning with traditional learning, educational models can balance both knowledge depth and practical application, fostering students' overall abilities.

3. The Role of Microlearning in Improving Academic Performance

3.1 Enhancing Learning Efficiency

Microlearning effectively enhances students' learning efficiency through concise content and flexible learning methods. By breaking down learning material into small, focused knowledge units, microlearning allows students to complete specific learning tasks in a short amount of time, thereby avoiding the attention decline often associated with traditional extended learning sessions. Long periods of study often lead to attention fatigue, negatively impacting learning outcomes. Microlearning, by dividing content into easily understandable small modules, helps students focus their attention and master key concepts efficiently. Microlearning offers personalized learning paths, utilizing big data to analyze students' learning behaviors and knowledge acquisition, thus pushing suitable content to optimize the learning process, reducing redundant or inefficient learning (Choudhary & Pandita, 2023). Personalized recommendations adjust the learning pace according to the needs of different learners, enhancing both the specificity and efficiency of learning. Microlearning platforms typically incorporate immediate assessment features, enabling students to immediately test their knowledge after completing lessons and receive real-time feedback. This helps consolidate knowledge and reduce the forgetting curve. The immediate feedback mechanism during learning allows students to quickly identify mistakes, adjust their learning strategies, and further enhance learning effectiveness. Moreover, microlearning, relying on mobile devices and social platforms, allows learning to occur anytime and anywhere, removing the constraints of time and space and significantly enhancing the convenience of learning. Students can utilize fragmented time for learning, such as while waiting for a bus, during lunch breaks, or other short intervals, engaging in efficient learning through short videos or online quizzes, which not only increases the utilization of learning time but also ensures the continuity of learning. In summary,

microlearning optimizes content, strengthens feedback mechanisms, and increases flexibility, significantly improving students' learning efficiency, especially for students who require effective and flexible learning strategies.

3.2 Enhancing Students' Motivation for Active Learning

Microlearning significantly enhances students' motivation for active learning by relying on interactive, diverse content presentation methods. Unlike traditional passive learning, microlearning emphasizes students' independent exploration and personalized experiences, making the learning process more engaging and interesting. Traditional learning models tend to be teacher-centered, with students primarily in a passive role, lacking active engagement. Microlearning, on the other hand, breaks learning content into independent, short modules, allowing students to choose what they want to learn and enhancing the learning process through diverse formats. Short videos, gamified learning, interactive quizzes, and other methods capture students' attention, making learning more intuitive and easier to comprehend. Especially for abstract concepts, interactive learning formats make them easier to understand. Microlearning is not just about content transmission; it is also an effective tool to stimulate students' interest and initiative in learning. By incorporating social platforms for knowledge dissemination, students can share and discuss content with peers after learning, fostering a positive learning environment and further enhancing their motivation. Discussions and collaborations not only deepen students' understanding of the content but also improve their interaction and teamwork skills. The application of artificial intelligence technology allows microlearning content to be intelligently recommended based on students' interests and learning needs, ensuring that the learning content aligns with individual preferences, thereby enhancing the proactivity of learning. Additionally, some microlearning platforms incentivize students to continue learning through gamification mechanisms such as point rewards and leaderboards, making the learning process more challenging and enjoyable. By unlocking new tasks and achievements, students gain a sense of accomplishment, which motivates them to continue exploring. The immediate feedback and sense of achievement mechanisms in microlearning also effectively maintain students' interest in learning, preventing burnout caused by monotonous learning experiences.

3.3 Deepening and Expanding Knowledge Mastery

Microlearning not only improves the efficiency of knowledge acquisition but also plays a crucial role in the depth and breadth of knowledge mastery (Alphrazy & Octavia, 2023). By providing concise content, microlearning allows students to revisit key knowledge points, reinforce memory, and improve the precision of knowledge retention. In traditional learning models, students are often limited by course time and the number of topics, making it difficult to engage in deep learning of challenging concepts. Microlearning, by breaking down complex knowledge into smaller units, helps students master knowledge points in a shorter period of time. Through repeated learning and immediate feedback mechanisms, it helps deepen memory and reduce forgetting. Microlearning typically combines interactive learning methods, such as immediate assessments and case studies, which help students understand knowledge more profoundly and enhance their application abilities. In scientific subjects, micro-courses can illustrate complex concepts through animations, making abstract knowledge more tangible, thereby deepening students' understanding. For example, in physics and chemistry, microlearning can use virtual experiments and simulated demonstrations, enabling students to intuitively grasp and perform complex experimental procedures, enhancing their experimental skills and scientific thinking. Microlearning provides a wealth of learning resources, enabling students to access a broader range of knowledge areas and expand the depth and breadth of their understanding. Students can use micro-courses during their spare time to expand their

knowledge in various subjects, exploring interdisciplinary content and forming a more comprehensive knowledge structure. At the same time, microlearning supports personalized learning paths, allowing students to delve deeper into specific topics according to their needs, compensating for the depth of exploration that is often limited by time constraints in traditional learning. Therefore, microlearning not only facilitates the efficient intake of knowledge but also broadens students' intellectual boundaries, enhancing their overall literacy and cognitive abilities. When addressing complex issues, students can apply interdisciplinary knowledge, developing multifaceted thinking to better solve practical problems.

4. Evaluation Methods for the Effectiveness of Microlearning

4.1 Basic Indicators for Effectiveness Evaluation

The evaluation of microlearning effectiveness primarily relies on several key indicators, including academic performance, learning attitude, learning efficiency, and student engagement. Academic performance is the most direct evaluation criterion. By comparing students' scores before and after microlearning, the impact of microlearning on knowledge mastery can be clearly reflected. Improvements in academic performance are typically one of the key indicators used to assess the effectiveness of microlearning, as they directly show whether microlearning has effectively facilitated students' knowledge absorption and application abilities (Lopez, 2024). Changes in learning attitudes are also a critical evaluation criterion, particularly with regard to students' learning interest, initiative, and self-directed learning abilities. Learning attitudes are usually assessed through surveys, interviews, and other methods, which provide insight into students' acceptance of the microlearning model and their motivation to learn. An improvement in learning attitude often indicates that microlearning has been successful in stimulating students' interest, thus enhancing their academic performance. Learning efficiency is assessed by comparing the time students require to complete the same task in traditional learning versus microlearning modes, in order to determine the time optimization effect of microlearning (Rof et al., 2024). The microlearning model typically enables more efficient knowledge delivery in a shorter time, saving students' learning time and improving time utilization. Student engagement directly impacts the effectiveness of microlearning; by examining students' activity levels and interaction frequency in microlearning activities, we can assess their level of commitment to learning. Students with higher engagement are typically better able to absorb and apply the knowledge learned. By integrating these indicators, a comprehensive understanding of microlearning's impact on improving academic performance can be achieved.

4.2 Common Evaluation Tools and Methods

The evaluation of microlearning typically involves the use of multiple tools and methods to gather comprehensive feedback. Common evaluation tools include online tests, learning management systems (LMS), data analytics platforms, and student feedback surveys. Online tests, through immediate quizzes and interactive exercises, assess students' mastery of knowledge points. Real-time feedback helps educators understand students' progress and identify weak areas. Through online tests, educators can accurately capture students' learning performance in microlearning and adjust teaching strategies and content difficulty accordingly. Learning management systems track students' learning paths, record learning time, task completion status, and engagement data, providing detailed analytical reports. LMS not only records students' learning trajectories but also offers detailed data support for educators, helping them better understand each student's learning status. Data analytics platforms analyze students' learning behavior data, such as learning frequency and review patterns, assisting in evaluating the effectiveness of their learning models. Automated data analysis from these

platforms provides real-time feedback, enabling educators to intervene based on these data. Regular student feedback surveys, interviews, and questionnaires are also important methods for evaluating microlearning effectiveness, as they collect students' satisfaction with the microlearning model and their perceptions of the learning experience. By combining these tools and methods, a multi-dimensional evaluation of microlearning effectiveness can be conducted, providing a basis for further optimization of learning strategies. Through diversified evaluation methods, the comprehensiveness and accuracy of microlearning's impact can be ensured.

4.3 Case Study Analysis

Specific evaluation case studies offer a more intuitive understanding of the practical application effects of microlearning in various educational environments. In a high school mathematics course, the school introduced a microlearning teaching model by breaking down each knowledge point into short micro-courses for online learning. The evaluation results showed a 15% improvement in students' final exam scores after microlearning, with microlearning demonstrating significant advantages in understanding and applying difficult concepts. Students reported that the short microlearning sessions helped them focus better, not only improving learning efficiency but also stimulating their interest in self-directed learning. In microlearning, students were able to grasp key knowledge points in a short time, enhancing both the efficiency and quality of their learning. In another case study from a university English course, the microlearning model combined online videos with interactive quizzes, significantly improving students' listening and speaking skills, particularly among non-English major students. Through real-time assessments and feedback, students were able to identify and address their learning deficiencies more quickly, thereby enhancing their practical application abilities. Evaluation data showed that students' engagement and motivation were significantly higher compared to traditional teaching methods. Students not only exhibited higher levels of participation but also displayed greater self-motivation during the learning process. These evaluation results indicate that the microlearning model has a clear impact on improving academic performance and also enhances students' motivation to learn, optimizing their learning experience. Through these case analyses, we can observe the advantages of microlearning in practice, especially in improving students' learning efficiency, stimulating students' learning interest, and promoting student engagement.

5. Application Effects of Microlearning in Different Disciplines

5.1 Microlearning Application in Fundamental Subjects

The application of microlearning is particularly significant in fundamental subjects. Disciplines such as mathematics, physics, and chemistry have extensive and abstract knowledge systems, and students often encounter difficulties in understanding the interrelationships between knowledge points. Microlearning addresses this by breaking down these complex concepts into smaller units, helping students better grasp foundational concepts, reduce cognitive load, and improve learning efficiency. For example, in mathematics, micro-courses not only explain basic formulas and theorems but also help students understand how to apply theoretical knowledge to practical problems through real-world examples (Alias & Razak, 2023). These micro-units are typically accompanied by immediate assessments to ensure that students fully comprehend and retain each knowledge point. When students encounter more challenging concepts, they can benefit from video explanations, animated demonstrations, and other visual aids, which help them understand abstract content more intuitively. In science courses, microlearning is also applied in experimental classes, where interactive videos, virtual experiments, and other methods allow students to complete experiments and data analysis in a short period of time, cultivating hands-on skills and practical knowledge of experimental

procedures. The immediate feedback mechanism in microlearning helps students identify and correct mistakes during the learning process, reducing the cognitive biases that may arise in traditional learning. Overall, the application of microlearning in fundamental subjects not only improves academic performance but also effectively addresses challenges in traditional learning methods, particularly in terms of the systematic and in-depth mastery of knowledge, helping students establish a solid foundation in their respective disciplines.

5.2 Microlearning Application in Applied Subjects

In applied subjects, the flexibility and diversity of microlearning have been more widely applied, particularly in fields such as technology, the arts, and languages. Technical disciplines, such as computer science and engineering, typically involve a substantial amount of practical application and theoretical learning. Microlearning breaks down complex topics such as programming and algorithms into simple, easy-to-understand short courses, helping students progressively master key skills. Students can watch micro-videos, participate in online coding exercises, and quickly master basic syntax and common algorithms, accumulating practical experience in a short time. Similarly, microlearning has also achieved significant success in the arts, where hands-on courses such as painting, music, and performance benefit from short videos and interactive teaching platforms, allowing students to undergo skill training and receive immediate feedback to enhance their creative abilities and artistic perception. For instance, in a painting course, by demonstrating specific steps in the painting process and combining short video tutorials, students can practice and receive feedback to continuously improve their painting skills. In language studies, microlearning also demonstrates its efficiency, with short-duration listening and speaking practice, grammar explanations, and vocabulary memorization helping students better master language application skills. By offering a variety of learning materials, microlearning enables students to efficiently study even during busy daily routines, utilizing fragmented time to improve language proficiency. Microlearning in applied subjects not only improves students' practical skills but also makes the learning process more flexible and diverse, aligning with students' personalized needs. Through short learning modules, students can progressively master the relevant knowledge and skills of applied subjects without feeling burdened.

5.3 Interdisciplinary Microlearning Model

The interdisciplinary microlearning model integrates knowledge from multiple subjects, using flexible learning paths and interactive teaching to help students achieve comprehensive knowledge application and foster innovative thinking. In practical applications, microlearning can link knowledge points from different disciplines to create an interdisciplinary learning framework, enhancing students' ability to integrate knowledge. For example, in STEAM education, microlearning effectively combines content from science, technology, engineering, arts, and mathematics to help students explore and practice knowledge across fields. In an interdisciplinary environmental science course, students can use a microlearning platform to understand environmental principles from physics, analyze pollutants from chemistry, and explore mathematical modeling and solution strategies. This interdisciplinary microlearning model not only promotes students' comprehensive understanding of knowledge but also stimulates their ability to think innovatively and solve problems. In this learning model, students not only master knowledge from each subject but also learn how to integrate and apply knowledge from different disciplines, enhancing their problem-solving abilities in real-world scenarios. The advantage of the interdisciplinary microlearning model is that it breaks down the boundaries between subjects, allowing students to approach problems from multiple perspectives, developing a well-rounded knowledge structure and comprehensive skills to meet the complex and dynamic demands of future society. Furthermore, this model also fosters

students' ability to collaborate across disciplines, enhancing their communication and teamwork skills, preparing them for diverse professional environments in the future.

6. Issues in Technology and Platform Support

6.1 Rational Design of Pre-Class Learning Resources to Enhance Student Engagement

Although the microlearning model has achieved significant success in the field of education, its application still faces several challenges related to technology and platform support. The development and maintenance of technological infrastructure are key to ensuring the efficient operation of microlearning. In some regions or schools, outdated technological facilities may limit the widespread application of microlearning. Unstable network bandwidth or device incompatibility may lead to issues such as lag or loading delays when students use microlearning platforms, affecting the learning experience. While many microlearning platforms have emerged on the market, the quality and functionality of these platforms vary greatly. Some platforms may have overly simplified course content or lack interactivity, making it difficult to meet the diverse learning needs of students. Data security on these platforms is also a major concern. As vast amounts of data are collected and analyzed during the learning process, ensuring students' privacy and data security, while preventing data leaks and misuse, is an urgent issue that needs to be addressed. To address these challenges, educational institutions should increase investment in technology, improve the stability and security of platforms, and enhance platform functionality to ensure that they can meet the personalized learning needs of different students, thus providing stronger support for the sustainable development of microlearning.

6.2 Addressing the Differentiated Needs of Students

Microlearning, as a flexible and efficient learning model, holds great potential, but addressing the differentiated needs of students remains a challenge that requires urgent attention. Each student has different learning foundations, interests, learning pace, and styles, and microlearning needs to fully meet these diverse needs to improve its learning effectiveness. Currently, many microlearning platforms focus too much on general applicability and lack personalized adjustments for different learners. Students with weaker learning foundations may need more review and consolidation, while students with stronger learning abilities may seek more challenging tasks and in-depth content. Additionally, some students have different learning preferences and receptivity; some may prefer text-based learning, while others may prefer visual or video-based formats. Providing personalized learning paths to optimize students' learning experiences is a major challenge for microlearning. To effectively address these differentiated needs, educators should integrate big data and artificial intelligence technologies to establish personalized learning profiles for students, adjusting learning content and pace in real time through data analysis to ensure that each student maximizes knowledge absorption and skill development in the microlearning process. Personalized teaching not only enhances learning efficiency but also boosts students' motivation and sense of achievement.

6.3 Future Directions and Improvement Suggestions

With the continuous development of technology and changes in educational demands, microlearning is expected to have even greater prospects in the future. Future microlearning will place more emphasis on the deep integration of artificial intelligence and big data, using intelligent analysis technologies to help educational platforms track students' learning progress, understanding levels, and emotional feedback in real time, thus providing more accurate personalized learning recommendations. Virtual reality (VR) and augmented reality (AR) technologies will offer a more immersive learning experience, allowing students to engage in

interactive operations within virtual environments, intuitively understanding complex concepts (Kohnke, 2023). This will be particularly beneficial in fields such as experimentation and artistic creation, where the integration of these technologies will further enhance the effectiveness of microlearning. The content design of microlearning should also become more diversified, not limited to textbook knowledge, but incorporating more real-world cases, interdisciplinary content, and innovation training to promote the holistic development of students' abilities. In terms of platforms, future microlearning should enhance cross-platform compatibility to ensure smooth operation across different devices, while ensuring data security and privacy protection. Educational institutions and educators should also innovate microlearning teaching models, continually optimizing the integration of classroom and online learning, and promoting the widespread adoption of "blended learning," further expanding the boundaries of learning methods. In summary, the future development of microlearning will rely on technological innovation and changes in educational needs, continuously driving educational model transformation and the diversification of student learning methods.

7. Conclusion

As an innovative learning model, microlearning has demonstrated significant advantages in improving students' academic performance. Through concise learning content and personalized learning path design, microlearning not only effectively enhances students' learning efficiency but also increases their interest in active learning, promoting a deeper and broader mastery of knowledge. With microlearning, students are able to efficiently grasp key knowledge in a short period of time, while also choosing appropriate learning content based on their individual needs, thereby enhancing the personalization and autonomy of their learning. Moreover, microlearning provides immediate feedback, helping students identify and correct errors in real time, further consolidating their knowledge mastery. However, microlearning still faces challenges in its application, including insufficient technical support, platform functionality differences, and the need to address differentiated student demands, which limit its widespread adoption. In the future, microlearning will enhance its teaching effectiveness and expand its scope of application through the further integration of artificial intelligence, big data, and virtual reality technologies, increasing interactivity and immersion in the learning process. To realize its full potential, educators must continuously improve instructional design and platform functionality to meet the diverse learning needs of students, driving continuous innovation and progress in educational models. At the same time, educators and technology developers should collaborate to enhance the stability and security of microlearning platforms, ensuring accurate resource delivery and the protection of student data, thereby promoting the sustainable development of microlearning.

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Conflict of Interest Statement
The authors declare that there is no conflict of interest regarding the publication of this study.

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