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EKSPLORASI PEMAHAMAN KONSEPTUAL MAHASISWA FISIKA: PEMBELAJARAN LANGSUNG VS. SISTEM MANAJEMEN PEMBELAJARAN PLATFORM

Exploration of Physics Students' Conceptual Comprehension: Live Learning vs. Platform Learning Management Systems

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Abstract

This study aims to explore and compare physics students' conceptual understanding between direct learning and learning through a Learning Management System (LMS) platform. The significance of this research lies in its effort to provide insights into the effectiveness of both learning methods in the context of physics education, which can contribute to the development of more effective curricula and teaching strategies. The methodology employed was a quantitative survey involving 104 physics students from Makassar State of University. Data were collected through questionnaires designed to measure conceptual understanding, information retention, and levels of learning satisfaction. Statistical analyses were conducted to evaluate the differences between the two learning groups. Reseach findings show that the direct learning group achieved an average conceptual understanding score of 87.15 compared to 73.93 in the LMS group, while the LMS group scored higher in information retention (73.83 vs. 68.00). The limitations of this study include a sample limited to physics students from a few universities in Indonesia and the lack of consideration for factors such as variation in course design and interactions with instructors. The practical implications of this research highlight the importance of balancing direct learning and the use of LMS in designing physics education curricula. The combination of these two methods can maximize conceptual understanding and information retention, as well as enhance students' learning satisfaction.

Abstrak

Penelitian ini bertujuan untuk mengeksplorasi dan membandingkan pemahaman konseptual mahasiswa fisika antara pembelajaran langsung dan pembelajaran melalui platform Learning Management System (LMS). Pentingnya penelitian ini terletak pada upayanya untuk memberikan wawasan tentang efektivitas kedua metode pembelajaran dalam konteks pendidikan fisika, yang dapat berkontribusi pada pengembangan kurikulum dan strategi pengajaran yang lebih efektif. Metodologi yang digunakan adalah survei kuantitatif yang melibatkan 104 mahasiswa fisika dari Universitas Negeri Makassar. Data dikumpulkan melalui kuesioner yang dirancang untuk mengukur pemahaman konseptual, retensi informasi, dan tingkat kepuasan belajar. Analisis statistik dilakukan untuk mengevaluasi perbedaan antara kedua kelompok belajar. Temuan penelitian menunjukkan bahwa kelompok pembelajaran langsung mencapai skor pemahaman konseptual rata-rata 87,15 dibandingkan dengan 73,93 pada kelompok LMS, sedangkan kelompok LMS mendapat skor lebih tinggi dalam retensi informasi (73,83 vs. 68,00. Keterbatasan penelitian ini termasuk sampel yang terbatas pada mahasiswa fisika dari beberapa universitas di Indonesia dan kurangnya pertimbangan terhadap faktor-faktor seperti variasi desain mata kuliah dan interaksi dengan instruktur. Implikasi praktis dari penelitian ini menyoroti pentingnya menyeimbangkan pembelajaran langsung dan penggunaan LMS dalam merancang kurikulum pendidikan fisika. Kombinasi kedua metode ini dapat memaksimalkan pemahaman konseptual dan retensi informasi, serta meningkatkan kepuasan belajar siswa.

I. INTRODUCTION

The rapid advancement of technology has profoundly reshaped many aspects of modern society, and education is no exception. The integration of technological innovation into teaching and learning practices has been one of the most significant transformations of the twenty-first century. In particular, the rise of digital platforms has provided new opportunities for instructors and students to engage with knowledge in ways that were previously unimaginable. One of the most notable examples of this transformation is the growing implementation of Learning Management Systems (LMS) as complements or alternatives to traditional face-to-face instruction. It has been proven that blended learning models can strengthen students' abilities such as scientific literacy (Aris et al., 2025). The COVID-19 pandemic further accelerated the adoption of online learning systems worldwide, making the debate about their effectiveness particularly timely and relevant. However, despite their popularity, questions remain about how these systems impact learning outcomes, especially in demanding disciplines such as physics, where conceptual understanding is foundational to academic success.

Physics education is well recognized as a field that presents unique and often daunting challenges. Students are not only expected to memorize formulas and factual information but also to develop the ability to think conceptually and abstractly about phenomena governed by the laws of physics. A strong conceptual foundation is critical because it enables students to connect theoretical principles to real-world contexts, solve complex problems, and engage in scientific reasoning (Gjerde et al., 2021; Harlow et al., 2020). The ability to move beyond rote memorization toward deep comprehension is what ultimately distinguishes successful learners in physics. Moreover, such understanding contributes to the cultivation of transferable skills such as critical thinking, creativity, and analytical reasoning that remain highly valuable across diverse professional domains (Simeon et al., 2022; Geller et al., 2019). Therefore, the methods educators employ to teach physics play a central role in determining how effectively students can internalize and apply key ideas.

Traditional classroom instruction, often termed direct learning or face-to-face teaching, has historically been the dominant mode of education. This method emphasizes the interpersonal interaction between instructors and students in real time, allowing immediate feedback, guided practice, and the dynamic exchange of ideas. In physics classrooms, these interactions can be particularly beneficial, as they allow teachers to detect misconceptions quickly, provide clarifications, and adapt explanations to students' levels of understanding. Several studies have highlighted the effectiveness of direct instruction in promoting conceptual learning because it provides structure and ensures that students can progress step by step through complex material (Dignath & Veenman, 2021; Aderibigbe, 2021). Additionally, collaborative activities in traditional classrooms such as group experiments, discussions, and peer-to-peer learning support the active construction of knowledge and strengthen motivation (Cavinato et al., 2021).

Nevertheless, direct learning is not without its limitations. Fixed schedules, geographic constraints, and the need for physical presence can restrict accessibility for certain groups of learners. In a world where flexibility has become increasingly valued, these restrictions may pose barriers for students with family commitments, part-time jobs, or those living in remote areas. Furthermore, the rapid growth of information technology has provided learners with new preferences and expectations, making it necessary to rethink whether traditional methods alone can effectively respond to twenty-first-century educational demands.

This context has led to the widespread adoption of LMS-based learning, which has been promoted as a more flexible and adaptive alternative. LMS platforms allow instructors to organize materials systematically, track student progress, and incorporate multimedia resources such as simulations, videos, and interactive quizzes. This flexibility enables learners to engage with educational content at their own pace, revisiting materials as needed, and thereby fostering self-regulated learning (Martins et al., 2019; Zabolotniaia et al., 2020; Bansah & Darko Agyei, 2022). Moreover, the inclusion of diverse media formats helps accommodate a variety of learning styles, increasing accessibility for students who may struggle with conventional lectures (Downer et al., 2021). From the perspective of instructors, LMS also facilitates efficient task management, assessment, and feedback provision, as assignments and quizzes can be automatically graded or monitored for progress (Sáiz-Manzanares et al., 2021; Zhang et al., 2020).

Despite these advantages, LMS-based learning also presents notable challenges. One of the most frequently cited drawbacks is the lack of immediate interaction between instructors and students. Unlike direct learning, where questions can be asked and answered on the spot, online environments may delay clarification and reduce opportunities for spontaneous discussions. This limitation can be especially problematic in physics education, where complex and abstract concepts often require repeated explanation and guided problem solving. Furthermore, the effectiveness of LMS depends heavily on students' self-discipline and intrinsic motivation. Without these qualities, learners may become disengaged, leading to procrastination, incomplete tasks, and ultimately poorer outcomes. Previous research has shown that even though LMS enhances flexibility, not all students are equally capable of managing their learning independently (Alamri et al., 2020; Yan et al., 2021). This raises questions about whether LMS-based instruction can fully substitute traditional methods, particularly in contexts that demand deep conceptual engagement.

The contrasting strengths and weaknesses of direct learning and LMS platforms point to an important research gap. While numerous studies have investigated the effectiveness of either direct instruction or LMS individually, few have conducted a direct comparison of the two methods in the specific context of physics education. For instance, prior research has often focused on isolated outcomes such as improved flexibility, efficiency, or engagement with LMS (Ahmed & Opoku, 2022; Bizami et al., 2023) or on the benefits of face-to-face interaction in traditional classrooms (Bernard et al., 2019; Yang & Lu, 2021). However, comprehensive comparative analyses that examine conceptual understanding, information retention, and learning satisfaction simultaneously within the same sample remain scarce. This gap limits educators' ability to make evidence-based decisions when designing curricula that combine traditional and digital elements.

The novelty of the present study lies in its integrated approach to evaluating both instructional methods within a single research design. By comparing physics students' conceptual understanding, information retention, and satisfaction across direct learning and LMS-based environments, this research provides a holistic assessment of how these two approaches perform relative to each other. This is particularly significant because physics, as a discipline, relies heavily on conceptual depth and problem-solving abilities that may be influenced differently by varied instructional contexts. Previous research has tended to isolate variables or treat outcomes in fragmented ways, but this study acknowledges that effective learning is multi-dimensional and interconnected.

The contributions of this research can be understood from both theoretical and practical perspectives. Theoretically, it advances the understanding of how different instructional modes affect learning in physics by addressing the comparative gap noted above. Practically, the findings offer valuable guidance for educators and policymakers. If direct learning is shown to significantly outperform LMS in fostering conceptual understanding, then it may suggest that universities should prioritize classroom-based interactions in physics education while using LMS only as a supplement. Conversely, if LMS proves more effective in retention and satisfaction, it may highlight the need to incorporate online tools more extensively. Most importantly, this study seeks to explore whether a blended learning approach that combines the strengths of both methods may be the most effective solution for twenty-first-century physics education.

The research questions guiding this study are therefore threefold: (1) How do face-to-face and LMS-based learning methods compare in promoting students' conceptual understanding of physics? (2) Which method is more effective in enhancing students' retention of information over time? and (3) How do students perceive and experience these learning environments in terms of satisfaction and motivation? By addressing these questions, the study aims to provide a comprehensive comparison of two instructional methods that continue to shape modern educational practice.

Finally, the broader significance of this study extends beyond physics education alone. The growing integration of digital tools into classrooms worldwide has sparked ongoing debates about the role of technology in learning. This research contributes empirical evidence to these debates, emphasizing not just the convenience and accessibility of online platforms, but also their impact on fundamental learning outcomes. The findings will help ensure that physics curricula and potentially those in other STEM fields remain responsive to the evolving needs of twenty-first-century learners. By highlighting both the potential and the limitations of direct learning and LMS, this study advocates for balanced, evidence-based instructional design that maximizes student achievement, engagement, and satisfaction in the digital era.

II. METHODE

This study uses a quantitative research design with an analytical survey type (Gurbuz, 2017) to compare the conceptual understanding, information retention, and learning satisfaction of physics students between direct teaching methods and learning through LMS platforms. The design of this study was chosen because it allows researchers to objectively evaluate and compare learning outcomes based on numerical data obtained from predetermined instruments. The participants in this study were 104 students of the physics study program from one of the universities in Eastern Indonesia. The participants were selected using simple random sampling to minimize selection bias, and then evenly assigned into two groups of 52 participants each.

The Direct Teaching Group is students who get material face-to-face with conventional teaching methods that involve direct lectures by lecturers. while the LMS Group is students who participate in online learning through the LMS platform, where material is presented in the form of modules, videos, quizzes, and virtual discussions. Before the learning activities began, both groups were given a pre-test to measure their initial understanding of relevant physics concepts. After learning for several weeks, a final test (post-test) was given to both groups to assess the extent to which conceptual understanding improved after the learning process. In addition, a learning satisfaction questionnaire was filled out by participants to measure their level of satisfaction with the learning methods applied (Almusharraf & Khahro, 2020).

This study uses several instruments to collect data. The Conceptual Comprehension Test contains questions designed to measure participants' understanding of core concepts in physics (Stoen et al., 2020). Tests are given in the form of pre-test and post-test to assess the development of student understanding (González-Alonso et al., 2020). Information Retention Surveys conducted in the form of follow-up tests to measure the extent to which participants are able to retain the information they have learned (Ahn et al., 2019). The Learning Satisfaction Questionnaire is used to determine the perception and level of student satisfaction with the learning process, both through direct teaching and LMS (Diep et al., 2017; Yuen et al., 2019). The Likert Scale is used to measure satisfaction with a range of 1 (very dissatisfied) to 5 (very satisfied) (Braunsberger & Gates, 2009). The instruments used in this study were validated by expert judgment to ensure content validity. The reliability test showed a Cronbach's Alpha value of 0.82 for the Conceptual Comprehension Test and 0.85 for the Learning Satisfaction Questionnaire, indicating high internal consistency.

The data obtained from the test and survey were analyzed using several statistical techniques. The Independent t-test (Kim, 2015) was used to find out if there was a significant difference in conceptual comprehension and information retention between the group receiving hands-on instruction and the group learning through the LMS. This t-test was also carried out to compare the results of the pre-test and post-test of each group. Descriptive analysis was used to describe the distribution of data, such as mean, and percentage, to provide an overview of participants' understanding and satisfaction.

III. RESULT AND DISCUSSION

Understanding Concepts

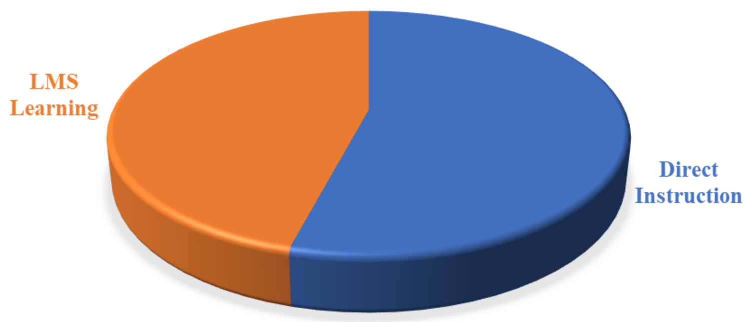

Figure 1. Comparison of Students' Conceptual Understanding Scores between Direct Learning and LMS

The findings of the conceptual understanding assessment suggest that students who engaged in direct, face-to-face instruction exhibited a higher average performance compared to those who learned through a LMS platform. The average conceptual understanding score for the direct learning group was 87.15, while for the LMS group it was 73.93. An independent t-test showed a p-value of 0.001, suggesting that this difference is statistically significant. This finding implies that traditional, in-person instruction is generally more effective in enhancing physics students' conceptual understanding compared to learning through a digital platform. The direct interaction and immediate feedback provided by face-to-face teaching appears to better facilitate the development of deep conceptual knowledge among physics students, rather than relying solely on a digital LMS.

Information Retention

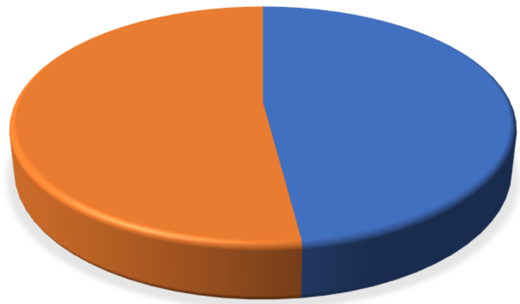

Figure 2. Comparison of Information Retention Scores between Direct Learning and LMS

The results indicate that students who learned through the LMS demonstrated better information retention, with an average score of 73.83 on the assessment compared to 68.00 for the students in the direct learning group. This suggests that the LMS was more effective in helping students retain the information and concepts they had learned over the course of the study. Independent t-test analysis also showed a significant p-value of 0.001, suggesting that the LMS was more effective in helping students retain the information and concepts they had learned over the course of the study compared to the direct learning approach. The statistical significance indicates that the difference in performance between the LMS and direct learning groups was unlikely to have occurred by chance, further supporting the conclusion that the LMS was more effective in facilitating student learning and knowledge retention.

Learning Satisfaction

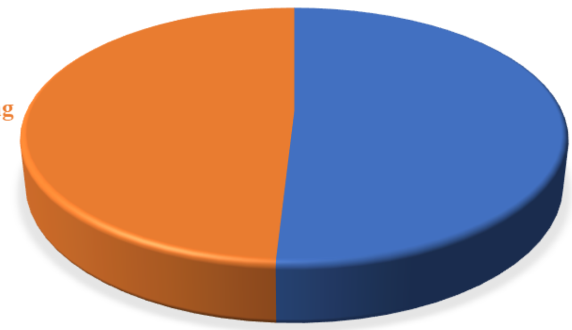

Figure 3. Comparison of Learning Satisfaction Levels between Direct Learning and LMS

The survey on learning satisfaction revealed that students who engaged in direct learning reported higher satisfaction with their learning approach compared to the group learning through the LMS. The direct learning group appreciated the personal interaction and immediate feedback from the instructor, while the LMS learning group felt the online platform was less engaging and limited their ability to ask questions in real-time. The average satisfaction score for the direct learning group was 82.48 out of 100, indicating a high level of satisfaction with the personal interaction and immediate feedback from the instructor. In contrast, the average satisfaction score for the LMS learning group was 79.56 out of 100, suggesting that the online platform was perceived as less engaging and limited the students' ability to ask questions in real-time.

The Effectiveness of Direct Learning in Concept Understanding

Physics learning requires a deep understanding of often abstract and complex concepts (Bao & Koenig, 2019). The direct instruction method is a frequently used approach in physics classrooms (Good et al., 2019). Direct instruction involves the clear and systematic delivery of information by the teacher, often through lectures or demonstrations, followed by guided practice and assessment (de Jong et al., 2024). This teaching approach can be highly effective in helping students comprehend physics concepts by providing a structured learning environment and focusing on the clear communication of key principles and theories. The direct instruction method allows instructors to control the pace of learning, ensuring that students have sufficient time to grasp each concept before progressing to the next (Bernard et al., 2019). Guided practice and immediate feedback further reinforce student understanding and help correct any misconceptions (Yang & Lu, 2021). While this method may be less interactive compared to other approaches, it can be particularly beneficial for physics learning, which often requires a solid foundation in core concepts and principles.

Direct instruction allows lecturers to convey physics concepts in a clear and structured manner, reducing the likelihood of misunderstandings (La Braca & Kalman, 2021; Wang, 2020). By controlling the pace of learning, instructors can ensure that students have sufficient time to thoroughly grasp each concept before progressing to the next. This method helps students focus on specific learning objectives and minimizes the distractions that may occur in more open-ended learning approaches (Alfadil et al., 2020). The provision of guided practice and immediate feedback aids in reinforcing student understanding and promptly correcting any errors or misconceptions they may have, further solidifying their comprehension of the material.

While direct instruction has significant benefits in clearly conveying physics concepts and providing a structured learning environment, it tends to be less interactive compared to other teaching methods, such as project-based learning or group discussions. This reduced interactivity can potentially limit student engagement, as learners may find the format and pace of direct instruction challenging, particularly for those with diverse learning styles. Moreover, this method may be less effective in fostering critical thinking and creativity, as it places more emphasis on the acquisition of information rather than independent exploration and problem-solving. To address these limitations, a combination of direct instruction with more interactive and student-centered approaches, such as incorporating hands-on activities, collaborative learning, and opportunities for self-directed inquiry, can provide a more well-rounded and effective approach to physics education (Debs et al., 2019).

Direct instruction offers significant advantages in terms of clear concept delivery and structured learning, which can be highly effective in helping students comprehend physics concepts (Schalk et al., 2019). Nonetheless, challenges such as limited interactivity and variations in student learning styles must be addressed to maximize the effectiveness of this method. This hybrid approach (Bayoudh, 2024) can help foster critical thinking, creativity, and deeper engagement among students, while still leveraging the strengths of direct instruction in conveying key concepts and principle (Sliwka et al., 2024). By blending these complementary teaching strategies, instructors can create a more dynamic and inclusive learning environment that caters to the diverse needs and learning preferences of physics students (Bustamante et al., 2024). LMS Effectiveness in Information Retention.

LMS are digital platforms widely used in educational and training settings to plan, implement, and assess learning processes (Annamalai et al., 2021; Cabero-Almenara et al., 2019). These platforms provide a wide range of learning tools, including course modules, discussion forums, online quizzes, and a variety of other learning materials (Díaz Redondo et al., 2021; Kumar et al., 2021). The effectiveness of LMS in facilitating information retention is an important topic, as it directly impacts the success of the learning process in both formal educational settings and professional training environments (Anthony et al., 2019; Müller & Wulf, 2020). LMS often offer interactive content such as videos, simulations, and educational games (Kerimbayev et al., 2020) that can make the learning experience more engaging and help strengthen information retention. Periodic quizzes, tests, and assignments administered through LMS help measure student understanding and provide immediate feedback (Duin & Tham, 2020), further reinforcing students' recall of the material. Additionally, LMS enable students to access learning materials anytime and anywhere, allowing for easier repetition and review of the content (Shchedrina et al., 2021), which can enhance information retention. Interactions with peers and instructors through discussion forums and collaborative projects facilitated by LMS help strengthen comprehension and information retention through the exchange of ideas and concept clarification.

LMS allow for personalization of learning content according to the individual needs and learning pace of students (Cardenas et al., 2022), which can enhance information retention and comprehension. With a variety of interactive tools, LMS encourage active learning (Raharjo et al., 2021) that can help students become more engaged and better remember the information being presented. LMS provide direct and timely feedback through automated assessments and instructor comments (Deeva et al., 2021), helping students promptly correct any mistakes and reinforce their understanding of the concepts. The integration of multimedia elements, such as video, audio, and text, in LMS caters to diverse learning styles (Villegas-Ch et al., 2024), increasing the likelihood of successful information retention and conceptual understanding. However, uneven internet access and hardware limitations can pose challenges for some students in fully utilizing the benefits offered by LMS. Additionally, LMS require a high level of self-motivation from students as much of the learning often occurs independently without direct instructor supervision. If the LMS content is not well-designed and engaging, students may feel bored and disinterested, which can negatively impact their information retention and overall learning outcomes. These findings are consistent with Dessie at al (2023), who also reported that direct instruction enhances conceptual understanding in physics. However, in contrast with Alzahrani & Seth (2021), this study found higher satisfaction in direct learning rather than LMS, indicating contextual factors such as cultural learning preferences

Learning Satisfaction

In direct physics learning, students tend to feel more engaged and supported due to the direct interaction with lecturers and classmates (Rosen & Kelly, 2022). Questions can be answered in real-time, and class discussions can deepen understanding (Tissenbaum & Slotta, 2019). Interactions through LMS may be less spontaneous, but discussion forums and collaborative features can provide a space for questions and clarification. Students can also learn from questions and answers posted by others.

The flexibility and accessibility of direct learning is limited to specific schedules and locations, which may not always be convenient for all students (Valtonen et al., 2021). In LMS, the flexibility to access materials anytime and anywhere is a significant advantage, allowing students to learn at their own pace and on their own schedule. In direct learning, course materials are delivered directly by lecturers, who can use various methods such as lectures, demonstrations, and discussions to explain concepts (Han & Klein, 2019; Valtonen et al., 2021). These interactive teaching methods can help students better understand and retain the information. In LMS, materials can be presented in various engaging multimedia formats, such as videos, simulations, and animations, which can also aid in the understanding of complex physics concepts by providing visual and interactive learning experiences.

Feedback and assessment in direct learning can be provided directly in the classroom or through manually graded assignments and exams. This allows for immediate feedback and the opportunity for students to address any misconceptions or gaps in their understanding. In LMS, assessment can be conducted automatically through online quizzes, providing immediate feedback. However, feedback on more complex assignments may take longer, as the instructor may need to review and grade the work manually. Students' learning satisfaction with direct learning and LMS-based learning in understanding physics problems depends on various factors, such as interaction, flexibility, material quality, and feedback. Direct learning offers advantages in terms of direct interaction and support, while LMS provides high flexibility and accessibility, as well as the use of multimedia to aid the understanding of complex concepts.

A hybrid approach that combines the strengths of both methods can be the best solution (Alhusban, 2022), allowing students to enjoy direct interaction and support in the classroom while taking advantage of the flexibility and resources offered by LMS. Integrating these two methods can enhance students' learning satisfaction and deepen their understanding of physics concepts.

IV. CONCLUSION

The conclusion of this study emphasizes that both direct physics learning and LMS approaches have their respective advantages, which can complement each other. Direct instruction has been found to be effective in providing in-depth conceptual understanding, while LMS excels in facilitating information retention and enhancing learning satisfaction. Therefore, educators and educational institutions are advised to thoughtfully integrate these two methods to maximize the learning outcomes and overall academic performance of physics students. The limitations of this research include a relatively small sample size and some variation in course design across the study. Further research is needed to explore the optimal ways of effectively combining these two learning methods within a broader physics education curriculum. The findings of this study provide important insights that can inform the development of more effective and adaptive learning strategies to better meet the evolving needs of students in the digital era. Practically, lecturers are encouraged to integrate direct learning sessions for concept explanation and problem-solving, while using LMS for review activities, quizzes, and asynchronous discussions to strengthen retention and student satisfaction.

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