e-ISSN: 2549-5070
p-ISSN: 2549-8231

Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang
Volume 9, No. 1, 2025, pp. 92 - 116

https://doi.org/10.31331/medivesveteran.v9i1.3350

Engaging e-Learning in Higher Education: An Empirical Student Engagement Model for LMS-Mediated e-Tutorials

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Received: *July 2024.* ***Accepted***: *September 2024.* ***Published***: *May 2025.*

ABSTRACT

This study focused on developing an empirical student engagement model tailored to LMS-mediated higher education tutorials. As part of a larger initiative to create innovative learning strategies for first-year students. The research aimed to bridge the gap between prior knowledge and higher education demands using LMS-mediated tutorials. Despite the widespread adoption of Learning Management Systems (LMS) in delivering online tutorials, student engagement remains a significant challenge. In this article, which uses parts of the author's doctoral study, developing a Trigonometry module consisting of course content in the form of resources and tasks was used to identify key determinants of student engagement in LMS-mediated e-tutorials. A mixed-method research approach with a reflexive self-study research design was used. 129 first-year university student volunteers were used to test the tutorial through 4 development cycles. Through an empirical qualitative approach, questionnaires, interviews, direct observations, screen capture videos and student work samples were used as data collection methods. *The final e-tutorial was achieved through a progression from cycle to cycle, which involved the following significant changes: Cycle 1: Model theory oriented. Resources were seen as the core of the learning process. From Cycle 1 to Cycle 2: Quizlets were introduced as a motivating element. From Cycle2 to Cycle3: A learning model change from theory-oriented to problem-oriented with adaptive rehearsing and exploring content. Quizlets became the core of the learning process. From Cycle 3 to Cycle 4: Conditional release was introduced as a regulating element. The research highlights critical issues in current e-tutorial designs and proposes actionable improvements. The findings underscore the importance of addressing both cognitive and behavioural engagement strategies to enhance e-learning experiences and outcomes. This research offers valuable insights for educators and institutions seeking to foster deeper student engagement and improve the effectiveness of e-learning environments. The significance of this study lies in its potential to enhance the quality of e-learning by providing lecturers, educators and instruction designers with actionable insights into fostering deeper student engagement. The findings of this study also provide a blueprint for enhancing student engagement through well-structured, adaptive, and technology-mediated learning processes. The proposed engagement model can be applied to various fields, making the study's implications widely relevant for improving e-learning environments in higher education.*

Keywords: *Engaging e-Learning, Higher Education, Student Engagement, Learning Management System (LMS), LMS-mediated e-Tutorials, Empirical Study, Engagement Model*

How to Cite: Kigundu, S. (2025). Engaging e-Learning in Higher Education: An Empirical Student Engagement Model for LMS-Mediated e-Tutorials. *Journal Of Medives : Journal Of Mathematics Education IKIP Veteran Semarang, 9*(1).

INTRODUCTION

This study was part of a larger project in developing innovative learning intervention strategies to assist under-prepared first-year students in bridging the gap between their prior knowledge and the demands of higher education. In recent years, there has been a growing emphasis on using Learning Management Systems to deliver online tutorials. In the evolving landscape of higher education, e-learning platforms have become pivotal in enriching the academic experience. Despite the widespread adoption of Learning Management Systems (LMS) in higher education, student engagement remains a persistent challenge (Bond et al., 2020).; this study develops an empirical student engagement model for LMS-mediated tutorials, providing actionable strategies to enhance cognitive and behavioural engagement to improve e-learning outcomes for under-prepared first-year students.

The significance of this study lies in its potential to enhance the quality of e-learning by providing educators and administrators with actionable insights into fostering deeper student engagement. Existing literature has established a positive correlation between student engagement and academic performance, retention rates, and overall student satisfaction (Henrie et al., 2022). However, the dynamic and often impersonal nature of e-learning environments necessitates re-evaluating traditional engagement strategies to suit the digital context (Martin & Bolliger, 2018).

PROBLEM STATEMENT

Despite the widespread adoption of Learning Management Systems (LMS) in higher education, student engagement in e-Learning environments remains a significant challenge (Essel et al., 2024; Mushtariybonu, 2024; Chatterjee, 2024). Sometimes, students struggle to stay motivated and actively participate in online tutorials, leading to suboptimal learning outcomes (Hollister et al., 2022). Moreover, existing engagement models often fail to address the unique dynamics of LMS-mediated tutorials (Shatri et al., 2021). Therefore, there is a critical need to develop an empirically validated student engagement model tailored specifically for LMS-mediated tutorials to enhance the overall effectiveness of e-learning in higher education.

RESEARCH QUESTIONS

This study aimed to investigate the key determinants of student engagement in LMS-mediated e-tutorials for first-year students in higher education. Specifically, it seeks to explore how these determinants can be integrated into an empirically validated Student Engagement Model designed to enhance e-learning outcomes by bridging the gap between students' prior knowledge and the academic demands of higher education. The following questions guided this study:

1. What are the key determinants of student engagement in LMS-mediated e-tutorials?
2. How can these determinants be effectively integrated into a comprehensive Student Engagement Model?

The answers to these questions address the gap in existing models by focusing on the unique dynamics of e-learning and aim to create an empirically validated model that improves cognitive and behavioural engagement in the context of Learning Management Systems.

LITERATURE REVIEW

As e-learning gains momentum in South African higher education, previous studies have predominantly focused on teaching material development while adopting Learning Management System (LMS) tools to mediate students' engagement in learning remains under-researched (Meyer & Norman, 2019). This study explored and documented the student engagement model for developing LMS-mediated tutorials to address this gap. Building on the literature, this study examined key strategies to support the investigation of LMS-mediated tutorial design and development, incorporating insights from conventional student engagement models, key elements of student engagement models, issues associated with implementing student engagement models and how to address challenges and adopting best practices.

Current instructional design trends (influenced by technology advances in social media, cloud-based services, big data and information processing) suggest the focus of instruction not just on learning outcomes but also on the student's overall experience (Alqahtani & Rajkhan, 2020; Gibson & Ifenthaler, 2016). This suggests that technology should be used to encourage students to spend time on content engagement, enhance critical appraisal and literature review, and encourage ongoing learning (Green et al., 2024). To achieve this objective, the conceptualisation and design of e-learning environments need to be driven by principles of sound pedagogical practice. Thus, e-learning integration into the educational process has emphasised the following learning approaches: Behaviourism, Cognitivism, Connectivism, and Constructivism (Moore & Anderson, 2023).

CONVENTIONAL STUDENT ENGAGEMENT MODELS

The literature review highlights several conventional models of student engagement, primarily categorised into cognitive, affective, and behavioural dimensions, which are crucial in understanding how students interact with learning materials, instructors, and peers within e-learning environments. Here, I will discuss the current models, debates, and issues related to student engagement derived from the literature review.

Cognitive engagement involves investing mental effort and strategies to understand complex ideas and master difficult skills, emphasising deep learning, critical thinking, and problem-solving (Fredricks et al., 2019). Measurement challenges and balancing depth and breadth are key issues here (Henrie et al., 2022). Affective engagement refers to emotional responses to learning activities, significantly impacting motivation and learning outcomes (Trowler & Trowler, 2020; Quaye, 2020). However, maintaining consistent affective engagement is difficult due to emotional variability and external influences (Linnenbrink-Garcia et al., 2019). Behavioural engagement involves participation in academic activities, serving as an observable indicator of overall engagement levels. However, distinguishing between surface and deep engagement and the impact of technology on traditional engagement models present challenges (Reeve & Tseng, 2021). These engagement models provide a comprehensive framework for understanding and enhancing student interaction with learning materials. However, debates and issues remain regarding their

measurement, balance, and integration within e-learning environments (Zepke, 2021). Ongoing research and adaptation are necessary to address these challenges and optimise student engagement as technology evolves (Bond et al., 2020).

KEY ELEMENTS OF A STUDENT ENGAGEMENT MODEL FOR LMS-MEDIATED E-TUTORIALS

Key elements of a student engagement model for LMS-mediated e-tutorials include enhancing student engagement, utilising technological tools, implementing blended learning approaches, and incorporating gamification and interactive elements. These are crucial for enhancing the effectiveness of e-learning environments, as discussed below.

1. Enhancing Student Engagement

Student engagement is a critical factor for the success of e-learning environments. Engaged students are more likely to participate actively, retain information, and achieve better learning outcomes. Several studies emphasise the importance of tracking and enhancing student engagement in technology-mediated learning environments (Nakamura et al., 2024). Interactive elements, such as discussion forums, quizzes, and collaborative projects, play a crucial role in maintaining student interest. Real-time feedback mechanisms, such as automated grading and instant feedback on assignments, further support engagement by providing students with immediate insights into their performance (Chen et al., 2010)

Active participation opportunities are also vital. Strategies like peer reviews, group projects, and live webinars encourage students to engage deeply with the content and with each other. Such interactive learning approaches not only enhance engagement but also foster a sense of community among learners, which is often lacking in online environments (Lin & Nixon, 2024).

2. Utilising Technological Tools and Platforms

The choice of technological tools and platforms is crucial in creating effective e-learning environments. Advanced Learning Management Systems (LMS) and innovative e-learning software can support various learning activities and seamlessly integrate with other educational resources. Criteria for selecting these tools include user-friendliness, adaptability, and the ability to support diverse learning needs (Gaviria et al., 2024).

Successful integration of technological tools can significantly enhance the learning experience. For example, integrating multimedia resources, such as video lectures, interactive simulations, and digital textbooks, can cater to different learning styles and make the content more engaging (Al-Okaily et al., 2024). Moreover, tracking and analysing student performance through these platforms allows educators to tailor their teaching strategies to meet individual needs (Kirkwood & Price, 2014).

3. Implementing Blended Learning Approaches

Blended learning, which combines traditional in-person and online learning methods, has gained popularity as a flexible and comprehensive approach to education. This model leverages the strengths of both modalities, offering students the flexibility of online learning while

retaining the benefits of face-to-face interactions (Sareen & Mandal, 2024).

Research supports the effectiveness of blended learning approaches, showing improved engagement and learning outcomes compared to traditional or fully online models (Nikolopoulou & Zacharis, 2023). Blended learning provides students with the flexibility to learn at their own pace while also benefiting from the structured environment of a traditional classroom. This hybrid approach can accommodate diverse learning preferences and enhance overall student satisfaction (Bhadri & Patil, 2022; Müller & Mildenberger, 2021).

4. Incorporating Gamification and Interactive Elements

Gamification, or the use of game-like elements in educational contexts, has been shown to significantly boost student motivation and engagement. Techniques such as leaderboards, badges, and interactive simulations make learning more engaging and enjoyable (Ab Ghani et al., 2022).

Studies have demonstrated that gamification can lead to higher levels of participation and motivation among students (Park & Doo, 2024). For instance, the use of leaderboards can create a sense of competition and achievement, encouraging students to engage more deeply with the material. However, it is important to balance gamification elements to avoid potential drawbacks, such as increased stress or unhealthy competition (Ab Ghani et al., 2022).

Engagement Issues Associated with the Implementation of LMS-Mediated e-Tutorials

The adoption of Learning Management Systems (LMS) for e-tutorials in higher education has surged, particularly during the COVID-19 pandemic. While LMS-mediated e-tutorials offer numerous benefits, including flexibility and accessibility, they also present several challenges that can hinder student engagement. These challenges range from integration difficulties and technological barriers to maintaining student motivation and effective interaction. This literature review explores these issues to provide a comprehensive understanding of the obstacles associated with LMS-mediated e-tutorials. Addressing these challenges is crucial for developing a more effective and engaging e-learning environment.

1. Integration Challenges

One significant issue is the difficulty instructors face in integrating LMS services into their teaching practices. Many educators lack the technical skills necessary to effectively use LMS features, which can lead to inconsistent usage and diminished student engagement (Palve & Palve, 2023). Furthermore, resistance to change among faculty members and insufficient training exacerbate these problems. The complexity of some LMS platforms can also be a barrier to effective implementation (Antwi-Boampong, 2021). These integration challenges can significantly impact the effectiveness of LMS-mediated e-tutorials.

2. Course Satisfaction and Engagement

Student engagement is a critical factor in determining course satisfaction in online learning environments. Various factors, including the quality of content, levels of interaction, feedback mechanisms, and technological issues, can influence this relationship. Low levels of interaction between students and instructors can reduce engagement,

while timely and constructive feedback is essential for maintaining student satisfaction. Additionally, technical problems such as connectivity issues can disrupt the learning experience, further diminishing engagement (Baloran & Hernan, 2021). Therefore, addressing these factors is vital for enhancing student engagement and satisfaction in LMS-mediated e-tutorials.

3. Engagement Metrics and Data Analytics

Utilising data analytics to measure student engagement presents several challenges, including data privacy concerns and the accuracy of engagement metrics. Ensuring the privacy and security of student data is paramount, as is the correct interpretation of engagement data. Issues with scalability and integrating data from multiple sources also pose significant challenges. Ethical considerations related to monitoring student engagement must also be addressed (Nakamura et al., 2024). Overcoming these challenges is essential for leveraging data analytics to improve student engagement.

4. Persistence and Motivation

Maintaining student persistence and motivation in e-learning environments is crucial for engagement, yet it can be challenging. Students need strong self-regulation skills to stay engaged in online learning. Varying levels of intrinsic and extrinsic motivation among students require effective strategies to keep them motivated. Online learning environments can present more distractions than traditional classrooms, and the lack of adequate support systems can further hinder motivation (Adeshola & Agoyi, 2023). Developing strategies to enhance student persistence and motivation is critical for the success of LMS-mediated e-tutorials.

5. Student-Teacher Interaction

The quality and frequency of interactions between students and teachers are crucial for maintaining engagement in online settings. Online communication can lack the immediacy and personal touch of face-to-face interactions, making it challenging to ensure frequent and meaningful interactions. Providing timely and high-quality feedback and designing interactive activities that promote student-teacher engagement are essential. Effectively using technological tools to facilitate interactions can also help overcome these barriers (Lin & Nixon, 2024). Enhancing student-teacher interaction is vital for improving engagement in LMS-mediated e-tutorials.

6. Technological Barriers

Various technological barriers can impede student engagement in LMS-mediated e-tutorials. Ensuring that all students have access to the necessary technology and internet connectivity is a fundamental challenge. Providing adequate technical support for both students and instructors is essential for addressing technical issues. The usability of LMS platforms and ensuring compatibility with various devices and operating systems are also critical factors. Maintaining the reliability and uptime of LMS platforms is necessary to avoid disruptions to the learning experience (Chen et al., 2010). Addressing these technological barriers is crucial for enhancing student engagement in LMS-mediated e-tutorials.

The challenges associated with the student engagement model for LMS-mediated e-tutorials are multifaceted, involving integration difficulties, technological barriers, and issues related to motivation and

interaction. Addressing these challenges is essential for developing an effective and engaging e-learning environment. By overcoming these obstacles, higher education institutions can enhance the student experience and improve learning outcomes in LMS-mediated e-tutorials.

Addressing Challenges and Adopting Best Practices

The transition to e-learning poses several challenges, including technological barriers, varying levels of digital literacy among students and faculty, and issues related to maintaining engagement in a virtual environment. Identifying and adopting best practices is essential for overcoming these challenges and enhancing the overall learning experience (Lin & Nixon, 2024; Turnbull et al., 2021).

Best practices for effective e-learning implementation include regular training and support for both students and faculty, ensuring access to necessary technological resources, and creating a supportive online learning community. Continuous improvement through feedback is also critical. Collecting and analysing feedback from students and faculty can help identify areas for improvement and inform the development of more effective e-learning strategies (Lin & Nixon, 2024).

In conclusion, a comprehensive model for LMS-mediated e-tutorials can significantly enhance student engagement in higher education. By incorporating key elements such as interactive and real-time feedback mechanisms, utilising advanced technological tools, implementing blended learning approaches, incorporating gamification, and adopting best practices, institutions can create effective and engaging e-learning environments. However, it is important to remember that each learning environment is unique, and what works in one context may not work in another. Therefore, it is crucial to continuously evaluate and adapt these strategies based on the learners' specific needs and the tutorial's dynamics. This model addresses the immediate challenges posed by the shift to online learning and lays the groundwork for a more flexible and resilient use of LMS-mediated tutorials in the future.

The Research Methodology Research Design

This study used the Educational Design Research (EDR) methodology, a systematic and iterative approach (Azmi & Latisma, 2022), allowing for the development and testing of an e-tutorial, which was used as a testbed to investigate design prototypes and generate local theories and design principles. The suitability of the EDR approach for this study was substantiated by the following characteristics of Design research, which resonate with the objectives of this study: interventionist, iterative, process-oriented, utility-oriented, and theory-oriented (Giardina, 2023). The EDR approach involved three distinct phases. Preliminary Phase (prepare for the experiment), the Intervention Phase (test and formatively evaluate in the classroom) and the Evaluation Phase (conduct and document retrospective analyses. The Intervention Phase was the primary source of data. Testing, evaluation-review, and redesign-develop activities were iterated until an appropriate balance between the actual and original intended outcomes was achieved.

This study was centred on developing a local instruction theory (in the form of a student engagement

model) focusing on designing and interpreting learning trajectories, where educational interventions are iteratively refined through empirical cycles of design, implementation, and evaluation(Cárcamo et al., 2019). This approach allowed the testing and refining of the tutorial design over four development cycles with real students, incorporating their feedback and performance data into the evolving model. The theory emphasises adaptive learning, where problem-first approaches engage students in solving tasks before revisiting theoretical content. This shift aligned the learning process more closely with students' natural preferences, where they seek content review only when needed to solve problems. Hence, interactive components like Quizlets were integrated into LMS-mediated tutorials as core learning activities to encourage deeper engagement with mathematical problems.

Data Collection

The aim was to find out how task sequences and student interactions in LMS-mediated e-tutorials can guide student engagement in learning. To achieve this objective, various data collection methods, including screen capture videos, direct observations, questionnaires, interviews, and student work samples, were used. For each modality, raw data was transcribed and presented as a data display matrix. This was followed by a brief discussion of individual elements (that emerged from the data) that gave specific insights into student engagement. For example, in-class observations provided insight into four categories of engagement: student actions, system use, set system answers, and students' experience. Screen-capture video data provided insight into two types of engagement: student actions and system use. Interview responses provided insight into student experience and system use. Journal responses provided insight into three types of engagement: student feeling, system use, and system shortcomings. Student work samples provided insight into two categories of engagement: set-system answers and student errors. Each tool provided a unique lens on student engagement, collectively informing the iterative development of the LMS-mediated e-tutorials and creating the student engagement model.

Sampling Criteria

This study was conducted as a small-scale research project using convenience sampling.

for ease of implementation and cost-effectiveness (Jager et al., 2017) and saved time as the researcher was a tutor for this class. The key disadvantage of this approach was that no claims could be made regarding the representability of the outcomes. However, the aim was not to generalise the findings beyond the sample but to use the sample as a test bed during the design and development of the e-tutorial in response to the main research question. The target population was all the first-year students taking mathematics in the foundation and extended programs in the Faculty of Science, Engineering and Technology (FSET). A total of 129 students (an average of 37 per cycle) participated in the study. An explanatory (guided by the research questions) thematic qualitative analysis was conducted to find the key elements for developing an effective student engagement model for LMS-mediated tutorials.

Results

The Intervention Phase was the

main source of data. However, this paper focuses on the results of the evaluation and review processes across four iterative design cycles of the e-tutorial system. The objective is to reveal critical issues, implemented changes, and their impact on student learning outcomes, engagement, and system usability.

CYCLE 1 Results

Evaluation Process

Evaluation informed the decision process by providing an interim data analysis. The evaluation process involved a contradiction analysis, addressing the inconsistency between original design objectives or conceptions of the e-tutorial and the actual use during testing as the criteria for evaluation. Table 1 summarises the critical issues in the e-tutorial that emerged from the data of the student's interactions with the system. The evidence of these issues in the data and its source(s) are also recorded in the table.

Table 1. Summary of Critical Issues: Cycle 1

Original design	**Issues arising**	**Possible causes**	
Conceptions/objectives	Contradictions	Evidence	Data source
Learning outcome			
1. Performance The target success rate was 80% per activity.	The performance objective of a success rate of 80% per activity was not achieved.	On average, only 7% of correct attempts per activity were achieved	LMS generated data
Learning orientation			
1. Review of resources The purpose of this item was to enable students to learn through a review of the content presented in multimedia resources.	Students did not review resources.	No interaction with multimedia resources	Observation Screen capture video
Learning engagement			
(Design Limitations) 1. Introduction This item aimed to give students an overview of the tutorial.	Students did not review the introduction.	No interaction with the Introduction	Observation Screen-capture
2. Objectives This item presented the topic's content and enabled students to evaluate self-knowledge about the topic.	Students' self-knowledge of what they knew appeared inappropriate.	Students' self-evaluation inaccurate	KWL questionnaire
3. Set-system-answers This is the answer the system checks responses against	Restrictions in set-system-answers; Students consistently get answers that the system identified as incorrect	i) No room for partial credit; Question requires multiple steps but has space for one ii) Required format too constraining iii) No provision for typos iv) No provision for alternative answers	Student responses
System use			
5. Challenges in system use	i) No immediate feedback ii) Students encountered difficulties while using the system	LMS affords feedback only at the end of the activity Novice users found it challenging to use the system, such as: filling the blanks and	LMS generated data Student responses Interview

Original design	**Issues arising**	**Possible causes**	
Conceptions/objectives **Learning outcome**	Contradictions	Evidence correcting mistakes	Data source

(Kigundu, 2023, p. 135)

The evaluation of the e-tutorial system highlighted significant contradictions and critical issues that informed its redesign. The primary contradictions involved the tutorial's objectives, student behaviour, and system tools. Despite the goal of achieving 80% correct attempts, only 7% was achieved due to issues like marking errors and incorrect answer formats. Students often bypassed initial content reviews, attempting tutorial problems first, contrary to the initial design assumptions. The system's tools also fell short, with no allowance for partial credit or typographical errors, and feedback was only given at the end of activities. Secondary contradictions included difficulties students faced using the system, such as filling in blanks and correcting mistakes. The critical issues identified involved low success rates, inadequate student engagement with resources, and system design flaws in sections like introductions, objectives, and system answers. Addressing these issues was crucial for the subsequent design iteration (Cycle 2). Improvements were made to the e-tutorial system before Cycle 2 to resolve these issues. The review process is discussed below.

Review Process

The evaluation of results in Cycle 1 provided reasons for change and development that emerged from each data modality. The review provided the direction for transforming and improving the e-tutorial system. Table 2 shows a summary review process of the critical issues that emerged from the results of Cycle 1.

Table 2. Summary of Cycle 1 Review Process

Issue identified	**Change made**	**Justification**	**Objective**
(And how it was evident in the data)	Action	How it is expected to overcome the issue	What response is it expected to generate
Learning outcome			
Performance: Lack of understanding Very low correct attempts per activity were achieved.	Introduce Quizlets	as rehearsal problems	80% success rate
Learning orientation			
Review of resources Students did not review resources	Introduce Quizlet feedback.	Direct students to review resources and try again.	Students review resources as they work.
Design changes			
1) Introduction item Students did not review the introduction.	Make it an interactive presentation by linking clickable tabs to different presentation sections.	Flexible access to the different pieces of information	Make reading the Introduction interesting. Students spend more time reading.

Issue identified	Change made	Justification	Objective
2) Objectives item Students' self-evaluation inaccurate (KW questionnaire, 6.2.20	Introduce pre-test	Assist students to i) identify knowledge gaps from the results of the pre-test ii) realise that they need to do tutorial	Students make accurate self-evaluations of knowledge about the topic.
3) Set-system-answers (Student responses; 6.2.7.1)			
i) No room for partial credit; Questions require multiple steps but have space for one	Break up answers into smaller sections; a minimum of 3 sections per question.	Create space for multiple steps	System to allow partial credit
ii) No provision for typing errors	Re-format answers	Include all possible answers.	To allow flexibility in marking to cover typos and alternative answers.
iii) No provision for alternative answers	Explore all possibilities		
iv) Required format too constraining	Change question to regular answer format. Add example of required answers	Simplify answer format	To make the answering straightforward
4) Difficulties in using the system (Observation)			
i) Novice users found it difficult to use the system, challenges: filling the blanks and correcting mistakes	Add hints directing students to ask for assistance.	Facilitate students to ask for assistance	To enable the tutor to identify and assist struggling students.
ii) LMS affords feedback only at the end of the activity	Add Quizlets feedback	Immediate feedback	To guide students as they work.

(Kigundu, 2023, p. 138)

The table shows the changes made during the transformation of the tutorial, addressing various issues and implementing new strategies to enhance student learning outcomes, engagement, and orientation. In response to very low correct attempts per activity, rehearsal problems were added as short quizzes to improve understanding. To motivate students to review resources, Quizlet feedback was introduced. The introduction was made interactive for better engagement, and a pre-test was added to help students identify knowledge gaps. The set-system-answers were reformatted to allow flexibility in marking, and hints were included in Quizlet feedback to assist struggling students and facilitate tutor intervention.

CYCLE 2 Results

Evaluation process

Evaluation informed the decision process by providing an interim data analysis. The evaluation process involved 1) a contradiction analysis of components of the e-tutorial activity system and learning

environment, 2) an evaluation of the effectiveness of Cycle 2 changes, and 3) identifying the critical issues to work on in Cycle 3. Table 3 shows a summary of issues identified for consideration for re-design in the next cycle. Evidence from data on these issues and source(s) are also recorded in the table.

Table 3 Summary of Critical Issues: Cycle 2

Original design	**Issues arising**	**Possible causes**	
Conceptions/objectives	Contradictions	Evidence	Data source
Learning outcome			
1. Performance The target success rate was 80% per activity.	The performance objective of a success rate of 80% per activity was not achieved	A success rate of 80% was achieved in only 1 out of the 6 activities 2 of the remaining 5 had a reasonable performance with a success rate of 70%	LMS generated data
	This could have been due	such as:	Student work samples
	i) to student slip-ups.	spelling error	Activity 1
		not squaring	Activity 2
		sing incorrect info	Activity 3
	ii) mathematical challenges	difficulty in solving simple equations with fractions	Activity 5
Learning orientation			
1. Learning process Initial conceptualisation of the learning process model: *read first, then do problems*	Student actions: *do first read when required*. Misalignment between the two.	Most students preferred to do problems first and reviewed content to get answers when they experienced challenges.	Contradiction analysis
Learning engagement			
(Design Limitations)			
1. Introduction Make the Introduction interactive; make students spend more time reading the introduction.	No challenge for students to engage effortfully and conceptually with the introduction content.	Students spent a short time on the item; there were no follow-up actions to indicate whether the student had the correct idea of what they needed to do.	Observation Screen-capture
2. Objectives Introduce pre-test to assist students in identifying the knowledge gap	Pre-test and KW-questionnaire results do not match. Which one would work better under the problem-first approach?	70% of the class scored less than 39%. 50% of students said they know the topic	Pre-test results KWL results
3 Resources Use Quizlet feedback, directing students to review resources and try again.	It was difficult for the students to i) access the resources,	The system presented a connectivity error.	Observation Screen capture
	ii) search/find the information they need to address their task-gap	The student needed assistance when playing the video to look for specific details in the video	Observation
		ii) Required format too constraining iii) No provision for typos iv) No provision for alternative answers	
4. Quizlets Use Quizlet feedback to direct students to ask for assistance from the tutor.	Quizlets were a positive contribution,	Quizlets, in some cases, motivated students to review the resources.	Observation
	But there were still issues to be addressed.	Quizlets a little confusing; some students did not know how to start or	Observation Interview

Original design	**Issues arising**	**Possible causes**	
Conceptions/objectives	Contradictions	Evidence	Data source
Learning outcome			
		could not figure out how to do Quizlet again.	
		LMS could not pick up students' responses in the Quizlets	LMS data

(Kigundu, 2023, p. 156)

The table above indicates that the evaluation of Cycle 2 of the e-tutorial activity system identified contradictions within its object, subject, and tool elements. Despite setting an 80% success rate goal, only one of six activities achieved this, with two others reaching 70%. Students faced challenges like spelling errors and simple equation solving, not engaging deeply with the resources. Quizlets, introduced for knowledge reinforcement, were hindered by unclear questions and inadequate feedback. The evaluations highlighted that while redesign efforts such as interactive introductions and pre-tests aimed to improve engagement and self-evaluation, they often fell short. Issues like rigid system answers and difficulties in resource access persisted. A critical observation was the need to shift from a theory-first to a problem-first approach to align the learning process with student actions better, suggesting further design changes for improved engagement and knowledge development in future cycles.

Review process

Table 4 shows a summary review process of the critical issues that emerged from the results of Cycle 3.

Table 4: Summary Cycle 3 review process

Issue identified	**Change made**	**Justification**	**Objective**
(And how it was evident in the data)	Action	How it was expected to overcome the issue	What response was it expected to generate
Learning outcome			
1. Performance i) The target success rate was 80% per activity was not achieved,	Lock progress until the pass mark is achieved.	Make students review resources and try again.	Students achieve a Success rate of 80% in all activities.
ii) Wrong answers due to errors such as spelling, not squaring, using incorrect information	Add hints or examples at respective questions about the format	Enable students to correct errors	
Learning orientation			
Initial conceptualisation of the learning process model: read first, then do problems. Student actions: do first read when required. Misalignment between the two.	Make the Quizlets (challenge) the core of the learning process.	Change in approach from theory-first to problem-first.	Students learn by adaptive rehearsing Quizlets problems and exploring content.
Learning engagement			
1. Introduction Students spent a very short time on the introduction.	Start the introduction with the test.	Encourage students to engage with reading the introduction content.	Students spend more time reading and achieve a reasonable level of success on the test.

2. Objectives Pre-test and KW-questionnaire results do not match.	Keep Pre-test and drop the KW questionnaire.	A pre-test is a better indicator of students' prior knowledge.	A low pre-test mark indicated a knowledge gap. Students see the need to do the e-tutorial.
3. Resources Resources not accessible due to connectivity error and challenging to search/find specific information when needed	Embed resources in LMS activity	Avoid external links	Make resources easy to open. and to simplify the search process.
	Create a short, topic-focused video	Student gets direct access to the relevant section in resources	
4. Quizlets i) Some students found Quizlets a little confusing	Give 3 chances to try Quizlet again.	Students learn to use Quizlet.	Students achieve a reasonable level of success.
ii) Quizlet feedback was not elaborate	Make feedback per Quizlet question elaborate.	A student who gets a wrong answer is directed to the relevant section in the resources.	Student review resources
iii) LMS could not pick up students' responses in the Quizlets	Set Quizlet to send results to the tutor's email	Make students' responses in the Quizlets accessible.	Get data on students' responses to the Quizlets.

(Kigundu, 2023, p. 161)

The table shows the review process aimed to transform and improve the e-tutorial system based on Cycle 2 results, which identified issues needing addressing. The system's orientation shifted from theory-first to problem-first, resulting in the development of Tut3. Key changes included offering students second chances to correct errors, emphasising problem-solving first, and redesigning the introduction as a challenge to engage students. The pre-test was retained while the KW-questionnaire was dropped. Resources were made more accessible and concise, using embedded short videos and maintaining PDF notes. Quizlets were improved by providing multiple attempts and feedback and ensuring results were sent to tutors' emails for better tracking.

CYCLE 3 Results

Evaluation process

Cycle 3 evaluation showed success in the four changes made during the review process in terms of achieving objectives set during the review process and overcoming the issue. Success was achieved in the 1) objectives, 2) performance, 3) Quizlets, and 4) resources. Table 7.12 shows a summary of the four issues which were resolved.

Table **Error! No text of specified style in document.**.1: Summary of resolved in Cycle 3

Issues arising	**Redesign**	**Results**	
	Action	Effect	Evidence
Learning outcome			
Performance The target success rate of 80% per activity was not achieved,	Lock progress until the pass mark is achieved.	Success rate greater than 80%. Students can correctly complete activities.	LMS data Column statistics Item Analysis

Issues arising	**Redesign**	**Results**	
	Action	Effect	Evidence
		Number of repeat attempts per activity	View all attempts
Learning orientation			
Misalignment between the Initial conceptualisation of the learning process model: read first, then do problems and student actions: do first read when required.	Change the learning process model from theory-first to problem-first .	Make the Quizlets (challenge) the core of the learning process.	Students explored resources before doing Quizlets or when they experienced difficulties answering Quizlets.
Learning engagement			
1. Objectives pre-test and KW-questionnaire results did not match	Drop KW-questionnaire and keep the Pre-test	The pre-test was a reasonably precise indicator of students' prior knowledge.	Pre-test results
2. Quizlet results No data from students' responses in the Quizlets.	Set Quizlets to send results to email	Quizlet results were available.	Captured in Appendix 10.
3. Resources Resources not easy to: access search	Embed resource in LMS Activity Create a short topic-focused video.	A small number of students experienced challenges with resources.	Interview and Journal responses

(Kigundu, 2023, p. 179)

The table shows the evaluation of Cycle 3 results, which involved analysing contradictions in the e-tutorial activity system, assessing the effectiveness of changes, and identifying critical issues for Cycle 4. Primary contradictions were found within the components of object, subject, and tool, such as reduced student completion rates, errors in student responses, and shortcomings in Quizlet questions. The evaluation highlighted the effectiveness of implementing the LMS conditional release function, which improved performance by allowing multiple attempts. Changes to the learning process model emphasised a problem-first approach, with Quizlets playing a central role, though student engagement with introduction content remained low. The pre-test proved a better indicator of prior knowledge than the KW-questionnaire, and Quizlets, despite being somewhat confusing, positively impacted student engagement. Enhancements to resource accessibility and design led to improved student interaction with materials. Overall, the evaluation demonstrated success in achieving Cycle 3 objectives and resolving key issues but identified areas needing further attention, particularly in encouraging student engagement and improving Quizlet feedback. Table 5 summarises two remaining critical issues identified in Cycle 3 and the corresponding proposed pedagogical and technological solutions.

Table 5: Summary of Critical issues in Cycle 3

Redesign	**Issues arising**	**Possible causes**	
Changes/objectives	Contradictions	Evidence	Data source
Learning engagement			
1. Introduction Redesigned Introduction as a challenge by adding a test.	Students did not engage effortfully/conceptually with the introduction content.	62% of the students did not attain 60% in the introduction test	Introduction test results
2. Quizlet Give students three chances to try the same Quizlet question, using elaborate feedback to direct them to relevant sections in the resources.	Some students were still struggling with answering the Quizlets. These needed to be identified and assisted.	There were still issues to be addressed: i) the number of Quizlets responses declined in activities 3, 4 and 5. ii) students ignored the feedback. iii) only 30% found feedback informative and or directed.	Quizlets results

(Kigundu, 2023, p. 181)

Review process

Table 6 shows a summary review process of the critical issues that emerged from the results of Cycle 4.

Table 6: Summary Cycle 4 review process

Issue	Change made	Justification	Objective
(And how it was evident in the data)	Action	How it is expected to overcome the issue	What response is it expected to generate
1. Introduction Poor performance in the Introduction test	Add adaptive release	Make reading the Introduction compulsory.	Students spend more time reading.
2. Quizlets Some of the students were still struggling to answer the Quizlets.	Set Quizlet feedback to tell the student to ask for help after failing three attempts.	Identify struggling students	Assist struggling students

(Kigundu, 2023, p. 182)

The table shows that In Tut 4, two key changes were implemented: first, an adaptive release condition was introduced in the introduction test to encourage students to pay more attention by allowing repeated attempts until the required performance was achieved. Second, feedback for Quizlets was adjusted to prompt students to seek assistance after three failed attempts, targeting those who struggled with the material and encouraging them to ask for help.

CYCLE 4 Results

Evaluation process

In the Cycle 4 evaluation, the result of each change made during the review process was assessed by contradiction analysis in relation to achieving objectives set during the review process and overcoming the issue. Table 7 shows a summary of the

two issues which were resolved in Cycle 4.

Table Error! No text of specified style in document.**: Summary of resolved issues in Cycle 4**

Issues arising	Redesign	Results	
	Action	Effect	Evidence
Learning engagement			
1. Introduction Poor performance in the Introduction test	Add adaptive release	Issue partially resolved	56% of students got 60% in the test
2. Quizlet feedback Quizlet feedback was not adequately used. Students not paying attention to feedback	Add after 3 attempts: Ask the tutor for assistance.	Students responded to the feedback request to ask for assistance.	Tutors' notes Examples of requests noted by tutorial assistants.

(Kigundu, 2023, p. 191)

The table shows that in Cycle 4, poor performance in the Introduction test was addressed by allowing students to retake the test and introducing an achievement-based release at a minimum passing level of 60%. This resulted in a success rate of 56%, indicating a partial resolution of the issue. Additionally, some students continued to struggle with Quizlets. To support them, feedback was provided after three failed attempts, prompting students to ask for assistance. This led to 30 requests for help, and the students were subsequently assisted with their technical or mathematical challenges.

Thematic Analysis of Results

Thematic analysis of the results reveals six key elements essential for developing an effective student engagement model for LMS-mediated tutorials:

1. Interactive and Engaging Content Delivery: Interactive presentations and pre-tests can enhance student engagement by making introductory materials more captivating and encouraging active participation. Initial findings showed low interaction with static content, leading to the introduction of these interactive elements.

2. Immediate and Elaborate Feedback: Providing immediate and detailed feedback is crucial for student learning. Issues with delayed and unclear feedback were addressed by incorporating real-time, elaborate feedback mechanisms, helping students promptly understand and correct their mistakes.

3. Flexible and Adaptive Assessment: Assessments need to be flexible, accommodating partial credit and alternative answers to reflect student understanding fairly. Rigid answer formats were modified to explore all possibilities and provide adaptive release conditions, ensuring a comprehensive evaluation of student efforts.

4. Enhanced Resource Accessibility: Easy access to resources is vital for effective learning. Technical difficulties were mitigated by embedding resources directly in the LMS activities and creating concise, topic-focused videos, simplifying the process of locating and utilising necessary materials.

5. Problem-First Approach: Aligning the learning process with students' natural tendencies through a problem-first approach encourages deeper

engagement. By making problem-solving the core of the learning process, students are more likely to interact with theoretical content as needed, improving their overall learning experience.

6. Support for Novice Users: Providing support for novice users helps them navigate the LMS and tutorials more effectively. Introducing hints and guidance mitigates initial challenges, reducing frustration and enhancing the learning experience for all students.

These themes underscore the importance of creating an interactive, supportive, and flexible learning environment to improve student engagement and learning outcomes in LMS-mediated tutorials. Implementing these strategies addresses the critical issues identified in the evaluation cycles, leading to a more effective and engaging educational experience.

Findings and Discussion

This section addresses the second research question; ***What are the key determinants of student engagement in LMS-mediated e-tutorials?***

The findings indicate several key elements for developing an effective student engagement model for LMS-mediated tutorials, such as students learning orientation, interactive content, student-friendly activity design, and robust support mechanisms.

Students Learning Orientation

Most students in the study preferred adaptive problem-solving and exploration over a theory-first approach in their learning orientation. At the start of the study, it was assumed that students would initially use the theory-first approach to construct knowledge by reviewing content and then developing proficiency through practice. However, the results indicated that most students experienced learning through adaptive rehearsing of problems and exploring content. They preferred to answer the tutorial questions first, and only reviewed content resources when they experienced challenges in answering tutorial questions. This means that students are more inclined to engage directly with problem-solving activities and seek out content review only when they encounter difficulties. This approach reflects a more active and iterative learning process, where students dynamically adjust their strategies based on their immediate learning needs. This finding aligns with contemporary educational research emphasising active and problem-based learning (PBL) methodologies. For instance, Prince and Felder (2019) highlighted the benefits of PBL in fostering deeper understanding and retention of knowledge. Their study suggests that students engaging in problem-solving activities develop critical thinking skills and a better ability to apply theoretical knowledge in practical contexts. Similarly, Hmelo-Silver et al. (2022) underscore the importance of adaptive learning strategies, noting that students who engage in self-directed problem-solving tend to exhibit higher levels of motivation and engagement, which are crucial for effective learning.

Interactive Content and Student Actions

The study highlighted that students were more engaged with mathematical tasks and tutorial questions than with introductory content or multimedia resources. This indicates the necessity of designing LMS content, prioritising interactive and problem-

solving activities over passive content consumption. According to Prifti (2022), the relevance and engagement of online learning activities significantly influence student satisfaction and motivation. Additionally, interactive content, such as quizzes and problem-solving tasks, has been shown to enhance student engagement and retention of material (Hartwell, 2023). Therefore, incorporating more interactive elements into LMS tutorials can foster greater engagement and learning outcomes.

System Design and Use

The findings revealed student challenges with the system, such as navigating presentations, inputting answers, and dealing with system errors. Effective system design should include intuitive navigation, error-tolerant answer formats, and immediate, clear feedback mechanisms. Procko et al. (2020) emphasise the importance of user-friendly design in LMS platforms to facilitate seamless student interaction and reduce frustration. Similarly, Razmak et. al. (2021) advocate for LMS systems that support easy navigation and provide clear guidance to enhance the learning experience. Hence, LMS platforms must be designed to be user-friendly, accommodate diverse student needs, and minimise technical barriers.

Support Mechanisms

The study identified the critical role of support mechanisms, such as tutor assistance and peer interactions, in enhancing student engagement. Students often relied on tutors for help with system navigation and understanding content. This aligns with the findings by Noushad et al. (2024), who reported that effective mentorship and support systems are crucial for maintaining student engagement in online learning environments. Moreover, collaborative learning and peer support can significantly contribute to a positive learning experience (Washington, 2019). Therefore, integrating robust support mechanisms, including access to tutors and promoting peer interactions, is essential for fostering a supportive and engaging learning environment.

Feedback and Assessment

Effective feedback is a vital component of student engagement. The study noted that students benefited from detailed feedback and opportunities to correct their mistakes. Timely and constructive feedback can guide students through their learning process, helping them identify areas for improvement. Goldenthal et al. (2022) highlight that LMS-mediated feedback should be informative, timely, and actionable to enhance student learning and engagement. Additionally, regular assessments and feedback loops are crucial for keeping students motivated and engaged (He and Wang, 2024). Implementing comprehensive feedback mechanisms within LMS activities can significantly enhance student engagement and learning outcomes.

Proposed Engagement Model

This section addresses the second research question: ***How can these determinants be effectively integrated into a comprehensive Student Engagement Model?***

The proposed Student Engagement Model for LMS-mediated tutorials integrates key pedagogical strategies to enhance student interaction, resource accessibility, support structures, and feedback mechanisms to foster a more engaging and supportive learning environment.

Student-Friendly Activities: Develop intuitive, interactive (e.g. fill-in multiple blanks), error-tolerant activities with clear guidance (e.g. instructions), and gamified elements (e.g. conditional release) to facilitate student interaction and reduce frustration. Ali et al. (2021) and Bradley (2021) both emphasise the importance of a supportive digital infrastructure in improving student interactions with LMS tools.

Purposeful Resource Provision: Incorporate purposeful resource provision as an effective mechanism for balanced information delivery to prevent cognitive overload. This involves three distinct levels of resources: big picture items (e.g., pdf notes) to provide awareness of the scope of the topic, precession items (e.g., short video clips) to provide content details and help items (e.g., hints on answer format) to provide improve the accessibility of the system. This aligns with the recommendations by Hamid et al. (2022) on the effectiveness of varied instructional materials in digital learning environments.

Assessment and Feedback: Create a demand for knowledge through formative assessments (e.g. Quizlets) with adaptive feedback (e.g. timely responses, informative comments, and actionable advice) to enhance student learning and engagement. Regular assessments and feedback loops are crucial for keeping students motivated and engaged (He and Wang, 2024).

Support Structures: Establish just-in-time verbal communication (e.g. tutor assistance) and social interaction (e.g. face-to-face peer support) to address individual learning challenges and promote a collaborative learning environment. Kahu and Thomas (2022) highlight the benefits of community-building within LMS platforms for sustained engagement.

The mind map below (Figure 1) visualises the proposed Student Engagement Model, outlining key strategies such as interactive activities, resource provision, assessments, and support structures to enhance student engagement in LMS-mediated tutorials.

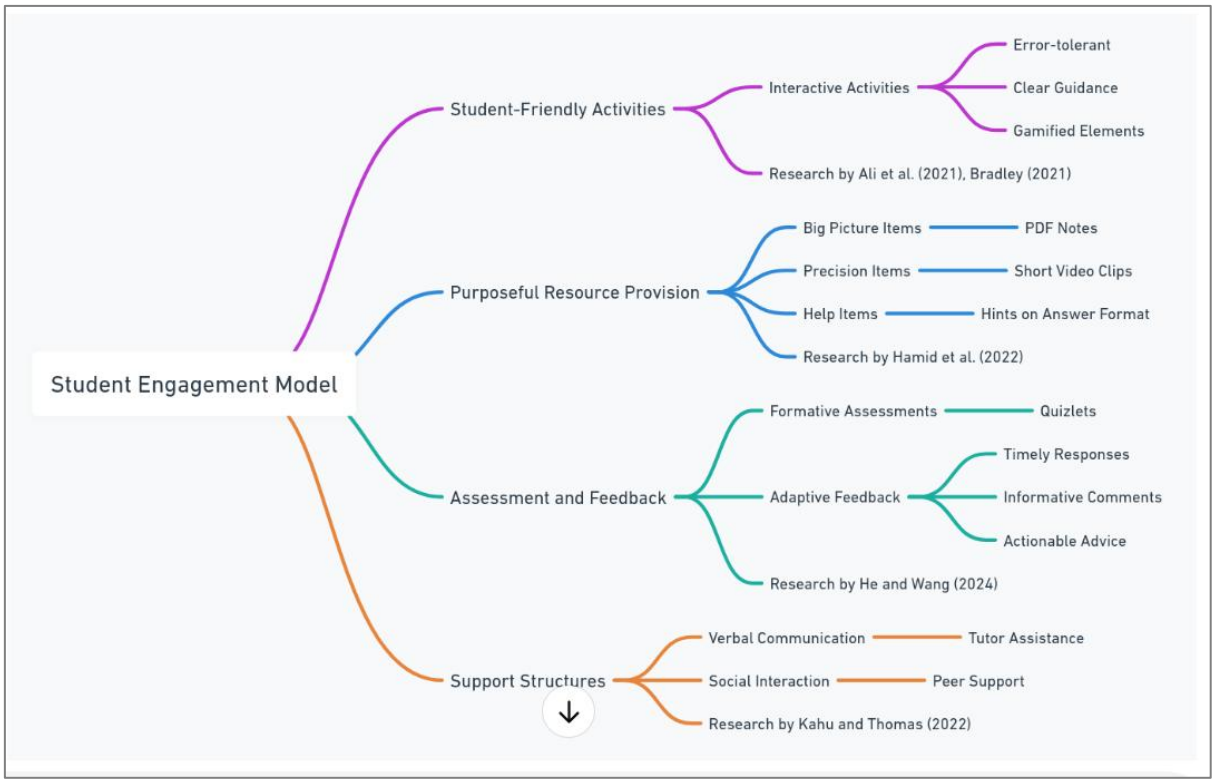

Figure 1: An Empirical Student Engagement Model for LMS-Mediated e-Tutorials

Conclusion

The topic of engaging e-learning in higher education, particularly through LMS-mediated tutorials, is critically important in the context of contemporary education. With the rapid advancement of digital technologies and the increasing shift towards online learning, understanding how to effectively engage students in virtual environments is essential. This study aimed to develop an empirical student engagement model for LMS-mediated tutorials, which can help educators design more effective online learning experiences.

Implementation

The study employed iterative Educational Design Research (EDR) methodology which was implemented in three phases. The Preliminary Phase: Conceptualisation and the initial formulation and design of the LMS-mediated tutorial based on literature and expert consultation. Initial prototypes of the tutorial system were created, with a focus on content delivery. The Intervention Phase: Deployment of the LMS-mediated tutorials with first-year students over four cycles. In each cycle, data collection tools such as questionnaires, interviews, direct observations, screen capture videos, and student work samples were used to assess engagement and identify areas for improvement. The design was refined based on student interactions with the LMS, focusing on addressing challenges related to usability and engagement. Key issues like system navigation difficulties, low interaction with the resources, and technical barriers were addressed. The Evaluation Phase: Retrospective analysis and interpretation of data related to the specific insights into student engagement to integrate categories and their properties, delimit and write the theory.

Summary of Findings

The study suggests that student engagement in LMS-mediated tutorials can be significantly enhanced through *developing and refining knowledge through adaptive rehearsing and exploring content.* This can be achieved by student-friendly activities incorporating interactive content, providing robust support and implementing effective feedback mechanisms.

1. **Activity Design and Use:** Students faced challenges with navigation and inputting answers, suggesting a need for designing student-friendly activities.
2. **Interactive Content and Student Actions:** The study found that students engaged more with problem-solving activities than passive content, suggesting the importance of interactive elements in LMS-mediated tutorial design.
3. **Feedback and Assessment:** Effective feedback mechanisms were essential for guiding students and maintaining their engagement with the tutorial activities.
4. **Support Mechanisms:** Tutor assistance and peer support played a crucial role in enhancing student engagement, underscoring the value of robust support structures.

Significance of the Results

The results of this study are significant as they provide a comprehensive understanding of the factors that influence student engagement in LMS-mediated tutorials. By addressing these factors, educators can design more engaging and effective online learning environments, leading to improved student outcomes and satisfaction.

Educational institutions should prioritise integrating interactive content, ensure user-friendly LMS platforms, and establish strong support systems to foster student engagement. Additionally, continuous feedback during assessment practices should be incorporated to guide students throughout their learning journey.

Limitations of the study

Common issues found in similar research were considered to discuss the study's limitations. Then used recent citations to support these points.

1. Limited Generalisability:

The study's findings may have limited generalizability due to the specific context and population studied. The model was developed for under-prepared first-year students in a particular higher education institution, its applicability to other contexts, educational levels, or institutions remains uncertain. Future research should test the model in diverse educational settings to enhance its external validity (Johnson et al., 2019).

2. Reliance on Self-Reported Data:

The study extensively used self-report measures to assess student engagement, which can be subject to biases such as social desirability and inaccurate self-assessment. These limitations may affect the validity of the findings. Incorporating more objective measures of engagement, such as learning analytics and behavioural data, could provide a more comprehensive understanding of student engagement (Smith & Davis, 2020) .

3. Technological Variability:

The study's reliance on a specific LMS platform may introduce variability due to differences in LMS functionalities and user interfaces. Since different LMS platforms offer varying features, the engagement model's effectiveness might

differ across platforms. Future studies should examine the model's applicability across multiple LMS platforms to ensure broader relevance and applicability (Brown et al., 2021).

Future Research Possibilities

Many future research possibilities offer numerous avenues for further investigation and enhancement of learning management systems (LMS) in education, in general, and student engagement models for LMS-mediated e-tutorials. For example:

1. Future research should explore the long-term impact of these engagement strategies on student learning outcomes and retention rates (Pellas & Kazanidis, 2019).
2. Studies could also investigate the effectiveness of different types of interactive content and feedback mechanisms across various disciplines and educational levels (Bond et al., 2020).
3. Furthermore, exploring the role of emerging technologies, such as artificial intelligence and virtual reality, in enhancing LMS-mediated tutorials could provide valuable insights (Kohnke & Moorhouse, 2022).
4. Future research should test the model in diverse educational settings to enhance its external validity (Johnson et al., 2019).

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