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Online student engagement and academic outcomes in a Moodle learning management system at an open distance e learning institution

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Research Article

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Abstract

Background: Learning Management Systems (LMSs) generate extensive log data that can be used to examine student engagement in online learning environments, particularly within Open Distance e-Learning (ODeL) institutions.

Aim: This study investigated patterns of online student engagement using LMS log data and examined the relationship between participation levels and engagement dimensions in an ODeL context.

Methods: An explanatory mixed-methods design was employed. LMS log-view data were extracted from a postgraduate Applied Health Statistics module offered at the University of South Africa during the 2023,2024 and 2025 longitudinal academic years. A minimum of 65,535 log-view records generated in one year by 266 postgraduate diploma students were analyzed. Engagement was operationalized across behavioral, emotional, and cognitive dimensions using interactions with specific LMS tools. Descriptive statistics were used to examine participation patterns.

Results: Students engaged most frequently with assessment-related and cognitively oriented resources, while emotional engagement tools were accessed less frequently. High participation levels were associated with broader and more sustained engagement across LMS tools.

Conclusion: LMS log data provide valuable insights into student engagement and

can inform targeted student support strategies in ODeL institutions.
Keywords: Student Engagement; Learning Management Systems; Moodle; Learning Analytics; Open Distance e-Learning.

1.Background

The rapid expansion of online and blended learning has intensified scholarly and institutional interest in how students engage within digital learning environments. Learning Management Systems (LMSs) now function as core infrastructures for teaching and learning, particularly in Open Distance e-Learning (ODeL) institutions, where structured student–content interaction largely replaces face-to-face engagement. Consequently, LMS-generated log data have emerged as a scalable and granular resource for examining patterns of student engagement, participation, and academic performance.

Student engagement is widely recognized as a critical predictor of academic success, persistence, and retention in higher education. Engagement theory conceptualizes learning as a multidimensional construct encompassing behavioral participation, emotional investment, and cognitive effort (Fredricks et al., 2004; Kuh, 2003). In online environments, however, engagement is often less visible to instructors, complicating early identification of disengagement and timely academic support. In response, learning analytics research has increasingly relied on LMS log data as proxies for engagement-related behaviours, including access frequency, interaction with learning resources, and assessment activity (Henrie et al., 2018; Kovanović et al., 2015).

Despite growing adoption of analytics-driven approaches, important theoretical and methodological challenges remain. Prior research suggests that while higher levels of LMS activity are often associated with improved academic outcomes, the relationship between participation frequency and learning is neither linear nor uniform. Rather, learning outcomes appear to be mediated by the quality, breadth, and purpose of engagement rather than by volume alone (Junco, 2012; Kovanović et al., 2015). This challenge is particularly pronounced in ODeL contexts, where student participation patterns are highly heterogeneous and self-regulated. There is therefore a need for theoretically grounded studies that move beyond descriptive click counts to operationalize established engagement constructs using LMS data and to examine how engagement evolves over time in relation to academic performance.

Responding to this gap, the present study investigates longitudinal patterns of online student engagement using LMS log-view data from a postgraduate Applied Health Statistics module offered at a large ODeL institution. Anchored in the tripartite model of behavioral, emotional, and cognitive engagement (Fredricks et al., 2004; Kuh,

2003), the study classifies LMS tools according to engagement dimensions and examines how varying levels of participation relate to engagement breadth and academic outcomes. By integrating engagement theory with learning analytics, this study advances innovation in higher education by demonstrating how LMS data can be systematically interpreted to support evidence-based student support, early identification of at-risk learners, and analytics-informed pedagogical design in ODeL environments.

1.1 LMS Log Data and Online Student Engagement (Conceptualization)

LMS log data capture time-stamped records of user activity within digital learning environments, including page views, clicks, access frequency, time on task, and interaction with assessments or learning tools (Henrie et al., 2018). As activity-level measures, log data provide dynamic insights into how students navigate, access, and engage with course resources over time. While such data offer significant analytic potential, scholars caution that their educational value depends on theoretically informed interpretation rather than on activity counts alone (Henrie et al., 2018).

Online student engagement is commonly associated with the time, energy, and effort students invest in their learning and learning community (Bond, 2020; Strong, 2022). Importantly, engagement is not static; it fluctuates across the semester and exists along a continuum influenced by contextual, motivational, and instructional factors (Muir et al., 2019). In this study, online student engagement is operationalized as students' active choice to access, load, and view course-related LMS tools, as captured through log-view data.

1.2 Theoretical Framework: Student Engagement

Student engagement has been conceptualized through multiple lenses, including behavioral investment, psychosocial processes, institutional context, and learning outcomes (Kahu, 2013). Among these, the tripartite framework proposed by Kuh (2003) and Fredricks et al. (2004) remains the most widely applied in higher education research. This model conceptualizes engagement as comprising three interrelated dimensions: behavioral, emotional, and cognitive engagement.

In this study, LMS tools were classified according to the dominant engagement dimension they were designed to elicit. Cognitive engagement was represented by interaction with content-oriented tools requiring intellectual effort and conceptual

understanding. Behavioral engagement was operationalized through interaction with assessment and practice-oriented tools reflecting observable academic action. Emotional engagement was reflected through interaction with communication-oriented tools designed to foster connection, belonging, and course orientation. The classification framework used in the analysis is presented in Table 1.

Behavioral engagement refers to observable participation in academic activities, including accessing learning materials, completing assessments, and persisting with academic tasks. Emotional engagement encompasses students' affective responses to learning, such as interest, belonging, anxiety, and connection to instructors or peers. Cognitive engagement reflects students' investment in deep learning strategies, problem-solving, and mastery of complex ideas.

Table1. Classification of LMS Tools/Icons According to Student Engagement Dimensions

Engagement Dimension	LMS Tool / Icon	Contextual Explanation
Cognitive Engagement	Official Study Material	Direct engagement with core course content requiring sustained cognitive focus
	Prescribed Reading Material	Reading for conceptual understanding and knowledge acquisition
	Apps for student support (Applied Health Statistics)	Interaction with applications designed to support comprehension and application of statistical concepts
	Raosoft Sample Size Calculator	Application of statistical principles through problem-solving
	Probability Calculator	Engagement with mathematical concepts and analytical reasoning
	Appropriate Statistical Tests	Conceptual problem-solving and methodological decision-making
	Lesson Plan Themes (1–4)	Engagement with theoretical foundations of the module
	Lesson Plans (1–4)	Review and integration of structured conceptual content
Behavioural Engagement	Assessment 01–04	Observable participation through completion and submission of graded tasks
	Self-assessment (Practice Problems and Solutions)	Active practice and skills development through task completion
	Additional Resources	Voluntary exploration of supplementary learning materials
	Frequently Asked Questions	Task-oriented information seeking to resolve learning challenges
Emotional Engagement	Welcome Message	Establishes initial affective tone and course orientation
	Announcements	Ongoing communication fostering connection, belonging, and instructor presence

2. Purpose of this Study:

The purpose of this study was to examine the relationship between online student engagement within a Moodle learning management system and academic performance outcomes in an open distance e learning context. Specifically, the study investigated how patterns of interaction, participation in online support activities, and utilisation of digital learning resources contribute to measurable academic success within a selected module.

3. Main Research Questions:

RQ1. How can students be grouped based on participation behaviours obtained from LMS log records?.

RQ2. What is the effect of LMS participation levels on university students' engagement?

4. Methods

This study employed an explanatory mixed-methods design, integrating quantitative learning analytics with theoretically informed qualitative interpretation. Such designs are increasingly recommended in higher education research to contextualize LMS-derived metrics within established learning theories. Quantitative LMS log-view data were analysed to identify participation patterns, while qualitative interpretation drew on engagement theory to explain observed behaviours.

4.1 Context and Participants

The study was conducted in a fully online postgraduate Applied Health Statistics module offered at a large Open Distance e-Learning (ODeL) University in South Africa. Participants comprised 266 postgraduate diploma students enrolled across the 2023–2025 academic years. All data were extracted from the Moodle LMS and anonymized prior to analysis to ensure ethical compliance.

4.2 Data Sources and Measures

LMS log-view records captured students' interactions with course resources, assessments, and communication tools. Drawing on the tripartite engagement framework (behavioral, cognitive, emotional), LMS tools were classified according to their dominant engagement function. This theoretically grounded operationalization responds to calls for stronger alignment between learning analytics measures and engagement theory in higher education research.

4.3 Data Collection and Analytical Procedure

4.3.1 Module Context

The study was conducted within the online Applied Health Statistics module offered by the Department of Health Studies at the University of South Africa. The module introduces foundational concepts in biostatistics, with emphasis on descriptive and analytical health measurement within quantitative research. The course is delivered fully online through the Moodle learning management system (LMS), which provides structured digital content, assessment activities, and interaction tools to support asynchronous learning.

Course materials made available via the LMS included topic summaries, lecture notes, structured lesson plans, instructional resource videos, and continuous assessment activities. A discussion forum was also established to facilitate peer-to-peer interaction and communication between students and the course instructor.

4.3.2 Data Source and Extraction

Engagement data were extracted from the Moodle system log database for three consecutive academic years (2023–2025), during which annual enrolment exceeded 200 students. The log database captured system-generated behavioral records, including the frequency of page views and access interactions within the LMS environment.

Data extraction was performed using institutional dashboard access. Immediately following extraction, all personally identifiable information was removed. Student identifiers were replaced with anonymized codes to ensure confidentiality prior to statistical analysis. No identifiable personal data were retained at any stage of the research process.

4.3.4 Operationalization of Engagement

Student engagement was operationalized using the number of recorded LMS log views over the duration of each academic year. Log views were treated as a longitudinal behavioral indicator reflecting observable interaction with digital learning materials.

To categories engagement intensity, cluster analysis was performed using Stata version 17. The clustering procedure grouped students according to similarity in log view frequency. Based on the distribution of engagement patterns, three participation categories were established:

High participation: more than 100 log views

Medium participation: between 50 and 100 log views

Low participation: fewer than 50 log views

Each student was assigned to one engagement category per academic year based on their cumulative interaction frequency.

4.3.5 Analytical Framework

Following cluster classification, participation group membership was analyzed in relation to academic performance outcomes. Engagement group served as the independent variable, while academic achievement indicators derived from official module assessment records served as dependent variables.

The longitudinal dataset enabled examination of engagement patterns across multiple academic cohorts while preserving anonymity and analytical consistency.

4.3.6 Ethical Considerations

The study utilized secondary institutional data generated through routine academic activity within the LMS. All data were anonymized prior to analysis, and no direct interaction with students occurred for research purposes. The research was conducted in accordance with institutional data governance and research ethics guidelines governing the use of anonymized educational records.

5. Results

According to Table 2 below the view of Course material 39.5% (25930) icon created more logs than any other icons for students of online Applied Health Statistics than any other icons in the classification of Content or Behavioural engagement. Behavioural engagement icons as per classification of engagement above in Table 1, followed in majority after Course material view (Content engagement as per classification of engagement) and they were as follows view of Assignment 01 was 20.8%(13679),Assignment 02 was 15.02%(13679) and Assignment 03 was 12.63%(8276) then followed by others as indicated on Table 2 below. Table 2 below shows a representative mixture of behavioral and content engagement.

Table 2**: Classification labelling of Icons that represent Content and Behavioral engagement.**

LMS Icons/Tools	Frequency (%)	Engagement Dimension
1. Course Material: PPH4811-23-Y	25930 (39.5%)	Cognitive Engagement
2. Assignment 01	13679(20.8%)	Behavioral Engagement
3. Assignment 02	9841(15.0%)	Behavioral Engagement
4. Assignment 03(EQP QUESTION Paper) October/November	8276(12.6%)	Behavioral Engagement
5. Welcome Message and Announcements.	2711(5%)	Emotional
6. Forum: Announcements.		Engagement
7. Folder: Additional Resources	1969(3%)	Behavioral Engagement
8. Folder: Lesson Theme 1 and Lesson Plan 1	880(1.34%)	Cognitive Engagement
9. Folder: Lesson Theme 2: Lesson Plan 2	555(0.85%)	Cognitive Engagement
10. Folder: Lesson Theme 3: Lesson Plan 3	497(0.76%)	Cognitive Engagement
11. File: SELF ASSESSMENT (MCQ TYPE QUESTIONS).	468(0.71%)	Cognitive Engagement
12. Folder: Lesson Theme4: Lesson Plan 4	373(0.57%)	Cognitive engagement
13. Folder: Lesson Theme3: Lesson Plan 3	356(0.54%)	Cognitive Engagement
14. Folder: Lesson Theme4: Lesson Plan 4	373(0.57%)	Cognitive Engagement
15. Folder: Lesson Theme3: Lesson Plan 3	356(0.54%)	Cognitive Engagement
16. Frequently Asked Questions	0(0.25%)	Behavioral Engagement
Total	**65535(100%)**	

Computer/ Information literacy is defined as the ability to find, use, and evaluate information effectively from a variety of formats. In this Research Study as a student to be able to fully participate and create log views in the online courses and be able to successfully complete assignments and tasks very well, gave me as a researcher an indication that students in this module were highly capacitated with computer literacy. In Table 3 below most of this students showed were able to create 46,24%(30301) log views of Assignments tasks execution and completion, followed by clicking and reading of other system folders which includes submissions, feedback, reading and others 36.32%(23805) times, others folders were also frequently viewed such as reading material Tutorial Letter 101(TUT101)6.42%(4207) etc. as shown in Table 3 below.

Table 3: **Log Views by LMS Tools indicating evidence of computer literacy created through student's academic year.**

LMS Tools/Icons	Frequency (%)
1. Log Views of Assignments	30301(46.24%)
2. Log Views of System Folders (System Attributes such as submissions,grading, reading and checking marks)	23805(36.32%)
3. Log views of Folders(Official Study Materials, Prescribed Reading Material, Additional Resources)	4207(6.42%)
4. Log views of Discussion Forums	2730(4.17%)
5. Log views of User Report	2526(3.85%)
6. Logviews of file submissions (Assignments Submitted)	1510(2.30%)
7. Log views of file (Feedback)	432(0.66%)
8. Log views of Submission Comments	12(0.02%)
9. Log views of Overview report	11(0.02%)
10. Recycle Bin	1(0.00%)
Total	**65535(100.00%)**

Students who are fully engaged are more likely to fully participate and succeed than those who are less engaged in an online teaching environment. Shown in Table 4 below; Conversely, the students within High Participation group not only followed the course but also interacted within the LMS so many times and achieved very well in terms of academic annual performance. Majority as shown in a column of academic performance, high participation group of students were on their way to achieve distinctions and pass rates in their academic performance. Similarly shown in Table 4 below there were medium participation group and low participation group. The Medium Participation group is a grey area with a pass and most at risk students (log views of >50 and <100 times). This represented a mixture group of students who some were becoming immensely cognitively engaged whilst others were stuck in procrastination and slowly becoming disengaged students. Contrary to above mentioned two groups

there was low participation Group (log views of <50 times) as shown in Table 4 below. Most of these students had adverse academic outcomes majority cancelled their module registration or dropped out when verified and traced on University SQL system. According to Michinov et al (2011) high-level procrastinators (low level participants) are less successful than low-level procrastinators(high level participants) because they do not participate in any activities online during the online learning process, therefore that can be an indicator of cancellation or drop out or loss of interest.

Table 4: Participation Groups and Academic Outcome.

Student Participation	Log Views Frequency (%)	Academic Outcome	Participation Groups	Notes
1. Unique Student A	1285(1.96%)	72%	High Participation	
2. Unique Student A	1016(1.55%)	73%	High Participation	
3. Unique Student A	975(1.49%)	66%	High Participation	
4. Unique Student A	908(1.39%)	74%	High Participation	
5. Unique Student A	861(1.31%)	74%	High Participation	**High Participation >100->1000 times**
6. Unique Student A	767(1.17%)	72%	High Participation	
7. Unique Student A	745(1.14%)	73%	High Participation	
8. Unique Student A	669(1.02%)	65%	High Participation	
9. Unique Student A	632(0.96%)	72%	High Participation	
10. Unique Student A	617(0.94%)	73%	High Participation	
1. Unique Student B	94(0.14%)	72%	Medium Participation	
2. Unique Student B	94(0.14%)	33%	Medium Participation	
3. Unique Student B	91(0.14%	68%	Medium Participation	
4. Unique Student B	90(0.14%)	73%	Medium Participation	**Medium Participation Group. >100 times**
5. Unique Student B	90(0.14%)	64%	Medium Participation	
6. Unique Student B	85(0.13%)	64%	Medium Participation	
7. Unique Student B	85(0.13%)	71%	Medium Participation	
8. Unique Student B	81(0.12%)	81%	Medium Participation	
9. Unique Student B	79(0.12%)	33%	Medium Participation	
10. Unique Student B	76(0.12%)	34%	Medium Participation	
1. Unique Student C	46(0.07%)	Cancelled	Low Participation	
2. Unique Student C	45(0.07%)	Cancelled	Low Participation	

3.	Unique Student C	24(0.04%)	Cancelled	Low Participation	
4.	Unique Student C	14(0.02%)	Cancelled	Low Participation	
5.	Unique Student C	13(0.02%)	Cancelled	Low Participation	
6.	Unique Student C	11(0.02%)	Cancelled	Low Participation	**Low Participation Group. <50 times**
7.	Unique Student C	9(0.01%)	Cancelled	Low Participation	
8.	Unique Student C	8(0.01%)	Cancelled	Low Participation	
9.	Unique Student C	8(0.01%)	Cancelled	Low Participation	
10.	Unique Student C	5(0.00%)	Cancelled	Low Participation	
Total		65535(100.0%)			

6. Discussion

This study provides empirical evidence that LMS log-view data can be meaningfully aligned with student engagement theory to better understand participation and learning outcomes in online higher education. Consistent with prior research, students with high participation levels demonstrated sustained interaction with cognitively and behaviorally demanding LMS tools and achieved stronger academic outcomes (Kuh, 2009; Bolliger & Halupa, 2018). These findings reinforce the central role of engagement as a mechanism through which learning occurs in digital environments.

Distinct participation profiles emerged across the high-, medium-, and low-participation groups. High-participation students engaged broadly across content, assessment, and communication tools, reflecting strong behavioral and cognitive engagement. In contrast, low-participation students exhibited limited LMS interaction and were more likely to experience adverse academic outcomes, including module withdrawal or cancellation. These patterns align with evidence linking low participation and procrastination to increased dropout risk in online learning environments (Michinov et al., 2011).

Importantly, the findings also highlight that engagement quality matters as much as participation frequency. While log-view counts were positively associated with performance, prior studies caution against equating low LMS usage with weak cognitive

engagement (Kovanović et al., 2015). The present study supports this nuanced view, suggesting that meaningful interaction with key learning tools—particularly assessments and core content—may be more indicative of successful learning than overall activity volume alone. This has important implications for the design of analytics-based early warning systems, which should prioritise patterns of purposeful engagement rather than raw interaction counts.

From an innovation perspective, the study demonstrates how LMS analytics can support data-informed teaching and student support strategies in ODeL institutions. By operationalizing behavioral, emotional, and cognitive engagement through LMS tool usage, educators can more effectively monitor student progress, identify at-risk learners, and design targeted interventions. This aligns with broader calls in higher education to leverage learning analytics for improving teaching quality, student retention, and equity of outcomes. Overall, the findings suggest that LMS log data, when grounded in engagement theory, offer a powerful resource for advancing analytics-informed pedagogy in online higher education. Future research should extend this work by integrating qualitative indicators of engagement and examining how instructional design choices influence engagement trajectories over time.

6.1 Participation Patterns and Engagement Outcomes

Clear distinctions emerged across participation groups. Students in the high-participation group demonstrated sustained interaction with the LMS, engaged consistently with course content and assessments, and achieved strong academic outcomes. The medium-participation group, characterized by moderate interaction levels (approximately 50–100 LMS interactions), represented a transitional cohort, including both pass-level and at-risk students. In contrast, the low-participation group, defined by fewer than 50 log views, showed the highest incidence of module cancellation or withdrawal, as confirmed through institutional enrolment records.

These findings align with evidence that low participation and high procrastination are associated with poorer academic outcomes, limited online activity, and increased risk of dropout (Michinov et al., 2011). High participation was associated with broader and more sustained engagement across behavioral, cognitive, and emotional dimensions (Huang et al., 2012). Students who actively navigated content and assessment tools were more likely to demonstrate academic success (Kobicheva, 2022). High-

participation students also exhibited stronger self-regulation, higher task completion rates, and greater use of advanced learning strategies, resulting in above-average academic performance.

From a pedagogical perspective, the dominant theoretical framework emerging from this study supports the view that an effective LMS must align with students' learning expectations, support future academic and professional needs, and be grounded in social constructivist principles. (Fredricks, et al (2004). Information literacy, conceptualized as the ability to locate, evaluate, and apply information across multiple formats, emerged as a key outcome of high participation. Students in the high-participation group demonstrated strong computer literacy, as evidenced by consistent LMS usage, effective task completion, and strategic engagement with learning resources (Kovanović et al., 2015).

Log-view patterns served as a proxy indicator of students' digital and information literacy skills, reflecting their ability to integrate technology into learning for problem-solving, self-regulation, and academic success (Kuh, 2009). However, while participation frequency was associated with performance, prior studies caution that low LMS usage does not necessarily imply weak cognitive development; rather, the quality of engagement is more predictive of meaningful learning outcomes than sheer quantity (Kovanović et al., 2015). Consistent with this view, performance-avoidance behaviours have been linked to low cognitive participation in online discussions (Junco, 2012; Junco et al., 2011).

Overall, these findings suggest that online student engagement—particularly high-quality, purposeful participation—can serve as a valuable metric for monitoring academic performance, identifying at-risk students, and informing targeted pedagogical interventions. Lecturers are therefore encouraged to design and scaffold online activities that promote meaningful engagement rather than passive interaction, thereby supporting student success, retention, and long-term learning outcomes.

6.2 Log Views as an Indicator of Students' Computer Literacy and Problem-Solving Ability

This study explored log views within the Learning Management System (LMS) as a potential indicator of students' computer and information literacy skills in relation to study problem-solving. Information literacy is commonly defined as the ability to locate,

evaluate, and effectively use information across a variety of formats. In the context of online learning environments, this competency is closely aligned with students' ability to navigate digital platforms and engage meaningfully with course content.

The findings suggest that students in the high-participation group demonstrated stronger engagement with online courses, completing assignments and learning tasks more effectively. This pattern aligns with previous research indicating that active online participation may reflect higher levels of computer literacy (Bolliger & Halupa, 2018). The high number of log views among these students indicates frequent interaction with the LMS, suggesting that they actively used the platform to remain informed and to support their learning activities.

Consistent with Kuh (2009), frequent LMS engagement can be interpreted as evidence of students' ability to integrate digital tools into their learning habits in ways that promote academic success, retention, and support. From this perspective, LMS log data, particularly log views, offer valuable opportunities for learning analytics research aimed at improving teaching practices and enhancing student outcomes. Such data can help educators better understand how students interact with course materials and identify patterns associated with successful learning behaviors.

These findings also highlight the instructional implications for lecturers. Encouraging consistent and meaningful online participation may enhance students' digital competencies and academic engagement. Online student engagement metrics, such as log views, may therefore serve as useful quality indicators for monitoring student participation and evaluating learning activities.

However, the relationship between participation and learning is complex. Prior studies have shown that performance-avoidance behaviors are associated with lower levels of cognitive participation in online discussions (Junco, 2012; Junco et al., 2011). At the same time, low LMS usage should not automatically be interpreted as evidence of weak cognitive development (Kovanović et al., 2015). These findings suggest that while participation levels are important, the quality of engagement is ultimately more critical than the quantity of LMS interactions.

Overall, while log views can provide insight into students' computer literacy and engagement patterns, they should be interpreted alongside qualitative indicators of learning to gain a more comprehensive understanding of students' cognitive and

academic development.

Students with high engagement strive not only to achieve good marks but also to achieve more than they learn. Students who are motivated to learn, solve problems, and analyze information have a higher level of engagement (Kuh, 2009). Such students are also more courageous and willing to use technology. Examining student engagement in this study was able to identify students who are on track for success and those who need additional support to succeed (Student Support).

The study findings also was able to further provide some relationship as to the quality of the learning activities, the quality and quantity of log views based on the tools used and the course participation and academic performance of students. Increasing student engagement could be an important step in helping students and improving online education and participation and computer literacy skills (Henrie, et al(2015).

The more a student is engaged in academic works or the learning environment, the greater their knowledge acquisition and cognitive development (Bolliger, D. U., & Halupa, C. (2018). Students who are fully engaged are more likely to succeed than those who are less engaged in an online teaching environment.

Main Highlights of the Research Study:

Theoretical Contribution

This study extends student engagement theory by demonstrating how behavioral, emotional and cognitive engagement can be operationalized using LMS log-view data in an ODeL context. The findings support the integration of engagement theory with learning analytics to provide a more nuanced understanding of online learning behaviours.

Social Implications for Odel Student Support

The findings highlight that Behavioral engagement (observable actions like attending class, submitting assignments) is the foundation, but needs to be paired with cognitive engagement (mental effort, critical thinking, self-monitoring) to produce high academic performance.

Practical Implications for ODeL Student Support

The findings highlight the value of LMS analytics for early identification of at-risk

students , assessment-driven engagement design and data-informed student support interventions in ODeL institutions (United Nations Educational, Scientific and Cultural Organization, 1998).

7. Conclusion

LMS log data provide valuable insights into student engagement in ODeL environments. Higher participation levels are associated with deeper and more consistent engagement, underscoring the importance of analytics-informed teaching and student support strategies.

8. Declarations and Statements:

Conflict of interest:

The authors declare no potential conflict of interests.

Consent for Human Participants

Informed consent was gained from the research participants prior to data collection. Written informed consent was obtained from all participants prior to their inclusion in the study. Participants were informed about the purpose of the study, the voluntary nature of participation, their right to withdraw at any stage without penalty, and the measures taken to ensure confidentiality and anonymity. No personally identifiable information was collected or reported.

Consent to Publish declaration: not applicable

Ethics, Consent to Participate, and Consent to Publish declarations:

This study received ethical clearance from the University of South Africa Research Ethics Committee. The research was conducted in accordance with institutional research ethics guidelines and relevant national regulations governing research involving human participants.

Data Availability Statement.

The datasets generated during and or analyzed during the current study are not publicly available due to institutional ethical and privacy restrictions but are available from the corresponding author on reasonable request.

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Author Contribution Statement:

Marang Tebogo Mamahlodi conceptualized the study, developed the theoretical framework, conducted the data analysis and calculations, and drafted the original manuscript. The author reviewed and approved the final version of the manuscript.

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