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Impact of Year-Level Progression on Students' Performance: A Longitudinal Study of LMS Effectiveness at University of Cape Coast (UCC)

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Abstract

This study explores how year-level progression influences students' engagement with the Learning Management System (LMS) at the University of Cape Coast (UCC). It examines usage patterns across academic levels, the relationship between LMS engagement and academic performance, and barriers to effective LMS utilization. Using time-series analysis, linear regression, correlation analysis, and factor analysis, the study provides a nuanced understanding of LMS engagement dynamics. Findings reveal a progressive increase in LMS usage from first-year to final-year students, with final-year students demonstrating the highest and most consistent engagement due to their reliance on LMS for advanced academic tasks. First-year students, however, face adaptation challenges, resulting in sporadic usage. While year-level progression significantly influences LMS engagement ($R = 0.621$), academic performance and credit hours completed showed weak correlations with LMS utilization ($r = 0.082$, $p > 0.05$), suggesting that other factors contribute more directly to academic success. Barriers to LMS usage were categorized into three main components: inadequate infrastructure and high data costs (40.3%), insufficient institutional support (13.5%), and usability and device accessibility challenges (10.1%). The findings highlight critical policy implications. They call for targeted interventions like digital literacy training for first-year students, strengthened LMS infrastructure to ensure equitable access, and tailored resource allocation for advanced academic needs. Recommendations include partnering with internet service providers to subsidize data costs, enhancing technical and academic support systems, and introducing specialized LMS features for final-year students. The study concludes that while LMS plays a pivotal role in

academic engagement, its effective utilization depends on addressing infrastructural, institutional, and user-specific barriers. By implementing the proposed measures, UCC can optimize LMS functionality, enhance student engagement, and support academic success across all levels, providing a model for other higher education institutions.

Keywords

Learning Management System (LMS), Academic Performance, Student Engagement, Year-Level Progression, Online Learning

1. Background to the Study

Technology has revolutionized education, offering new ways to engage, assess, and support students (Sung et al., 2020). Among these innovations, Learning Management Systems (LMS) stand out as a powerful platform for delivering learning materials, facilitating discussions, and tracking performance. Globally, technology-driven learning platforms like LMS have transformed traditional education by promoting flexibility and accessibility. A study by Al-Fraihat et al. (2020) found that LMS significantly impacts students' engagement, satisfaction, and academic performance when appropriately implemented. The study further asserts that ffeatures like instant feedback, personalized learning paths, and real-time tracking of progress make LMS indispensable in modern education. These benefits are particularly evident in higher education where diverse student needs necessitate adaptable learning solutions (Wang et al., 2020). Despite their potential, challenges persist in utilizing LMS effectively. Institutions often struggle with technical issues, limited faculty training, and resistance from students unfamiliar with digital platforms. These limitations have hindered performance improvements especially if LMS systems are not tailored to students' academic progression. For example, Shadat et al. (2021) highlighted that institutions without structured LMS evaluations fail to bridge performance gaps between underperforming and high-achieving students, exacerbating inequalities in educational outcomes.

This means that LMSs are essential tools for supporting teaching, learning, and assessment in universities. They enable seamless interaction between students and lecturers while providing resources that cater to various learning styles. However, students' engagement with LMS often changes as they advance through academic levels. According to Al-Fraihat et al. (2020), freshmen are more likely to rely heavily on LMS for guidance while seniors use them selectively for specific academic goals. This progression underscores the importance of adapting LMS features to meet evolving needs. Studies have shown that year-level progression can influence students' interaction with LMS features like discussion forums, quizzes, and resource sharing (Makokha & Mutisya, 2019; Bolliger & Martin, 2021). Similarly, Heo & Han (2021) noted that sophomores often engage more in group-oriented

tasks whereas juniors and seniors might prioritize research-related activities. These variations necessitate a deeper understanding of how LMS usage impacts academic outcomes at each level ensuring the platform supports students' needs throughout their academic journey.

On the other hand, research shows that evaluating LMS effectiveness across different year levels provides valuable insights into its role in academic success (Kintu et al., 2020). This evaluation has revealed patterns in how students engage with LMS in helping universities optimize the platform for maximum impact. For example, a study by Adarkwah (2021) found that Ghanaian students' LMS engagement was higher among freshmen compared to seniors, attributed to the novelty of the platform and initial academic demands. Thus, understanding these dynamics is essential for tailoring LMS features to different stages of academic progression. At UCC, for instance, aligning LMS functionalities with the specific needs of first-year students could ease their transition into higher education while advanced features might better support final-year students' research and project-based activities. Tracking effectiveness also highlights underutilized features, enabling institutions to address barriers to engagement like poor user interface or lack of awareness.

Furthermore, identifying year-level-specific challenges in LMS usage provides specific relevant information that tailors training programs for both students and faculty. Studies have shown that tertiary institutions leverage these insights to improve user experience, streamline course delivery, and boost overall academic satisfaction 88. By doing so, a University like UCC can foster an inclusive learning environment where all students thrive regardless of their academic stage. Theoretical frameworks provide a foundation for analyzing how LMS enhances academic performance. The Technology Acceptance Model (TAM), for instance, posits that perceived usefulness and ease of use influence technology adoption (Venkatesh et al., 2016). Thus, applying TAM will explain variations in LMS usage across year levels as students may find certain features more or less intuitive depending on their academic experience. Similarly, Constructivist Learning Theory emphasizes the importance of active participation in constructing knowledge (Aljohani, 2017). The theory argues that LMS features like discussion forums and interactive assignments align and support collaborative learning. It means that year-level progression affects how students engage with these features, as senior students prefer independent research over group discussions.

Finally, Self-Regulated Learning Theory highlights the role of LMS in promoting autonomy (Zimmerman & Schunk, 2011). According to the theory, features like goal-setting tools and progress trackers empower students to manage their learning effectively. However, as students advance, their reliance on these tools may decline, emphasizing the need for adaptive LMS designs that cater to varying self-regulation capabilities. Globally, Universities have embraced LMS to enhance educational delivery. In the United States, institutions like Harvard and MIT have integrated advanced LMS systems that offer AI-driven analytics for personalized

learning (Educause, 2020). In Africa, however, LMS adoption faces challenges like limited internet connectivity and inadequate training. Adarkwah (2021) reported that many African Universities struggle to implement LMS effectively due to infrastructural constraints. In Ghana, institutions like the University of Ghana and Kwame Nkrumah University of Science and Technology (KNUST) have made significant strides in LMS adoption. However, challenges persist, including low student engagement and technical issues. At UCC, LMS use is widespread, but its effectiveness varies significantly across academic levels. Addressing these gaps requires a localized approach that considers the unique needs and resources of Ghanaian Universities.

1.1. Problem Statement

Learning Management Systems (LMS) have transformed educational landscapes by providing digital platforms to enhance learning, teaching, and assessment. Despite their widespread adoption, there are persistent challenges in understanding how students' academic performance evolves with LMS use across different year levels. A study by Adarkwah (2021) highlighted that in Ghana, LMS adoption was crucial during the COVID-19 pandemic but faced issues like declining student engagement and inconsistent academic outcomes. This problem reflects gaps in evaluating LMS effectiveness over time, particularly at institutions like the University of Cape Coast (UCC), where LMS plays a central role in academic delivery. The magnitude of this problem is evident in the uneven usage and success rates among UCC students at different academic levels. For instance, a study by Acheampong and Fosu (2020) found that first-year students showed a 75% reliance on LMS for foundational courses, while only 45% of final-year students engaged with the system due to dissatisfaction with advanced functionalities.

Similarly, a survey by Abdul-Gafaar et al. (2024) revealed that only 52% of students accessed LMS consistently, and of those, fewer than 30% used it for tasks beyond downloading lecture notes. These findings highlight a declining trend in LMS engagement, particularly among upper-level students, which may adversely impact academic performance. Several factors contribute to this problem. Limited digital literacy among students and faculty, inadequate training on LMS functionalities, and technical barriers like inconsistent internet connectivity hinder effective usage (Adarkwah, 2021). Furthermore, the lack of tailored features that address specific academic needs at different year levels exacerbates the problem, leaving students unable to fully leverage LMS for their learning journeys. Efforts have been made to address these challenges. For example, UCC has implemented periodic training workshops for students and lecturers to improve digital literacy and introduced infrastructure upgrades to enhance LMS accessibility. Acheampong and Fosu (2020) also noted attempts to integrate interactive features like discussion forums and real-time assessments to boost engagement. However, these interventions have yet to address the core issue of adapting LMS to meet the evolving needs of students as they progress academically.

This creates a significant research gap. While studies have focused on the general effectiveness of LMS, few have explored how year-level progression influences engagement and academic outcomes. Understanding this dynamic is crucial to optimizing LMS usage and ensuring its long-term effectiveness. Without addressing this gap, institutions risk investing in LMS systems that fail to deliver equitable and impactful academic benefits. This study is necessary to provide insights into how LMS can be tailored to different academic stages to enhance its effectiveness. By examining the relationship between year-level progression and LMS engagement, the study aims to inform evidence-based interventions that improve user experience and academic performance. It also seeks to offer practical recommendations for policy and infrastructure improvements that benefit students and faculty alike. To address this problem, this study will evaluate LMS usage across year levels at UCC, identifying patterns, challenges, and potential solutions. The findings will guide the optimization of LMS features to better support teaching and learning, fostering academic success for all students regardless of their year level.

1.2. Purpose of the Study

The purpose of this study is to examine how year-level progression influences students' engagement, usage patterns, and academic performance concerning the Learning Management System (LMS) at the University of Cape Coast (UCC). The study seeks to identify challenges, explore opportunities for improvement, and provide actionable recommendations to optimize LMS effectiveness across different academic levels. The study will specifically seek to:

1. To analyze the usage patterns of LMS among students at different academic levels at UCC.

2. To analyze how year-level progression influences students' engagement with LMS at UCC.

3. To examine the relationship between LMS engagement and academic performance across year levels.

4. To identify barriers that affect effective LMS usage across the year levels at UCC.

2. Literature Review

2.1. Technology in Education

The integration of technology in education has significantly altered the teaching and learning landscape. Learning Management Systems (LMS) are at the forefront of this transformation, offering digital platforms that enhance student engagement and facilitate learning by providing instant feedback, personalized learning paths, and real-time tracking of progress. Almarashdeh et al. (2019) stated that LMS platforms allow students to access course materials, engage in discussions, complete quizzes, and continuously track their progress. The potential of LMS is further emphasized by Chou et al. (2020), who note that advanced systems can also harness AI-driven analytics to offer personalized learning experiences based

on individual performance data.

However, while LMS offers numerous benefits there are challenges related to its adoption and effectiveness. Research by Cochrane et al. (2020) reveals that the success of LMS largely depends on the extent of training provided to both students and instructors besides the integration of the platform with institutional goals. Some students, especially those in developing regions, face technical barriers like limited internet access or insufficient digital literacy hindering the full utilization of LMS platforms. This study aligns with the purpose of the current research by suggesting that the functionality of LMS is only as effective as the student's ability to engage with it.

The literature also suggests that as educational institutions increasingly rely on technology, there is a need for more adaptive and user-friendly systems to cater to diverse learning styles and levels. The purpose of this study aligns with these insights, aiming to evaluate how LMS effectiveness evolves across different year levels. This will help identify which features are most beneficial at each academic stage and how they can be tailored to improve student learning outcomes.

2.2. Year-Level Progression

Year-level progression plays a critical role in shaping students' academic engagement and their interactions with LMS features. Research suggests that students' learning behaviors evolve as they progress through their academic journey. For example, freshmen are more likely to engage with basic LMS features like course materials and discussion forums, whereas upper-year students tend to utilize more advanced features like research databases and self-assessment tools (Rienties et al., 2020). This progression in LMS engagement can be attributed to increased academic maturity and exposure to different learning demands as students move from one-year level to the next. However, there is some debate about whether year-level progression truly influences LMS engagement. A study by Gok et al. (2019) found that while academic maturity plays a role, external factors like course design and instructor involvement can have a more significant impact on how students interact with LMS.

These findings suggest that the influence of year-level progression may not be as pronounced as often assumed. This presents an alternative view, indicating that other institutional factors could be equally or more important in determining LMS usage. By focusing on year-level progression this study can investigate how LMS features support different academic stages. This aligns with the study's purpose of exploring how year-level differences impact student interactions with LMS, which can then inform strategies to tailor LMS features to enhance engagement at each academic stage. The findings can contribute to understanding whether institutions need to adapt their LMS offerings to meet the evolving needs of students.

2.3. The Effectiveness of LMS

The effectiveness of LMS is often measured by its ability to improve learning

outcomes, engagement, and satisfaction among students. Studies have shown that well-designed LMS platforms can significantly enhance academic performance by providing personalized learning experiences and immediate feedback (Almarashdeh et al., 2019). For instance, the integration of automated quizzes and feedback systems enables students to learn at their own pace, thus promoting self-regulated learning (Zimmerman, 2002). However, the success of LMS in improving learning outcomes depends on several factors, including user interface design, the quality of course materials, and institutional support. Conversely, some studies highlight that LMS might not always lead to improved academic performance. A study by Kintu et al. (2020) pointed out that while LMS offers valuable tools, its effectiveness is limited without proper instructor involvement and student motivation. Additionally, factors like inadequate internet connectivity and lack of digital literacy can impede the full utilization of LMS. These alternative views suggest that while LMS is a useful tool, its impact on learning outcomes might not be as substantial as anticipated without addressing these underlying issues. This research will assess LMS effectiveness across different year levels at the University of Cape Coast (UCC), with the goal of understanding which features are most impactful at different academic stages. The findings will help tailor LMS design to better meet the needs of students at various levels of their academic journey.

2.4. Theoretical Frameworks

Several educational theories can help explain the role of LMS in promoting academic success. The Technology Acceptance Model (TAM) suggests that students' acceptance of technology, including LMS, depends on its perceived usefulness and ease of use (Davis, 1989). This model aligns with the current study, as it provides a framework for understanding how students across different year levels may perceive and engage with LMS. Additionally, the Constructivist Learning Theory emphasizes that active participation in learning leads to deeper understanding. According to Jonassen and Land (2012), LMS platforms that facilitate interactive activities like collaborative projects and discussions can foster this active engagement. On the other hand, Self-Regulated Learning Theory highlights how LMS can support students in taking control of their learning process. Zimmerman and Schunk (2011) argue that LMS features like goal-setting tools and progress tracking encourage students to monitor their learning, adjust, and achieve better outcomes. These frameworks are crucial for understanding how LMS affects students at different year levels, as they provide insights into how technology can be used to support student autonomy and engagement. Incorporating these theories into the study will provide a solid foundation for analyzing the role of LMS in fostering student engagement and learning outcomes. This aligns with the purpose of the study by offering a comprehensive understanding of how year-level progression influences LMS engagement.

2.5. Global and Local Context of LMS Adoption

Globally, institutions have increasingly adopted LMS platforms to facilitate

blended and online learning. Institutions like Harvard and MIT use LMS to offer personalized learning experiences through AI-driven analytics, enabling students to engage with course materials in a way that suits their learning styles (Cochrane et al., 2020). Similarly, in African contexts, universities are leveraging LMS to overcome challenges such as large class sizes and limited physical resources (Ssekakubo et al., 2020). Despite these advancements, the adoption of LMS in some regions has been slow, largely due to infrastructural challenges and resistance from both students and instructors. The local context at the University of Cape Coast (UCC) reflects some of these challenges. According to recent reports, while UCC has made strides in implementing LMS, issues such as limited internet access, lack of adequate training, and low digital literacy remain prevalent among students and staff (Asare et al., 2021).

This aligns with findings from other African universities, where the digital divide continues to affect the effectiveness of LMS platforms. This study will address these challenges by evaluating how LMS can be made more effective at UCC, specifically in terms of year-level progression. By understanding the local barriers to LMS effectiveness, the study can propose strategies to overcome these challenges and enhance LMS engagement for all students.

2.6. Improving LMS Features

Improving LMS features to better support students' academic needs is a central concern for many institutions. Research suggests that adaptive learning technologies, personalized feedback, and collaborative tools are among the most impactful features in enhancing student engagement (Panadero, 2017). For example, personalized learning paths allow students to progress at their own pace, while interactive features like discussion forums encourage peer learning and engagement. Studies by Almarashdeh et al. (2019) and Gok et al. (2019) suggest that the integration of such features can improve student satisfaction and academic performance. However, there is also an argument that the effectiveness of these features depends on how they are implemented. Kintu et al. (2020) argue that without proper training for both students and instructors, these advanced features may not be fully utilized. Moreover, the design of the LMS should consider students' varying levels of technical proficiency to ensure equal access to learning resources. The purpose of this study is to assess how these LMS features can be optimized for students at different year levels. By identifying which features are most effective for students at each academic stage, the study will offer valuable insights into how UCC can improve its LMS to better support student learning outcomes.

3. Research Methods

3.1. Research Design

This study adopted a quantitative research design, specifically a descriptive and correlational approach, to address the study objectives. The descriptive aspect facilitated the analysis of LMS usage patterns and barriers while the correlational

approach examined the relationships between LMS engagement, year-level progression, and academic performance. This design aligned well with the study's goal of understanding trends and relationships quantitatively, ensuring objective analysis (Creswell & Poth, 2016). The design is suitable because it allows for the use of structured instruments like questionnaires to collect standardized data from a large student population. Such a framework is particularly effective for analyzing variables like year-level progression, LMS engagement, and academic performance (Babbie, 2020). It also supported the examination of differences in LMS engagement across academic levels and its impact on academic outcomes. Furthermore, the use of correlational analysis made it possible to identify significant associations between key variables, such as the extent to which LMS engagement predicted academic performance. This is crucial for addressing objectives related to identifying barriers and understanding LMS usage trends across year levels.

3.2. Study Area

The study was conducted at the University of Cape Coast (UCC), a leading tertiary institution in Ghana known for its robust academic programs and growing adoption of technology in education. The UCC's Learning Management System (LMS) is widely used for teaching, learning, and assessment, making it an ideal context for investigating LMS effectiveness and its relation to year-level progression. The UCC was chosen due to its diverse student population, consisting of over 20,000 students from different year levels offering a unique opportunity to examine how LMS usage varies across academic progressions. The institution's integration of LMS into both academic and administrative processes provided a relevant platform for evaluating the interplay between technology and academic performance.

3.3. Study Population

The study targeted the student population at UCC, focusing on first-year, second/third-year, and final-year students. The population breakdown is shown below (Table 1):

Table 1. Accessible population.

Year Level	Population	Justification
First Year	5000	New to LMS, exploratory stage of usage
Second/Third Year	10,000	Established users, reflecting sustained use
Final Year	5000	Advanced users, prioritize academic outcomes

These groups were selected to capture variations in LMS engagement and academic performance across different stages of academic progression.

3.4. Sample and Sampling Techniques

A total sample size of 1152 students were determined using Cochran's formula for large populations:

$$n = \frac{Z^2 \cdot P \cdot (1-P)}{e^2}$$

where:

- $Z = 1.96$ (confidence level of 95%);
- $P = 0.5$ (assumed proportion);
- e = 0.05 (margin of error).

The formula yielded a minimum sample size of 384 per year level. Stratified random sampling was used to ensure fair representation across year levels. Table 2 below illustrates the sampling distribution:

Table 2. Sample size.

Year Level	Sample Size	Sampling Justification
First Year	384	To capture early-stage LMS usage patterns
Second/Third Year	384	To examine sustained engagement and usage
Final Year	384	To assess advanced engagement and outcomes

3.5. Data Collection Instrument

A structured questionnaire was designed to measure year-level progression and LMS engagement using validated scales. Year-level progression in higher education is a multifaceted process influenced by various academic, structural, and institutional factors. Measuring it through academic performance (GPA) provides an objective benchmark of a student's mastery of coursework and readiness for the next academic level. The GPA reflects students' intellectual abilities, work ethic, and adaptability to academic demands, which are critical for determining whether they meet the standards to progress. It is also widely accepted as a universal metric in educational research, allowing for comparisons across institutions and studies. This makes it a foundational determinant in assessing progression. Credit hour completion complements GPA by capturing students' quantitative progress through their academic program. It ensures that students not only perform well academically but also accumulate the requisite credits to advance.

This metric is especially relevant in modular academic systems, where completion of specific credit thresholds signifies readiness for the next stage. It also accounts for scenarios where students may excel in specific areas while failing to meet overall credit requirements, offering a more holistic view of their progression. The inclusion of curriculum structure, student support systems, and personal and institutional factors provides a broader understanding of year-level progression. Curriculum structure evaluates the alignment of courses with academic and career objectives, influencing how effectively students are prepared for subsequent levels. Student support systems assess the availability of institutional resources like tutoring and counseling that aid students in overcoming challenges. Personal and institutional factors, measured by engagement and accessibility scales, reflect how well the institution creates an environment conducive to

learning. Together, these determinants capture the academic, structural, and contextual aspects that collectively influence year-level progression. On the other hand, LMS Engagement was mmeasured using the Utrecht Work Engagement Scale (UWES).

3.6. Data Collection Process

Participants were invited via email and class announcements to participate in the study. Information sessions were held to explain the study's purpose and assure students of confidentiality. A Google Forms link was shared for online data collection, complemented by paper-based forms distributed to students without internet access. Participants provided informed consent, and data collection spanned six weeks to ensure an adequate response rate.

3.7. Data Analysis

The data analysis approach employed in this study utilized specific techniques tailored to address each objective effectively, ensuring the findings were robust and reliable. For Objective 1, time-series analysis in Microsoft Excel was used to examine LMS usage patterns. This method allowed for the identification of trends over time, providing insights into how students' interaction with LMS evolved throughout the academic year. Time-series analysis is particularly useful for understanding usage fluctuations, such as increased engagement during examination periods or variations across different year levels. Its visual and quantitative outputs enabled a clear representation of trends critical for addressing the first objective. For Objective 2, linear regression analysis was conducted to explore how year-level progression influenced students' engagement with LMS. This technique was chosen because it establishes the predictive relationship between independent (year-level progression) and dependent variables (LMS engagement). Linear regression analysis provided a statistical basis to determine whether students' engagement levels increased, decreased, or remained constant as they progressed through academic levels. It was instrumental in identifying the strength and direction of this relationship, helping to quantify the effect of year-level progression on engagement.

For Objective 3, correlation analysis was applied to assess the relationship between LMS engagement and academic performance. This method revealed whether a statistically significant association existed between these variables, offering insights into the extent to which LMS usage might impact academic success. For Objective 4, factor analysis was used to identify barriers to effective LMS usage. This technique allowed for the reduction of complex data into key underlying factors, making it easier to interpret and prioritize challenges. Factor analysis is ideal for identifying latent variables that influence observed behaviors, providing a nuanced understanding of barriers and potential areas for intervention. The research method is justified as it enabled systematic and objective analysis of variables, ensuring reproducibility and comparability of results. This method was appropriate

for capturing patterns, relationships, and barriers related to LMS usage across different year levels.

4. Results and Discussion

4.1. The Usage Patterns of LMS among Students at Different Academic Levels at UCC

The chart in Figure 1 presents a comparative analysis of Learning Management System (LMS) usage patterns among the three categories of students at different academic levels at UCC. This includes the first-year students, second-to-third-year, and final-year students. Usage trends show notable fluctuations, with a progressive increase from first-year to final-year students. It can be observed that first-year students exhibit sporadic usage, with significant variability that indicates adaptation challenges to LMS platforms. The second-to-third-year group displays a steadier, more consistent usage pattern, likely reflecting a stabilized integration of LMS into their academic routines. The final-year students demonstrate the highest and most uniform LMS engagement underscoring the heightened dependency on these systems as they approach the culmination of their academic programs. The progression from intermittent to intensive LMS use across academic levels illustrates a learning curve in digital resource utilization. Initial inconsistencies in first-year usage suggest the need for interventions to bridge technological literacy gaps. Meanwhile, the increased reliance by final-year students signifies LMS's pivotal role in students' academic activities. These trends reveal critical insights into how academic maturity influences digital engagement and the role of LMS in fostering educational development at UCC.

The chart answers the objective of analyzing LMS usage patterns across academic levels by revealing a clear trajectory of increasing engagement from the first year to the final year. This progression highlights a correlation between the academic level and LMS utilization intensity. The fluctuating initial engagement indicates areas where additional support might enhance first-year students' transition to digital learning environments. Conversely, the stabilization observed in the intermediate years suggests effective adaptation, while the high final-year engagement showcases the critical reliance on LMS for advanced academic tasks. This layered understanding not only affirms the pivotal role of LMS in facilitating academic activities but also underscores the importance of tailoring digital learning strategies to specific academic levels. These patterns offer valuable insights for optimizing LMS deployment, ensuring all students regardless of year level can effectively leverage the platform for their academic growth.

The findings on year-level progression underscore a direct relationship between academic maturity and LMS reliance. Early inconsistencies in usage point to the need for targeted orientation programs and digital literacy training for first-year students. Without such interventions, the gap in digital competencies could impede effective learning, prolonging the adaptation period and potentially affecting academic performance in the early stages. For intermediate students, consistent

LMS use reflects its integration into routine academic workflows. Ensuring continued access to these platforms and introducing advanced features at this stage could further enhance engagement. For final-year students, the reliance on LMS underpins its essential role in managing complex tasks like thesis writing, group projects, and specialized research. Allocating resources to support these advanced functionalities, such as collaborative tools and research databases, would significantly benefit this cohort. These usage trends justify the need for strategic resource allocation policies. UCC must prioritize investments in training for first-year students, maintain robust LMS infrastructure for intermediates, and augment resources for final-year students. Such measures ensure equitable access and optimize the educational value of LMS, promoting academic success across all levels.

The findings align with studies such as Selwyn (2010), which emphasize the role of LMS in supporting academic progression through enhanced accessibility and resource consolidation. The observed progression mirrors findings from Porter et al., 2016, who highlighted the gradual increase in digital engagement as students become more entrenched in academic routines. This alignment underscores the universal trajectory of digital literacy development in higher education contexts. However, the findings diverge from research by Kumar (2021), which posited that first-year students show uniformly high LMS engagement due to institutional mandates. The variability observed at UCC suggests that compliance does not guarantee effective utilization, pointing to the need for tailored interventions. Additionally, while many studies focus on resource limitations as a barrier, the UCC-specific context indicates that awareness and literacy are equally significant factors. Overall, this study contributes to the literature by highlighting unique patterns at UCC, advocating for nuanced policy approaches tailored to year-level needs. Addressing both alignment and divergence reinforces the importance of a contextual understanding of resource allocation and LMS integration strategies.

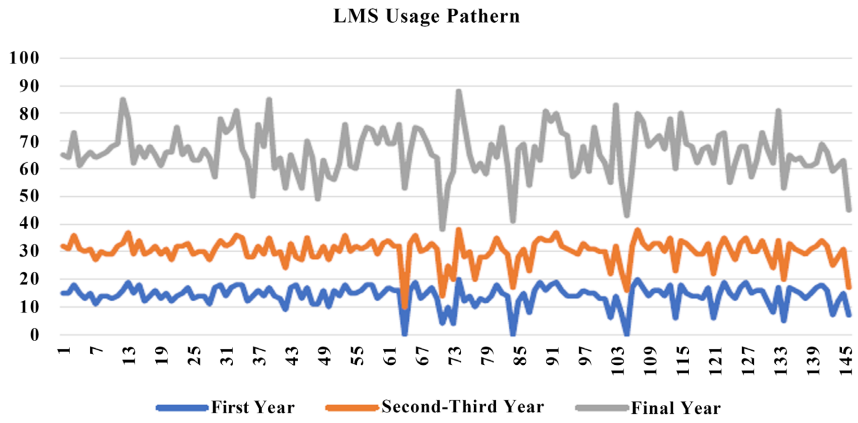

Figure 1. LMS usage pattern.

4.2. How Year-Level Progression Influences Students' Engagement with LMS at UCC

The results in Table 1, year-level progression is measured by academic performance,

credit hours completion, student support systems, and personal and institutional support factors. The results of the analysis are in three categories.

Firstly, the Model Summary

• R = 0.621: This indicates a moderate positive relationship between year-level progression and students' engagement with the Learning Management System (LMS). The closer the value is to 1, the stronger the relationship between the student's year-level progress and their engagement with the LMS. The results indicate the relation between the two variables is are about 62.1% strong.

• R Square = 0.603: This means that approximately 60.3% of the variance in students' engagement with LMS can be explained by the predictors (academic performance, credit hours completion, student support systems, and personal and institutional support factors).

• Adjusted R Square = 0.57: The adjusted R-squared is lower, reflecting the effect of adding more variables in the model. This suggests that after adjusting for the number of predictors, only 57% of the variance in engagement is explained, which might indicate that other unmeasured variables could be influencing engagement.

• Standard Error of the Estimate = 1.4949: This value reflects the average distance between the actual data points and the values predicted by the model. The lower value indicates more accurate predictions.

Secondly, the ANOVA Table

• F = 3.861, Sig. = 0.005: The F-test tests whether the model is statistically significant. Since the significance value (p-value) is less than 0.05 (0.005), it indicates that the regression model significantly predicts students' engagement with the LMS suggesting that at least one of the predictors has a meaningful relationship with LMS engagement.

Thirdly, the Coefficients in Table

• Constant (61.643): This is the intercept of the regression line, representing the baseline level of students' LMS engagement when all independent variables are zero. It suggests that without any of the factors in the model, the engagement level is about 61.64.

• Academic Performance (B = 0.202, $p = 0.209$): The positive but statistically non-significant coefficient suggests that academic performance has a slight positive influence on LMS engagement, but the relationship is not strong enough to be considered significant in this model ($p > 0.05$). This means that academic performance might have a minor role in engagement, but it is not a significant predictor.

• Credit Hours Completion (B = −0.119, $p = 0.534$): The negative coefficient indicates that credit hour completion has a slight negative impact on engagement, though it is not statistically significant ($p > 0.05$). This suggests that as students complete more credit hours, their engagement with the LMS might decrease, but this relationship is weak and not significant.

• Student Support Systems (B = 0.418, $p = 0.022$): This positive and statistically

significant coefficient indicates that student support systems have a significant positive effect on LMS engagement. As student support systems improve, engagement with the LMS increases, highlighting the importance of effective student support services in encouraging LMS usage.

• Personal and Institutional Support Factors (B = −1.830, $p = 0.001$): The negative and statistically significant coefficient suggests that personal and institutional support factors negatively influence LMS engagement. This could mean that students who receive less personal or institutional support might engage more with the LMS, or that those with higher support might not feel the need to engage as much with the LMS. The significant p-value ($p < 0.05$) supports this as an important finding.

The results highlight how various year-level progression factors influence students' engagement with LMS at UCC. Specifically:

• Student Support Systems and Personal and Institutional Support Factors are found to have statistically significant relationships with LMS engagement. As students progress through different year levels, it means their interaction with LMS features is influenced by the availability of support systems, suggesting that engagement patterns might shift based on the level of support students receive.

• The lack of significant relationships between Academic Performance and Credit Hour Completion suggests that year-level progression may not be as directly related to these factors, and engagement with LMS could depend on other aspects of the academic environment, such as support systems or institutional factors.

The results suggest that support systems, both academic and personal, play a pivotal role in students' engagement with LMS. Schools that provide strong student support services (e.g., advising, counseling, peer support, etc.) likely see higher engagement with LMS, which in turn can support academic success. Conversely, high levels of institutional support might not always translate into higher LMS engagement, as students with ample resources might not need to depend as heavily on the LMS for their learning. This points to the need for targeted interventions to enhance engagement across various levels of students, particularly for those who might not have as much personal or institutional support. These findings align with research by Al-Fraihat et al. (2020), who found that the presence of strong support systems significantly influences students' engagement with LMS. Similarly, Ashrafi et al. (2022), found that institutional and personal support factors play a key role in determining LMS usage among students. However, the negative relationship observed between Personal and Institutional Support Factors and LMS engagement might contradict some studies that found a positive correlation, suggesting that students who receive greater support may be more likely to use LMS platforms. This contradiction could be due to cultural or contextual differences in the learning environment.

The findings highlight the need for policymakers and university administrators to prioritize strengthening student support systems to enhance LMS engagement.

For example, academic advising, tutoring services, and mental health support may directly affect students' use of LMS tools. Additionally, universities should reassess how institutional support is delivered to ensure it doesn't inadvertently discourage LMS engagement. This study could influence decisions about resource allocation, particularly in providing technological tools, training for both students and staff, and support services that are directly linked to improving engagement with LMS platforms. Moreover, the results underscore the importance of tailoring strategies to the different needs of students at various year levels, ensuring a more personalized approach to LMS usage (Table 3).

Table 3. Effect of year-level progress on LMS engagement.

Model Summary	R	R Square	Adjusted R Square	Std. Error of the Estimate				
	0.621[a]	0.603	0.57	1.4949				
ANOVA		Sum of Squares	df	Mean Square	F	Sig.		
	Regression	867.478	4	216.869	3.861	0.005[b]		
	Residual	7527.270	134	56.174				
	Total	8394.748	138					
Coefficients		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
	(Constant)	61.643	8.669		7.111	0.000	44.498	78.788
	Academic Performance	0.202	0.160	0.148	1.262	0.209	−0.114	0.518
	Credit hours completion	−0.119	0.191	−0.073	−0.624	0.534	−0.496	0.258
	Student Support Systems	0.418	0.181	0.195	2.316	0.022	0.061	0.775
	Personal and Institutional Support Factors	−1.830	0.536	−0.287	−3.414	0.001	−2.890	−0.770

4.3. The Relationship between LMS Engagement and Academic Performance across Year Levels

• The Pearson Correlation Coefficient between Academic Performance and LMS Engagement is 0.082. This value indicates a very weak positive relationship between the two variables. In essence, slight increases in academic performance may be associated with slight increases in LMS engagement, but the relationship is minimal.

Significance (2-tailed)

• The p-value (Sig. (2-tailed)) is 0.338, which is greater than the conventional

significance threshold of 0.05. This means that the relationship between academic performance and LMS engagement is not statistically significant. Therefore, we cannot confidently conclude that changes in academic performance are associated with changes in LMS engagement.

Sample Size (N)

• The sample size for both variables is 384, indicating that 384 students were included in this analysis. A larger sample might provide more power to detect a relationship, but given this sample size, the observed correlation is not significant.

The research objective is to examine the relationship between academic performance and LMS engagement. The weak correlation and non-significant p-value suggest that academic performance has little to no meaningful relationship with how students engage with LMS. This implies that students' use of LMS does not directly depend on their academic achievements, at least within this sample. The findings highlight that other factors, such as support systems or curriculum design, may play a more significant role in influencing LMS engagement. The findings suggest that academic performance alone is not a strong predictor of LMS engagement. This indicates that students may not perceive the LMS as a critical tool for improving grades or achieving academic success. Instead, their engagement with the LMS might be driven by other motivations, such as ease of access, technological familiarity, or requirements set by instructors. This weak relationship also suggests the need for interventions that better integrate LMS tools into the academic success framework. For example, universities could align LMS functionalities more closely with performance-enhancing activities, such as formative assessments or personalized feedback.

These findings are consistent with studies such as Khan et al. (2020), which reported that LMS usage is not always a direct contributor to higher academic performance but is more strongly linked to organizational and instructional design factors. However, they contrast with studies like Dawson et al. (2019), which found moderate correlations between LMS activity and GPA, suggesting that the role of LMS in academic performance might be context-dependent. Differences in student perceptions, faculty expectations, and the quality of LMS implementation could explain these variations. The results underscore the importance of enhancing the pedagogical integration of LMS into teaching and learning processes. Universities should consider:

• Incentivizing LMS usage by linking it more explicitly to academic outcomes, such as incorporating graded assignments, quizzes, and other performance metrics into the platform.

• Improving training and awareness among both students and faculty to highlight how LMS features can directly support academic performance.

• Allocating resources to identify and address barriers that might discourage effective LMS engagement.

These steps could ensure that LMS becomes a more integral tool for academic success rather than just a supplementary resource (**Table 4**).

Table 4. LMS engagement and student performance.

		Academic Performance	LMS Engagement
Academic Performance	Pearson Correlation	1	0.082
	Sig. (2-tailed)		0.338
	N	384	384
LMS Engagement	Pearson Correlation	0.082	1
	Sig. (2-tailed)	0.338	
	N	384	384

4.4. Barriers That Affect Effective LMS Usage across the Year Levels at UCC

Table 5 presents the factor loadings for items grouped under three components derived from the analysis. Factor loadings represent the strength and direction of the relationship between each variable and the component.

o Component 1: Strongly associated with items such as Inadequate Internet Connectivity (0.861), Lack of Training and Orientation (0.839), and High Costs of Internet Data (0.831). These suggest that this component likely represents barriers related to infrastructure and cost.

o Component 2: Dominated by Lack of Training and Orientation (0.902) and Inadequate Institutional Support (0.718), which likely represent issues related to institutional support and preparedness.

o Component 3: Includes Technical Issues with the LMS (0.771) and Device Accessibility Challenges (0.679), suggesting challenges in technology usability and access.

The three components explain a total of 63.9% of the variance in the data:

o Component 1 explains 40.3%, making it the most significant factor influencing LMS usage barriers.

o Component 2 accounts for 13.5%, highlighting the importance of institutional support.

o Component 3 contributes 10.1%, emphasizing usability and device-related issues.

The research objective focuses on identifying barriers to effective LMS usage. The results reveal three key dimensions of barriers:

1. *Infrastructure and Cost* (*Component* 1): Most prominent, indicating that inadequate internet connectivity, high data costs, and insufficient training are major deterrents.

2. *Institutional Support* (*Component* 2): Points to a need for robust institutional mechanisms, such as better orientation programs and consistent support.

3. *Usability and Access* (*Component* 3): Highlights that technical and device-related challenges remain significant for effective engagement.

These insights provide a nuanced understanding of the barriers, aligning well to explore these issues and their variation across contexts.

The findings emphasize that addressing barriers is critical for improving LMS engagement. For example:

• Infrastructure issues like poor internet connectivity and data costs limit access for students in underserved areas.

• A lack of training and institutional support could deter first-year students or those less familiar with digital tools.

• Technical challenges undermine user experience and may reduce LMS adoption, even among technologically proficient students.

This understanding highlights the need for targeted interventions to address specific barriers rather than generic solutions.

The findings resonate with Ahmad et al. (2023), who identified internet connectivity and institutional support as critical challenges in LMS adoption. Similarly, et Mohammadi et al. (2021) noted that technical usability issues are among the primary deterrents to LMS engagement in developing countries. However, the emphasis on cost barriers in this study adds depth, contrasting with studies in developed contexts where affordability is less of a concern.

1. *Improved Infrastructure:* Universities should prioritize investments in high-speed internet and subsidized data packages for students to reduce cost-related barriers.

2. *Comprehensive Training:* Orientation and training programs should be tailored to different user groups to build digital literacy and confidence in LMS usage.

3. *Enhanced Technical Support:* Institutions should address LMS usability issues by providing continuous technical support and ensuring system reliability.

Table 5. Barriers to student's usage of LMS.

	Component		
	1	2	3
Inadequate Internet Connectivity	0.861		
Lack of Training and Orientation	0.839		
High Costs of Internet Data	0.831		
Lack of Training and Orientation		0.902	
Inadequate Institutional Support		0.718	
Technical Issues with the LMS			0.771
Device Accessibility Challenges			0.679
Total Variance Explained	40.3%	13.5%	10.1%

4.5. Summary of the Study Findings

Key findings, policy implications, and recommendations are summarized as follows:

o *Year-Level Progression and LMS Engagement:* LMS usage progressively increases across academic levels, with first-year students displaying sporadic and

inconsistent engagement due to adaptation challenges. Second-to-third-year students show steadier and more consistent usage, indicating effective integration of LMS into their academic routines. Final-year students demonstrate the highest and most uniform engagement, reflecting a critical reliance on LMS for complex academic tasks like thesis writing and research projects.

o *LMS Engagement and Academic Performance:* The linear regression analysis revealed a moderate relationship between year-level progression and LMS engagement (R = 0.621). Student support systems positively influence LMS usage, while inadequate personal and institutional support negatively impacts engagement. However, the direct impact of academic performance and credit hours completed was not statistically significant.

o *Relationship between LMS Engagement and Academic Performance:* The correlation analysis between academic performance and LMS engagement showed a weak positive relationship ($r = 0.082$, $p > 0.05$), indicating that LMS engagement alone does not strongly predict academic success. This suggests that other factors, such as teaching quality and personal study habits, may play a significant role.

o *Barriers to LMS Usage:* Three major barriers were identified:

▪ Infrastructure and Cost (40.3%): Inadequate internet connectivity, high costs of internet data, and insufficient training.

▪ Institutional Support (13.5%): Lack of orientation and support from the institution.

▪ Usability and Access (10.1%): Device accessibility challenges and technical issues with the LMS.

4.6. Policy Implications

The findings highlight several critical areas requiring policy intervention to enhance LMS functionality and engagement at UCC:

• *Targeted Support for First-Year Students:* Introducing robust orientation programs and digital literacy training during the first year to address early adaptation challenges.

• *Strengthened LMS Infrastructure:* Ensuring reliable internet connectivity, subsidized data access, and robust technical support to address infrastructure barriers.

• *Tailored Resource Allocation:* Providing advanced LMS features, such as research databases and collaborative tools, for final-year students who heavily rely on the platform.

• *Institutional Capacity Building:* Enhancing institutional support systems to ensure consistent engagement across academic levels.

4.7. Recommendations

1. Enhancing Digital Literacy: Develop structured training programs for first-year students to familiarize them with LMS functionalities and improve their digital competencies. Regularly update training modules to reflect changes in LMS

platforms and tools.

2. Improving Accessibility and Infrastructure: Partner with internet service providers to offer affordable data packages for students. Invest in campus-wide high-speed internet connectivity and ensure seamless access to LMS resources.

3. Strengthening Support Systems: Establish dedicated help desks for addressing technical and academic challenges related to LMS usage. Incorporate regular feedback mechanisms to identify and address barriers experienced by students.

4. Promoting Advanced LMS Features: Introduce specialized tools such as plagiarism checkers, group project management systems, and AI-driven tutoring for final-year students. Integrate the LMS with library resources to enhance academic research capabilities.

5. Conclusion

The study underscores the importance of addressing barriers and tailoring interventions to academic levels to maximize LMS engagement. While academic maturity significantly influences LMS reliance, the weak relationship between LMS usage and academic performance highlights the need for a comprehensive approach that incorporates quality teaching, access to resources, and enhanced institutional support. By adopting these recommendations, UCC can optimize LMS functionality, improve digital learning experiences, and support students' academic success across all levels.

Enhancing LMS Functionality, Engagement, and Research Scope

The study highlights key areas for improving LMS functionality to better support academic performance. Personalized learning features, including AI-driven recommendations, automated feedback, and gamification, could enhance engagement, particularly among first-year students. For final-year students, integrating advanced research tools and collaborative features would optimize LMS usage for thesis writing and academic projects. Additionally, seamless integration with academic workflows, such as course schedules and lecture recordings, would ensure that LMS engagement translates into tangible academic benefits.

The weak correlation between LMS engagement and academic performance is attributed to several external factors. While LMS usage facilitates learning, academic success depends on instructional quality, motivation, and study habits. Some students engage passively by merely downloading lecture slides without actively participating in discussions or assessments. Additionally, disparities in internet connectivity and device access may limit engagement, reducing LMS's impact on academic outcomes. Learning preferences also play a role, as some students may benefit more from traditional, in-person teaching methods.

Although the study focused on year-level progression, incorporating control variables like gender, faculty, and prior digital literacy experience could provide deeper insights. A multivariate regression model would help isolate these factors' effects on LMS engagement. Furthermore, subgroup analysis by faculty could

reveal discipline-specific engagement trends, offering a more nuanced understanding of LMS usage patterns. Future research should consider these variables to refine the findings and recommendations further.

Given the dynamic nature of LMS engagement, a longitudinal study could provide richer insights into how students' interaction with the system evolves throughout their academic journey. Tracking a cohort from their first to final year would help identify critical intervention points to enhance engagement at different stages. Additionally, qualitative follow-ups like student interviews, could capture personal experiences that quantitative data alone may not reveal. A longitudinal approach would offer more robust policy recommendations tailored to long-term engagement trends.

Finally, the study's findings are relevant to UCC but may have broader implications for other Ghanaian Universities with varying technological infrastructures. While UCC benefits from relatively stable digital access, other institutions may face more significant barriers to LMS adoption. However, the general trend of increased LMS engagement with academic progression is likely consistent across different settings. Future comparative studies across multiple universities could validate these findings, ensuring the development of scalable LMS enhancement strategies tailored to diverse educational contexts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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