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Evaluation of usability in Moodle Learning Management System through Analytics Graphs: University of Applied Sciences Teacher's perspective in Finland

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ABSTRACT

The Modular Object-Oriented Dynamic Learning Environment (Moodle), a type of Learning Management System (LMS), is growing globally. Across the world, the student population keeps growing, making it challenging for the existing physical infrastructure to accommodate all the students. Despite the enormous potential significance of Analytics Graphs, there needs to be more evidence regarding the utilisation of this Learning Analytics tool to significantly inform management on students' tracking capabilities and consequently improve their performance. This study demonstrates how Learning Analytics tools such as Analytics Graphs enable teachers and management to examine learners' activities in the LMS (e.g., Moodle) by utilising data from the system log to address the existing gap. This study focused on two fundamental questions. What is the usability of the Learning Management System Moodle through Analytics Graphs in the University of Applied Sciences context? Two, how can the Learning Management System Moodle through Analytics Graphs be adapted by educators and maximise its potential? The study employed a quantitative approach and tracked the available log data generated during teaching a marketing course at the University of Applied Sciences for five months (January to May 2022). The analytics graph plugin helps identify student profiles that enables the teachers to know the actual state of the students based on their responses to the activities. This study generates some interesting managerial implications for teachers, students, institutions (Universities) and the e-learning designer or Moodle administrator.

Keywords: *Usability; Moodle; LMS; Analytics Graphs; Marketing; Students; University; Teacher; Finland*

INTRODUCTION

The Modular Object-Oriented Dynamic Learning Environment (Moodle), a type of Learning Management System (LMS) that emerged over twenty (20) years ago as an open-source platform, is growing globally. In 2015, 78,000,000 users were recorded on the Moodle website, and surprisingly in 2022, the user's records soared to 317,000,000 (at May 28, 2022), with a 121.01% difference and 306.41% increase in seven years (Moodle, 2022). Globally, web-based systems

such as Learning Management Systems (LMS) have seen rapid adoption in teaching and learning (Dias et al., 2020; Raza et al., 2021). Thus, the management, development, and efficient distribution of digital resources, particularly for online teaching and learning, can be used for face-to-face teaching in higher education. An LMS provides opportunities for learners and their instructors in terms of personalized e-learning and synchronizing online learning resources with traditional face-to-face teaching techniques (Aljawarneh, 2020).

Chisimba, *ATutor*, *Moodle* and *Sakai* are popular LMS or online platforms with tools that provide an enabling environment that play a pivotal role in facilitating teaching and learning via interaction between instructors and their students (Unwin et al., 2010). These web-based systems provide tools that enable sharing of resources essential for teaching and learning between students and instructors. The use of these various LMS by institutions in higher education improves the quality and efficiency of on-campus teaching by playing a complementary role to the conventional face-to-face teaching and learning (Ssekakubo et al., 2011). Across the world, the student population keeps growing, making it challenging for the existing physical infrastructure to accommodate the growth. Even so, higher education institutions have employed these LMS to resolve the challenge of the growing student population by introducing blended and distance learning (Unwin et al., 2010). Another notable advantage of the application is evaluating students' participation in the learning process with minimal intervention from teachers or instructors.

Though these LMS have significantly improved and enhanced teaching and learning between learners and teachers, one critical aspect of these LMS Learning Analytics, particularly the Analytics Graphs, is a high potential to provide essential information on the period of login and its associated challenges, and how and when the actual interaction and learning takes place in the LMS since a most significant part of these activities transpires there (Jo et al., 2014). Though other subjective instruments have been used by management of higher institutions to find solutions associated with learners' problems, Analytics Graphs presented information on students' earliest interactions in real-time, providing clues related to students' learning challenges (Kotsiantis et al., 2013).

Since the early research noted above, the academic literature has grown in the research domain of Learning Management systems. However, Fenu, Marras & Meles (2017) discovered the e-learning analytics gap and mentioned that its goals are still under research. The study connects three types of analytics (descriptive, diagnostic, and predictive) as the learning environment's current, reasons, and future. A recent study examined how learning analytics use in Moodle can ascertain the learners' performance evaluation measurement and proposed more student activities extraction from Moodle with further data analysis (Justin, Krishnan, Nair & Samuel, 2022).

Despite the enormous potential significance of Analytics Graphs, there is a paucity of evidence regarding using Learning Analytics to significantly inform management on students' tracking capabilities, and consequently improve their performance. This study aims to demonstrate how Learning Analytics tools such as Analytics Graphs enable teachers and management to examine learners' activities in the LMS (e.g., Moodle) by utilizing data from the system log to address the existing gap. The study had the following objectives:

1) To establish the usability of the Learning Management System Moodle through Analytic Graphs, and
2) To expatiate on adopting the Learning Management System Moodle through Analytics Graphs and its maximization by the educators.

This study focussed on two fundamental questions:

1) What is the usability of the Learning Management System Moodle through Analytics Graphs in the University of Applied Sciences?
2) How can the Learning Management System Moodle through Analytics Graphs be adapted by educators and maximize its potential?

Earlier research has shown the relevance and importance of learning analytics by teachers and how the insights from the analytics graph help teachers evaluate the students based on their usability, learnability, efficiency, memorability, errors prevention and satisfaction (Johnson et al., 2011, p. 9).

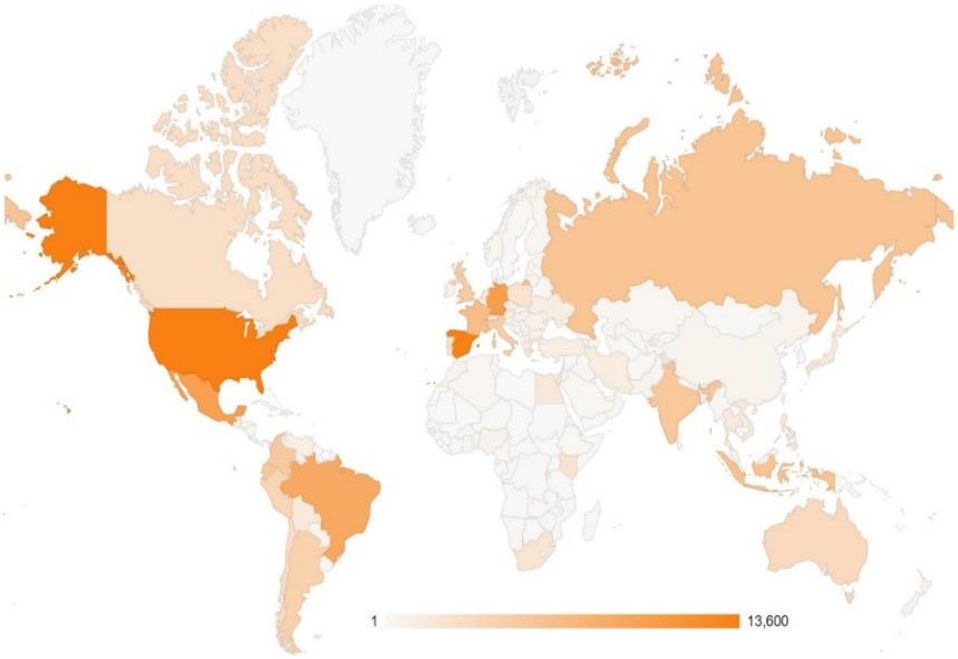


Fig. 1. Moodle Registration Map

Figure 1: Moodle Registration Map

The Moodle registration map is shown in Figure 1 above. The intensity of the colour for each country indicates the frequency of the registered sites. The Moodle Map confirms the relevance of the Learning Management System globally and its intercontinental adoption, use and advanced use.

The study used the data extracted from the Moodle website to plot a chart in Microsoft Excel to highlight the seven topmost continentals registered Moodle sites. As shown in Figure 2 below, the 2-D Line Chart comparatively reveals Northern America and, specifically, the United States of America as the leading registered Moodle sites (13,600), followed by Europe and Spain with 13,317 registered sites. Mexico in Central America was spotlighted with 9,842 registered Moodle sites and Brazil in South America with 8,821. In Asia, India emerged with 5,488 registered Moodle sites and Australia in Oceania with 3,346. Lastly, Kenya featured in Africa with 2,250.

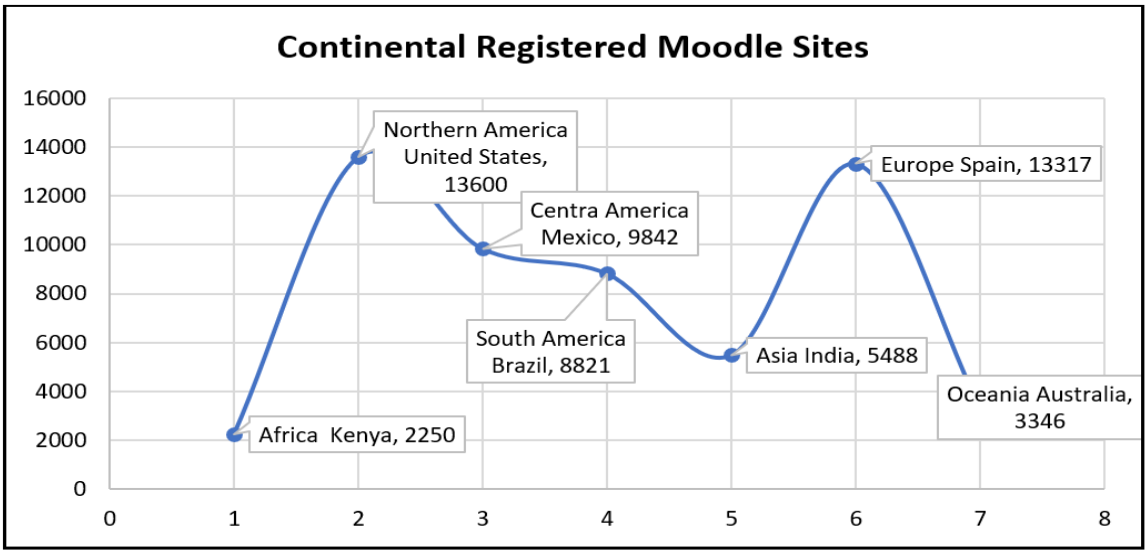


Fig. 2. Seven topmost Continental Registered Moodle Sites

Figure 2: Topmost Continental Registered Moodle Sites

EXISTING LITERATURE

According to a systematic review, web-based learning environments' specifically LMS, have become one of the principal areas or platforms for STEM and higher education (Li et al., 2020). Capterra (2021) conducted a comprehensive review and selection of the most predominantly used LMSs available globally for educational or academic purposes and interactions between learning and their instructors and noted that the number stood at 561 LMSs. The most widely used and researched learning platforms during 2015–2020 (Setiadi et al., 2021), included Google Classroom, Moodle, Edmodo, and MOOC, Chisimba, ATutor, and Sakai. Other LMSs such as Canvas, Blackboard and SumTotal were also recommended in the literature (Shkoukani, 2019; Xin et al., 2021), however Moodle remained the most preferred and most popular open-source LMS based on the propensities in the adoption of LMSs (Altinpulluk & Kesim, 2021). A study by Oguguo et al., (2021) proposed the learning usage of Moodle for lecturers because several active courses in many different languages with a high acceptance rate in many higher institutions have been studied (Al-Ajlan & Zedan, 2008; Sergis et al., 2017). Moodle has remained the world's leading open-source LMS currently used by higher education institutions (Moodle Project, 2020).

The concept of Learning Analytics has been making headlines for some years now, bringing much interest to higher learning institutions worldwide. The use of LMS by global higher learning institutions have established a significant link between these online platforms and students' performance (Filippidi et al., 2010; Whitmer et al. 2012; Jo et al., 2014; Macfadyen & Dawson, 2010). Given that, there is a need for higher learning institutions to make use of the full complement of the Analytics tool to improve the quality and intensity of LMS usage, a study by Naveh et al., (2012) posited that students are satisfied with courses offered via LMS.

Regarding Science, Technology, Engineering, and Mathematics (STEM) education in higher institutions, research suggests that the use of various web-based platforms such as LMSs has potentially brought about an increase in learners' collaboration, motivation and engagement

(Campbell et al., 2020; Hwang, 2020; Jones et al., 2021; Araya & Gormaz, 2021). Several other studies have provided enough evidence to argue that there is a strong correlation between the use of LMS and students' critical thinking, academic performance, and level (Alkholy et al., 2017; Cadaret & Yates, 2021; Ardianti et al., 2020; Bernacki et al., 2020; Hempel et al., 2020; Oguguo et al., 2021). Further, the ability for educators, teachers and administrators to effectively modify curriculum and adapt teaching practices through the constant tracking of learning outcomes of learners, predict students' achievement by identifying low performing and at-risk students has been demonstrated (Sergis et al., 2017; Hempel et al., 2020; Price et al., 2021). Through the integration of innovative technological tools and digital learning materials with LMS systems, virtual reality applications, online tutorials, and laboratories, LMSs have significantly improved the interactions between learners and teachers (Zhao et al., 2018; Christopoulos et al., 2020; Henke et al., 2021; Rissanen & Costello, 2023).

Other components of LMS often gather and accumulate a vast amount of data on the number of downloads students made, the number of times the student visits the platform, content pages visited, the number of messages posted or read, and the various types of LMS tools accessed (Macfadyen & Dawson, 2010). This accumulated data is primarily used to improve how students engage with the LMS (Beer et al., 2010) to improve students' behaviours in terms of the usage of LMS by instructors and administrators. Comparatively, such accumulated data from LMS have a superior number of student characteristics and variables responsible for the quality prediction of learning performance using variations in final grades, than the traditional student characteristic variables (Whitmer et al. 2012). Features like log data in LMS enable instructors to comprehend students' learning status to effectively predict their learning achievement (Yu & Jo, 2014). The main idea behind such Analytics tools for analysis is to possibly single out struggling learners in critical need of academic support (Macfadyen & Dawson, 2010) as well as to assess the quality of postings (Nistor et al., 2015) and visualize the behaviours in terms of usage in the LMS system (Scheffel et al., 2011). The log data stored in the LMS database, particularly Moodle, offers enormous opportunities and benefits, including factors such as regularity of learning interval, peer interaction, total studying time, and the number of downloads. These were noted as responsible for the academic achievement of learners in higher education in South Korea (Yu & Jo 2014). Another way of determining learners' performances in modules offered in LMS, specifically via Moodle, is using "candidates for proxy variables" often obtained from log data sets (Jo et al., 2014).

Usability is essential in assessing two fundamental things: user-friendliness and the utility of an artefact. It remains a significant consideration when using Learning Analytics tools in higher education. The International Organization for Standardization (ISO) Organization in Standard # 9241- 11 (2018, Section 3.1) defines usability as: “the extent to which specified users can use a product to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use" or design knowledge, competencies, activities, and design attribute that contribute to usability, such as usability expertise, usability professional, usability engineering, usability method, usability evaluation, usability heuristic". According to Zain et al. (2019), content quality and motivation are critical external factors influencing perceived ease of use and usability.

Adoption of Characteristics of Usability in LMS

Usability helps to measure the effective, efficient, and satisfactory use of a particular design or system. Usability is essential, and the designers constantly measure it throughout the development process and after deliverables. Usability is defined by five quality components: learnability, efficiency, memorability, error tolerance, and satisfaction. Learnability explains the ease of use and incorporating an exploratory interface, including functions such as 'undo' or cancel for inexperienced users to learn and unlearn (Johnson et al., 2011, p. 9), while efficiency is essentially the speed or the rate at which a novice or beginner can achieve a specific goal or complete a given

task, which is often measured by the number of screens visited, number of keystrokes and completed tasks based on time spent (Johnson et al., 2011, p. 9).

Memorability measures how easily new users or novice users remember a system (how navigations were done, the various interfaces, and functional tools) after a significant time has elapsed between the first visit or any other visits, which is often determined through system analytics. On the other hand, for a system to be user-friendly, the number of errors committed, the rate at which such errors are committed, and the severity of such errors are critical. Therefore, "Error tolerance is defined as the capacity of a specific system to aid its users to avoid error and to recover from the same" (Johnson et al., 2011, p. 9). Satisfaction reveals how users like a system, how pleasant it is to use it, the system's usefulness, and how impactful it is, which is often measured using interviews or instruments based on the user's perception (Johnson et al., 2011, p. 9).

METHODOLOGY

User experience assessment is crucial for any information systems platform. Fenu et al. (2017) confirmed that user experience is a daunting task in e-learning due to the cost involved and the availability of the target respondents. The study employed a quantitative approach and tracked the available log data generated during teaching marketing courses at the University of Applied Sciences for five months (January to May 2022). This methodology is similar to the study by Mwalumbwe & Mtebe (2017). Twenty-six students enrolled in the Marketing course from the Department of Hospitality Management/Tourism Management, and the students undertook five (5) activities. All the student activities in this course accounted for assignments I and II with five marks each, and assignment III worth twenty marks. The other activities were a presentation worth ten marks and a Final Examination for sixty marks that the Moodle Learning Platform captured as a quiz. The total score for the five activities accumulated to 100 per cent.

This study adapts the environment setup approach of desktop interface tracking, pre-processing, indicators computation, indicators comparison, and results in a presentation by Fenu et al. (2017). At the pre-processing stage, the study tracked related records of the user's interaction with the Moodle interface with the attention to Session Starting Time (SST), Session Ending Time (SET), Activity Starting Time (AST) and Activity Ending time (AET) based on Grades Chart, Content Access, Number of Active Students, Assignment Submissions, Quiz Submissions and Hits Distribution.

The log file was accessed through the Moodle Actions Menu (gear button) at the pre-processing stage. Under the reports button, the logs for all activities were examined by the authors to become familiar with the time stamp, full username, event context, component, event name, description, origin, and IP address. Indicators for computation focused on Learnability, Efficiency, Memorability and Satisfaction (LEMS). The study compared these quality indicators and finally the results are presented using charts. The log file was further downloaded in Microsoft Excel file format. Apart from the charts that Moodle Analytics generated, the study used the Microsoft Excel 365 App to plot charts for the student grades.

Ethics

This study obtained ethical committee approval from Jamk University of Applied Sciences, Finland, for responsible research. All data used in this study were anonymized, with personal information removed during the analysis to ensure strict adherence to ethical standards. This approach was taken to safeguard consent, privacy, and data de-identification issues. It is important to note that the data utilized in this research was solely for research purposes and was in no way connected to the unique profiles of the students involved.

RESULTS

The results generated with Moodle and Microsoft Excel are presented in charts. This section draws insights from the Grades, Content Access, Number of Active Students, Assignment Submissions, Quiz Submissions and Hits Distribution Charts. The analytics graph plugin helps identify student profiles and enables the teachers to know the actual status of the students based on their responses to the activities. It also allows the teacher to send an awakening call to the student due to their irrational behaviour on the Moodle learning platform, especially when they are confronted with decision paralysis while doing activities in Moodle.

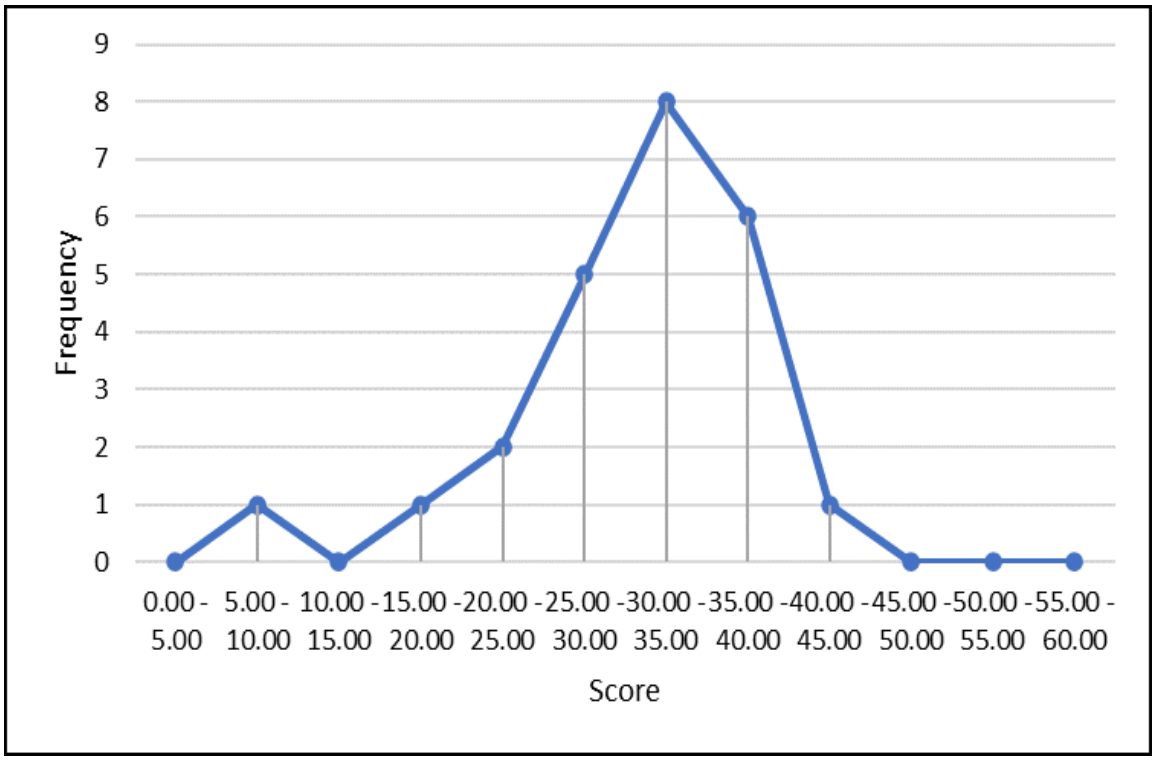


Figure 3: Students' Scores and Frequencies

The date in Figure 3 shows the normal distribution of the student scores, indicating that the students' examination result has a normal distribution throughout the class. Out of twenty-four (24) students that wrote the examination, one student's score fell within the range of 5 - 10, one student within the range of 15 - 19, two students within 20 - 25, ten students within 25 - 30, four students within 30 - 35, five students within 36 - 40 and one student within 41 - 45. The students earned an average score of 29.88 on the examination.

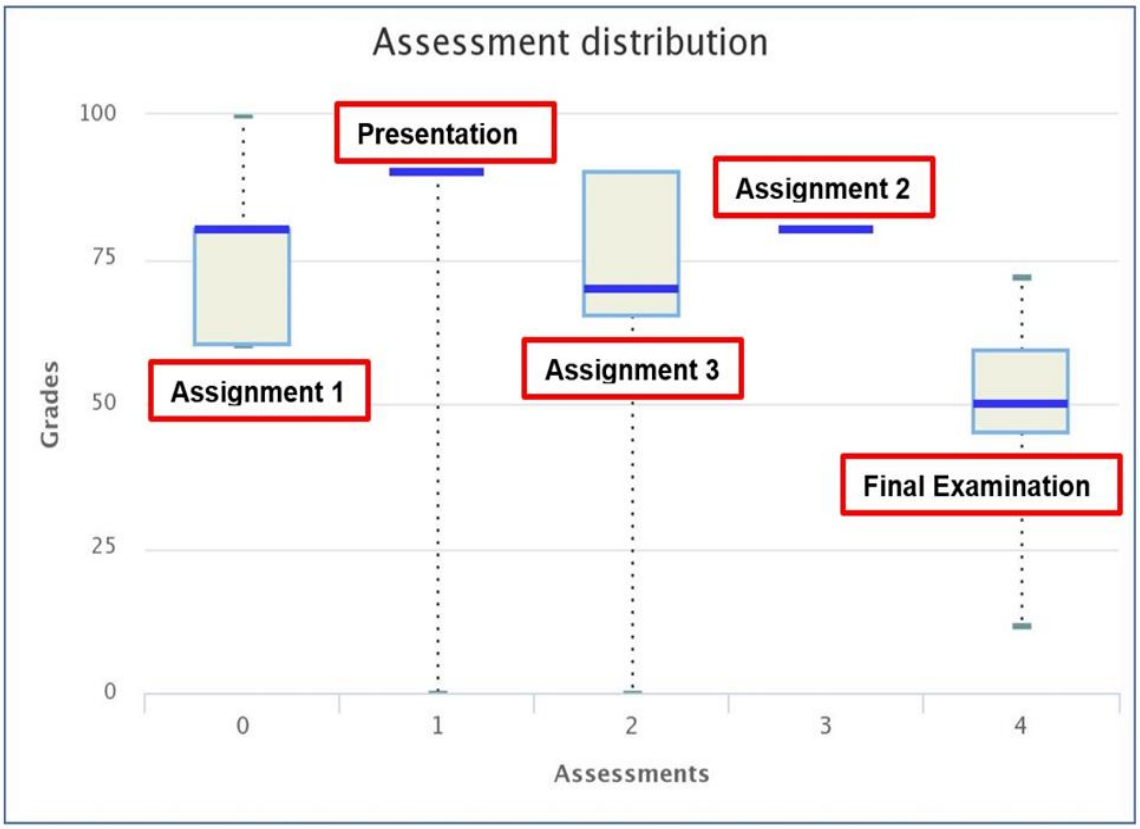


Figure 4: Assessment Distribution of the Students

The box plot in Figure 4 above lists all the assessments conducted in Moodle for the Marketing course. The analytics chart showcased in this study identified the differences among the five evaluations for the marketing students to ascertain their assimilation level of the course based on their performance and identify the students with problems. The box plot also helps establish the differences among the five evaluations and the distribution of students' scores. The box plot shows the whisker, lower quartile (Q1), median, upper quartile (Q3) and interquartile range (IQR), especially for the final examination scores. Assignment one was completed by twenty-six (26) participants with the lowest grade of 60% and the highest grade of 100%. The objective of this assignment was to test the academic writing style of the students, and it was a group assignment. The presentation result is next on the box plot, with the same number of participants as assignment one. The score distribution was between 0 and 90%. The objective of the task was to evaluate the preparation of slides and the presentation skills of the students. The third item on the box plot is assignment three, a destination case company task. The score distribution was between 0% and 90%, while assignment two captured the scores of twenty-six participants. Both the lowest and highest grades recorded 80%. The objective of the assignment was to assess the summary skills of the students. The last item on the box plot was the final examination which was completed by twenty-four students. The lowest grade was 12%, while the highest was 72%.

The active user's analytics chart shown in Figure 5 below, reveals the number of active students at a particular time of the day. It also shows students who accessed the Moodle course in different time slots based on 24-hour time notation. The data indicates that fifteen (15) students were mainly active at midnight, one hundred and fifty-one (151) students in the morning, twenty-four (24) students at noon, one hundred and sixteen (116) students in the afternoon and one hundred and

twenty-seven (127) students at night. Overall, marketing students are more active at night, but only four (4) students were active at 02.00 in the morning.

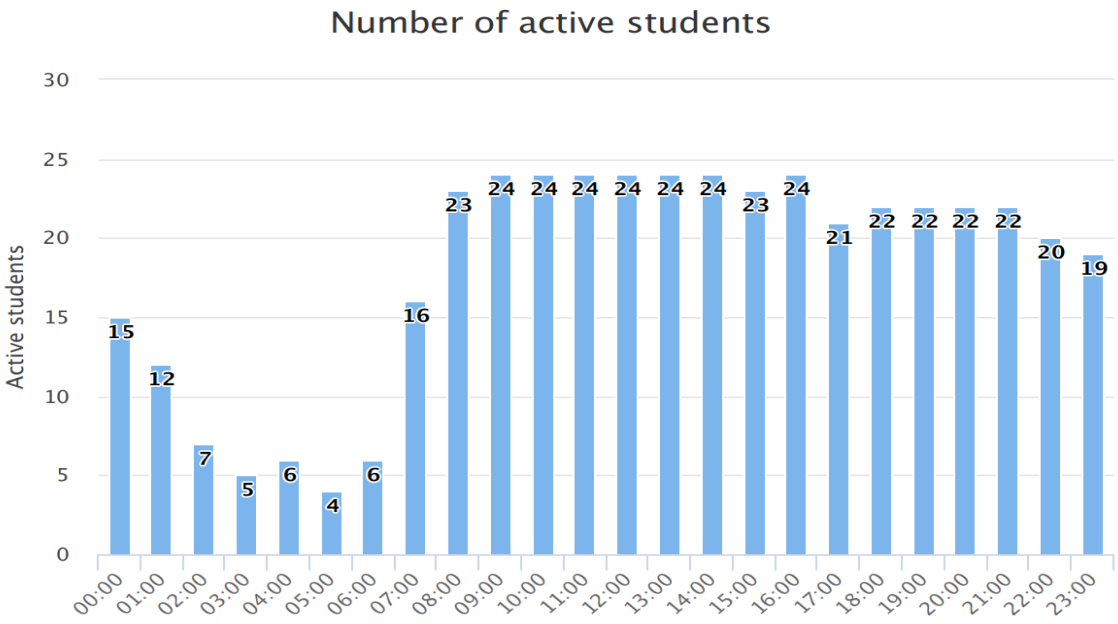


Figure 5: Number and Time of Student Activity

Students need to do more than just login into Moodle LMS platform. The activities they undertake matters and so too their performance. The students' activities in Figure 6 below are similar to that shown in Figure 5 based on the time slots.

The students' actions were more predominant at 15.00, 9.00, 12.00, 13.00 and 16.00 than at other times. The students' level of activeness was related to the activities they carried out.

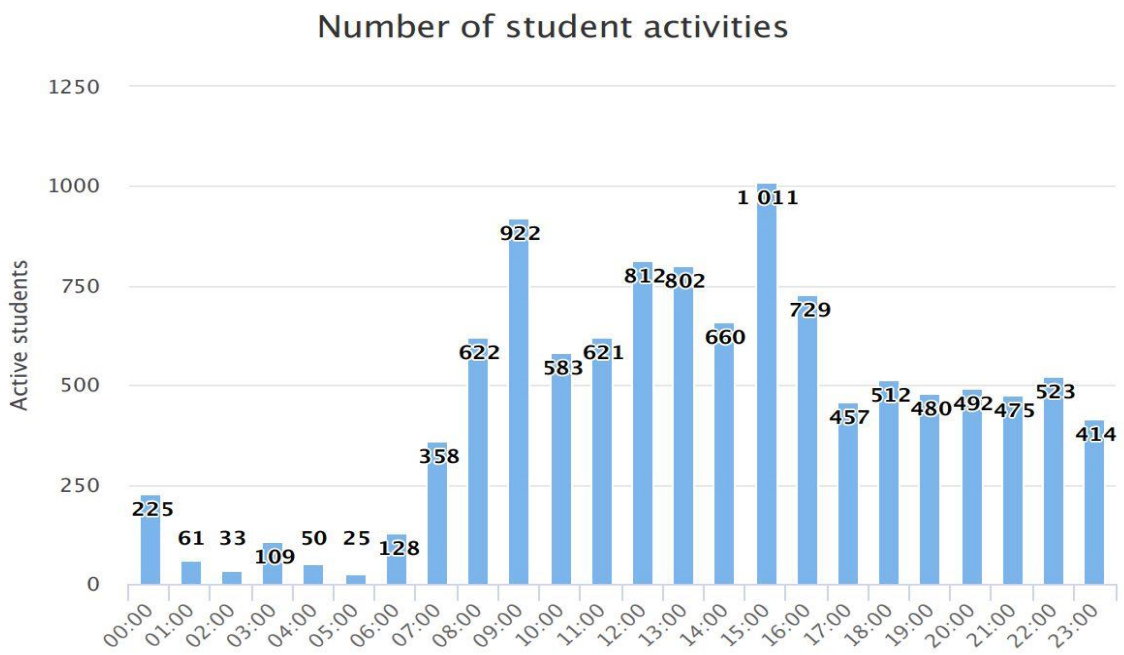


Figure 6: Number and Time of Students' Activities

This analytics graph, shown as Figure 7 below, indicates the number of accesses to each activity in the Moodle course by the students. The chart reveals that the students accessed news, a feature that updates the student on the developments in the class from time to time, final examination instructions and guidelines for writing the examination via Moodle quiz, Assignment 1 to 3 and the presentation instructions.

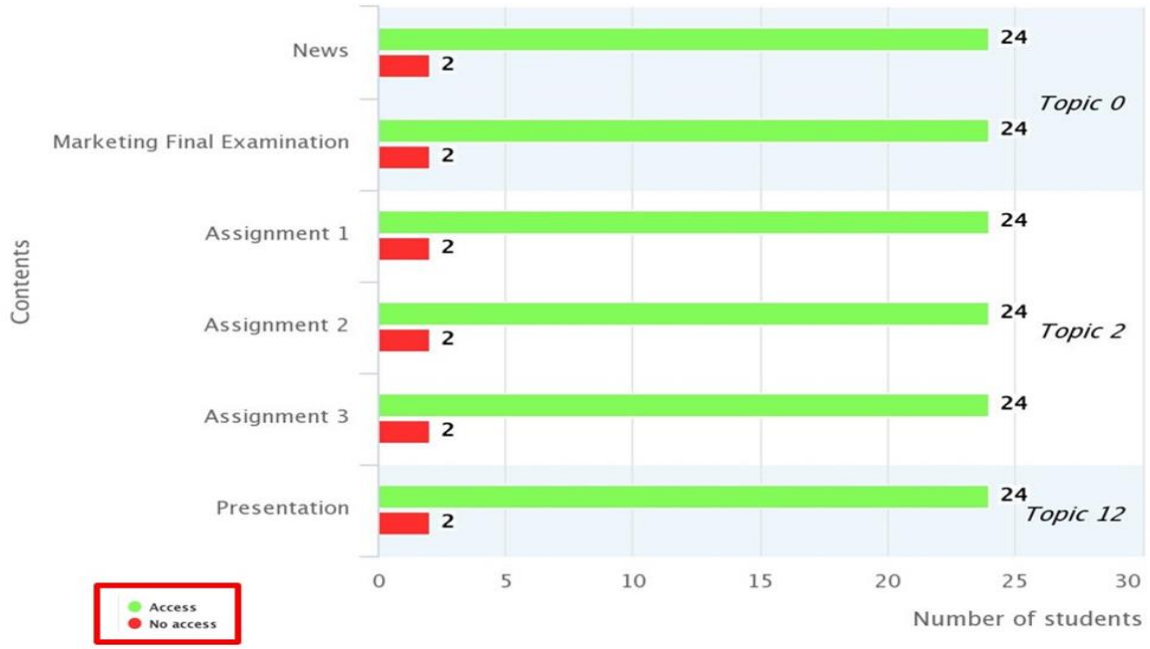


Figure 7: Students Distribution Access to the Content

Out of the twenty-six students that registered for the course, two were inactive, while twenty-four were active consistently. The green bars in Figure 7 indicates access, while the red bars indicate inactivity. The two students who were inactive did not respond to the motivating efforts of the teachers.

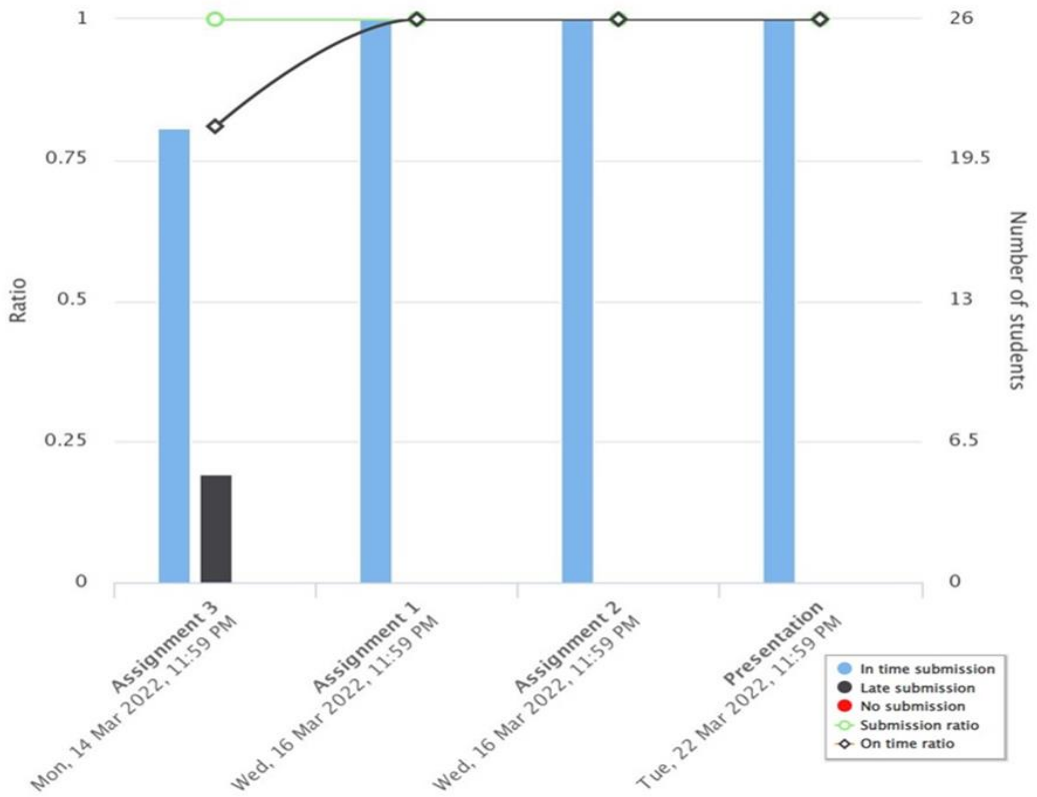


Figure 8: Student Assignment Submissions

The data in Figure 8 above depicts the students' assignment submission pattern. It reflects the timely and late submission of assignments 1 to 3 and presentation slides. The twenty-six students were prompt in submitting assignments 1, 2, and the presentation. The statistics show a ratio of 1 for submission, but for assignment 3, twenty-one students submitted on time with a ratio of 0.81, while five students had a late submission. This chart displays the status of the student assignment submission.

On the other hand, Figure 9 below showcases the timeliness of the student examination submissions via Moodle. Twenty students submitted on time with a ratio of 0.92, while two did not submit at all, and did not attempt the final examination.

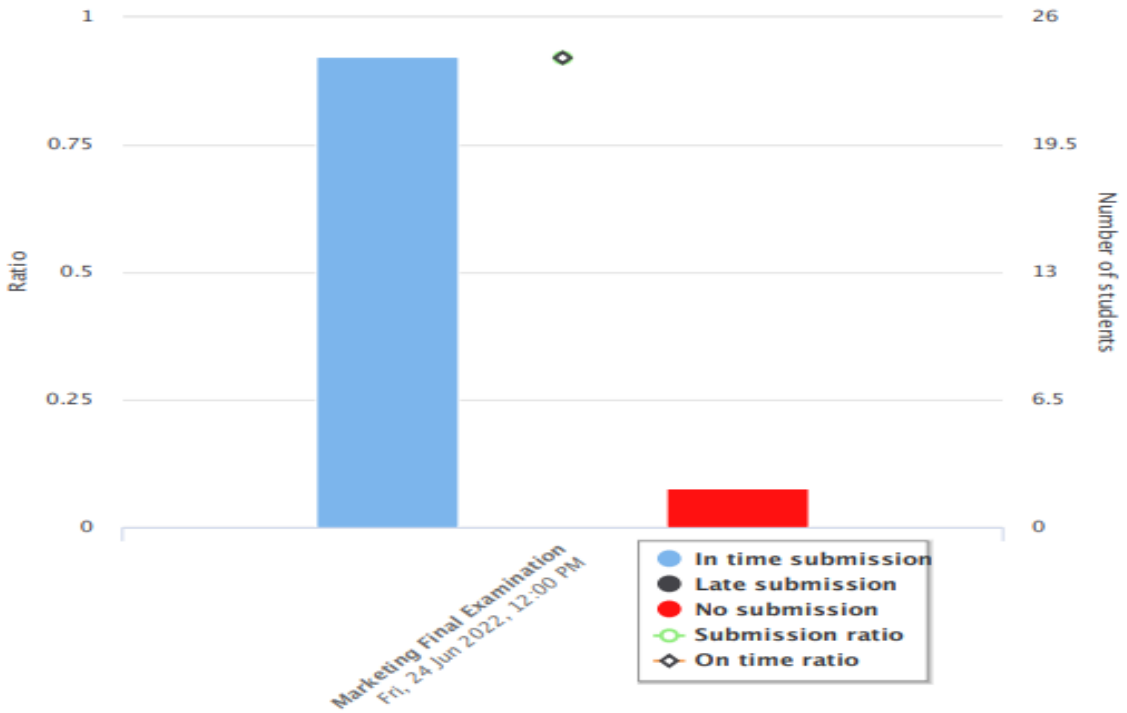


Figure 9: Students' Examination Submissions

This study displayed each student's hit distribution of the Moodle course in a graphical representation of the hits data in Moodle. Figures 10 to 14 below represent the hit distribution of the five groups of students for assignments 1 to 4. The triangles in each of the figures depict the following:

- The red triangle with the exclamation mark indicates that the concerned student did not access Moodle during the last week.
- The yellow triangle with the exclamation mark shows that the concerned student did not recently access Moodle.

The hits distribution charts displayed the student's name, the course hits days with access, the number of days by week with access, resources with access, and the number of resources accessed by week. There is an email button to reach the students with "no access." The results showed that Group 1 had fewer caveats than other groups, and only group 4 had "no Moodle was accessed until now".

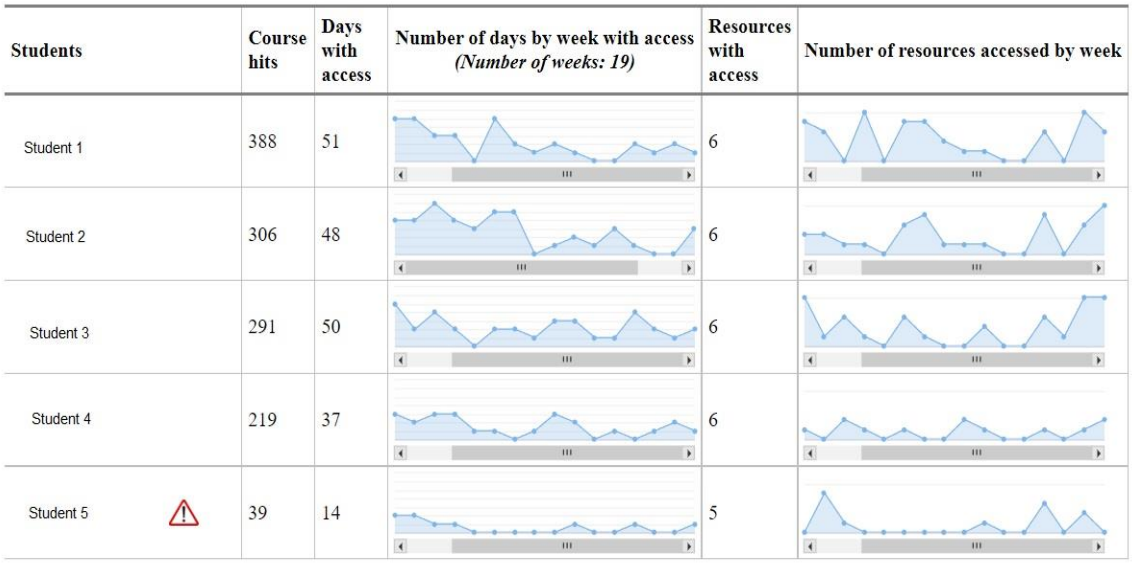


Figure 10: Group 1 Hits Distribution

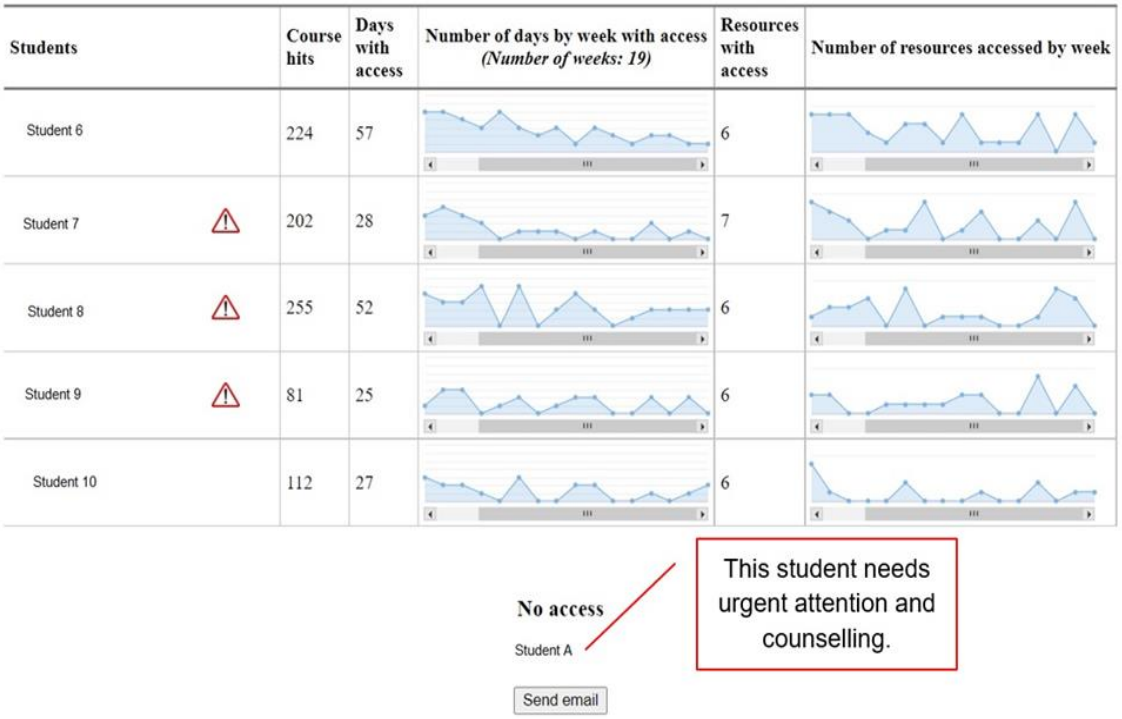


Figure 11: Group 2 Hits Distribution

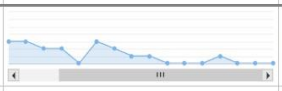
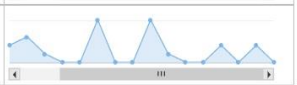
Students	Course hits	Days with access	Number of days by week with access *(Number of weeks: 19)*	Resources with access	Number of resources accessed by week
Student 11 ⚠	98	27		7	
Student 12	111	29		5	
Student 13 ⚠	224	46		6	
Student 14	566	82		7	
Student 15 ⚠	143	33		6	

Figure 12: Group 3 Hits Distribution

Students	Course hits	Days with access	Number of days by week with access *(Number of weeks: 19)*	Resources with access	Number of resources accessed by week
Student 16	401	44		6	
Student 17	165	44		6	
Student 18 No Moodle was accessed until now. ⚠	3	2		0	
Student 19 The Moodle was accessed in the last week. ⚠	26	17		5	
Student 20	78	20		6	

Figure 13: Group 4 Hits Distribution

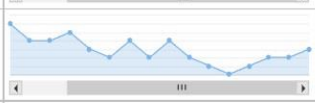
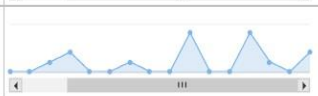
Students	Course hits	Days with access	Number of days by week with access *(Number of weeks: 19)*	Resources with access	Number of resources accessed by week
Student 21	231	43		6	
Student 22	175	41		7	
Student 23	64	23		6	
Student 24	198	56		7	
Student 25	142	33		6	

Figure 14: Group 5 Hits Distribution

DISCUSSION

Moodle usability through analytic graphs is made possible with the analytics graph plugins embedded in the Moodle learning system. The plugins enabled teachers and administrators to analyse students' scores and scores' distribution. It also helped to predict the possible reasons for students' good or poor performance by analysing their logins, total time spent within the online learning system, the activities engaged in, idle time and the purpose of their login to Moodle. Group performance (average score) and comparison of various groups' average time spent in Moodle can also be analysed to know what is responsible for the better performance of one group and the poor performance of the other.

The result of analysed charts in this study suggests that the students of the University of Applied Sciences whose activities in Moodle were used to generate these charts are more active at midnight while there are few activities early in the morning. The busy times are generally between 7:00 pm to 00:00 (midnight), depending on their activities. This information can inform administrators and teachers about the applicable deadlines to set in Moodle for students' assignments and exams as a motivation to encourage the students to have a good learning experience and get better grades. The learning analytics reports provide educators with the most recent learning trends to improve classroom instruction. At the same time, these reports make it possible for managers to frame progress regarding compliance, completion, and competency.

Reporting and analytics for e-learning and overall learning provide insights into the development of learners and guarantee that goals are being accomplished. The Analytics Graph can assist educators in improving the e-learning experience by viewing trends of participation, submissions, and other result charts in real time. This development can have a significant impact on retention rates and student accomplishments. The Analytics Graphs provide information about student progress against a range of indicators and student activities identified by current research as impacting student success in an online course. These indicators and activities have impacted student success in online courses.

The research on the use of Analytics tools on LMSs (Moodle) has gained popularity on a large scale with several learning tools, methods, and plugins used to predict, explain, and project student behaviour in LMS, particularly as fundamental components. LMSs are critical in this era of technological advancement for improving learners' thinking skills and introducing innovative ways of delivering lessons by teachers and mastering courses by learners at institutions of learning. Even so, using the full complement of such learning tools or Analytic tools is essential to bring full benefits to teachers, students, institutions (universities) and e-learning designers/Moodle administrators. This study highlighted the significance of the Moodle Analytics Graph (MAG) and how it can ease tension for both students and teachers. This study has provided an insight regarding two unanswered research questions in the literature on LMS. First, this study underscored the importance of Moodle LMS Analytics Graphs usability and showed how University teachers, lecturers, and professors could save time and effort in knowing their students' actual academic status and well-being. Through Moodle, the teachers can have an early warning signal of a student lagging behind in participation and performance during a course session. Second, this study is also an educative study for the University users of Moodle to maximize the various features of Moodle as a panacea for the arduous and tiresome student monitoring for excellent performance. Many are familiar with Moodle LMS, but only a few are up to date with its usability.

Theoretical and Managerial Implications

The contribution of extant studies (Dimopoulos et al., 2013; Einhardtet al., 2016; Mwalumbwe & Mtebe, 2017; Fenu et al., 2017; Liu et al., 2019; Makruf et al., 2022) on the literature on learning management systems are consistent with the insights from this study. The findings align with enhanced learning, students' assessment and performance, interactions, and usability on Moodle. This study contributes to the usability literature by connecting five quality components of usability: learnability, efficiency, memorability, errors, and satisfaction to the Moodle Analytics Graphs. This finding is consistent with the study of Johnson et al., (2011, p. 9). This study argues that using Moodle Analytics Graphs by teachers will aid the students learning, efficiency, and retainability. It will also lessen errors in the learning activities process and fulfil the students' needs. This study further posits that the teachers can use the Moodle Analytics Graphs to ascertain and achieve the three goals of compliance, completion, and competency of the students during a course that is implemented in the physical class with the aid of Moodle learning system or in a course fully designed for online delivery.

This study generates some interesting managerial implications for teachers, students, institutions (Universities) and the e-learning designer or Moodle administrator. Many teachers use the Moodle learning platform, but not all teachers pay the minutest details to the Moodle Analytics Graphs. Training and retention should be coupled with motivation for the teachers to be aware of the importance and application of Analytics Graphs. Teachers can use these Analytics Graphs to assess students' learning behaviour, improve learning materials, customise learning content for special students, visualise learning activities, and predict students' performance. For example, teachers and student counsellors should use this graph as an early warning of student truancy. It will facilitate collaboration between the teacher and the student counsellor as Moodle makes it easy to share the Analytics Graphs.

Further, it will help the teachers to give accurate feedback to the students. The institutions (Universities) should conduct a periodic audit on Moodle to evaluate its performance in association with the hardware, software, computer networks, data and human resources that aid its functionality. This conscious evaluation will help know when the necessary upgrading and maintenance of the learning platform quality are needed. It is recommended that there be a policy for evaluating the learning management system. The e-learning designer/Moodle administrator should be on the lookout for the rolling out of free and premium plugins for Moodle and present the

cost to the University management for consideration. The E-learning designer should also ensure the interoperability of Moodle with other university information systems.

The probability of generating and getting hold of Analytics Graphs to improve students' academic performance, inform policy, and improve teaching and learning is firmly established. The teachers could use Moodle data to enhance the administration of Moodle administrators, assessment, collaboration and communication among students, content, and the interface to identify potential ways to improve student's learning outcomes significantly. This study opines that teachers, students, institutions (universities) and e-learning designers/Moodle administrators elsewhere, mainly where Analytics Graphs have yet to be fully explored, will find the insights from this research useful. In the UASs, the IAPT log data has significantly improved and enhanced general teaching and learning. More importantly, institutions (universities) and e-learning designers/Moodle administrators can benchmark their service against others relative to the Analytics Graphs and other Analytics tools understudied by other researchers. This benchmarking will open the door to consider the development of collaborative networks in which teachers, students, institutions (universities) and e-learning designers/Moodle administrators come together to discuss common problems and learn from each other's solutions.

This study will further inform teachers, institutions (universities), and e-learning designers/Moodle administrators on how analytical graphs combined with other learning tools will help analyse student satisfaction, engagement, and retention rates. The recent studies of Antoniou & Papadima-Sophocleous, 2022; Colombero & Dal Zotto, 2022 focused on quizzes and gamification as Moodle learning tools. With the assistance of the Analytics Graph plugin, teachers can identify underachieving students in specific courses through students' profiles and the true picture of learners' performance based on their responses to specific LMS activities for several purposes, including accreditation. Thus, making it an awakening and possible remedial program for students using the LMS. Analytics Graphs, in conjunction with other learning tools, have the potential to help eliminate passivity among students and improve their cognitive activity. In institutions (universities) with poorly organised information infrastructure, an innovative teacher could organise the student learning process with the help of awareness of Analytics Graphs.

CONCLUSION

Learning Analytics, particularly Analytics Graphs, is an emerging research domain characterised by numerous analytical tools that offer enormous and relevant services to teachers, institutions (universities), and e-learning designers/Moodle administrators. These analytical tools assist the schoolteachers in monitoring and tracking students' interactions through the learning management system, Moodle. This paper presented the application of the Analytics graph, which has a high potential to serve as an analytics tool for monitoring and evaluating student performance and behaviour when using Moodle in LMS. An analytical graph has been established in Moodle to support teachers, students, institutions (universities) and e-learning designers/Moodle administrators in different forms.

Some of the extant studies that examined the role of data analytics, the strength of agreement and teamwork experience on students' performance findings differed from this study (Balogun, Olaleye & Agjei, 2020a; Balogun, Moshin & Olaleye, 2020b; Oyelere, Olaleye, Balogun & Tomczyk, 2021). These earlier studies were empirically based, while this current study is based on Moodle log data. The participant's opinion was targeted in the extant studies, while the Moodle user's behaviour tracking was the target of this study.

This study is limited to Moodle log data and focused only on the teacher's perspective of the Moodle LMS Analytics Graph. Future research should empirically evaluate the usability of Moodle among students and ascertain their engagement with the Moodle learning platform. Further, future

research should study Social Learning Analytics (SLA) with attention to students. Future researchers should examine how the students build their knowledge in networks and how they interact with other users of Moodle and with the learning environment. Future researchers can use Graph Theory to expand their understanding of social learning.

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