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Academic Engagement through Moodle Analytics: A Geo-Educational Approach to Early Detection of At-Risk Students in South African Higher Education

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ABSTRACT

This study investigates the diagnostic potential of Moodle analytics as a geo-educational tool for mapping student engagement and identifying academically at-risk learners within the Faculty of Education at Sol Plaatje University. Anchored in the Learning Analytics Framework and geo-educational theory, the study utilizes archival Moodle data from 24,722 students spanning 2021 to 2023. Employing robust quantitative methods, including Pearson correlation, independent sample t-tests, and Cohen's d effect size, the research establishes significant relationships between digital engagement metrics and academic performance. Among these metrics, activity completion emerged as the most consistent and powerful predictor of student success, while minimal interaction with Moodle was strongly correlated with academic underperformance. The results further revealed that students with higher frequencies of login, forum participation, and timely submission of assignments consistently outperformed their peers, reinforcing the multidimensional value of engagement metrics in predicting academic success. These findings underscore the value of Moodle analytics in the early detection of learning vulnerabilities, highlighting its potential for proactive academic support. The study recommends the integration of analytics literacy into faculty training and the implementation of adaptive, data-driven pedagogical strategies to foster inclusive and responsive digital learning environments. Though limited to a single institution and faculty, the study lays a critical foundation for broader investigations across disciplines and institutions. Its contributions advance the discourse on educational technology, student retention, and equity by illustrating how geo-educational tools can bridge the gap between learner behavior and institutional intervention in higher education.

Keywords: *Data Analytics; Geo-Education; Sol Plaatje University (SPU); Student Engagement.*

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INTRODUCTION

The accelerating integration of digital technologies into higher education has fundamentally reshaped the pedagogical landscape, enabling institutions to monitor academic engagement, optimize instructional delivery, and promote student success. [1] Among these technologies, Learning

[1] Abdullah Saykılı, "Higher Education in the Digital Age: The Impact of Digital Connective Technologies," *Journal of Educational Technology and Online Learning* 2, no. 1 (2019): 1–15; Mayada Ibrahim Mohamed, "Impact of Social Media Marketing on Brand

Management Systems (LMSs) such as Moodle have become central to the digital learning ecosystem due to their adaptability, user-centered design, and potential for real-time academic tracking.[2] Globally and in South Africa, Moodle is widely used to disseminate course content, facilitate student-instructor interaction, and log user engagement patterns. Despite its growing adoption, Moodle's potential as an analytics-driven platform for identifying academically at-risk students and informing proactive interventions remains significantly underexplored in the South African higher education (HE) context, particularly within historically disadvantaged institutions.[3] Persistent challenges such as high dropout rates, low academic throughput, and entrenched educational disparities continue to plague South African HEIs. [4] These challenges disproportionately affect students from underprepared or marginalized educational backgrounds.[5]

Early detection of at-risk students is therefore critical not only for mitigating academic failure but also for advancing institutional goals of inclusivity and equitable student success.[6] Learning analytics, defined as the measurement, collection, analysis, and reporting of data about learners and their contexts for the purpose of understanding and optimizing learning.[7] This study adopts a geo-educational perspective to examine the efficacy of Moodle analytics in mapping academic engagement and detecting early signs of student underperformance at SPU, a young and growing South African institution that is committed to inclusive, student-centered education. Drawing on archival data from the Centre for Learning, Teaching and Professional Development (CLTPD), the research analyzes platform engagement indicators such as login frequency, page views, assessment participation, and activity completion. By applying the Learning Analytics Framework, this study investigates how these metrics correlate with academic outcomes and how they can serve as spatial and pedagogical markers of risk. Theoretically, the study contributes to the discourse on digital education by localizing global learning analytics paradigms within the unique constraints and affordances of South Africa's under-resourced HE sector.

Practically, it offers valuable insights for educators, instructional designers, and institutional policymakers seeking to harness Moodle data for early interventions and strategic student support. More critically, it frames Moodle not merely as an instructional tool but as a geo-educational mechanism for "mapping" patterns of academic risk, ultimately enhancing responsiveness, promoting equitable access, and supporting data-informed decision-making across the higher education spectrum. Student success and retention continue to pose enduring challenges for Higher Education Institutions (HEIs) globally,[8] with these issues assuming heightened urgency in developing contexts such as South

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Equity The Mediating Effect of Customer Brand Engagement" (Sudan University of Science and Technology, 2016); Mohamed Ashmel Mohamed Hashim, Issam Tlemsani, and Robin Matthews, "Higher Education Strategy in Digital Transformation," *Education and Information Technologies* 27, no. 3 (2022): 3171–95.

[2] N H S Simanullang and Juniastel Rajagukguk, "Learning Management System (LMS) Based on Moodle to Improve Students Learning Activity," in *Journal of Physics: Conference Series*, vol. 1462 (IOP Publishing, 2020), 012067.

[3] K Syamala Devi and M Aparna, "Moodle–An Effective Learning Management System for 21st Century Learners," *Alochana Chakra Journal* 9, no. 6 (2020): 4474–85.

[4] Monica Njanjokuma Otu and Zamambo Mkhize, "Understanding Black African Student Attrition in the Context of Transformation in South African Higher Education Institutions," *Journal of African Foreign Affairs* 5, no. 1 (2018): 149–71.

[5] Farshid Marbouti, Heidi A Diefes-Dux, and Krishna Madhavan, "Models for Early Prediction of At-Risk Students in a Course Using Standards-Based Grading," *Computers & Education* 103 (2016): 1–15; Michael Cross, "Steering Epistemic Access in Higher Education in South Africa: Institucional Dilemmas," 2018; Aradhana Sivanath, "Teaching and Learning Challenges of Disadvantaged Students in the Context of Access and Equity in South African Higher Education: A Case Study of the Durban University of Technology" (2020).

[6] Laetitia Cassells, "The Effectiveness of Early Identification of 'at Risk'Students in Higher Education Institutions," *Assessment & Evaluation in Higher Education* 43, no. 4 (2018): 515–26; Himabindu Lakkaraju et al., "A Machine Learning Framework to Identify Students at Risk of Adverse Academic Outcomes," in *Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 2015, 1909–18; Shannon M Suldo et al., "Identifying High School Freshmen with Signs of Emotional or Academic Risk: Screening Methods Appropriate for Students in Accelerated Courses," *School Mental Health* 11, no. 2 (2019): 210–27.

[7] Gökhan Akçapınar, Arif Altun, and Petek Aşkar, "Using Learning Analytics to Develop Early-Warning System for at-Risk Students," *International Journal of Educational Technology in Higher Education* 16, no. 1 (2019): 1–20.

[8] Samukelisiwe Mngomezulu and Labby Ramrathan, "Academic Intervention Experiences of 'at Risk'Students in a South African University," *Interdisciplinary Journal for the Study of the Arts and Humanities in Southern Africa* 17 (2015): 116–41; Vikash Rowtho, "Early Detection of At-Risk Undergraduate Students through Academic Performance Predictors.," *Higher Education Studies* 7, no. 3 (2017): 42–54.

Africa.[9] Despite expanded access and increasing enrolments, many students, particularly those from historically disadvantaged backgrounds which struggle academically,[10] resulting in persistently low graduation rates, high dropout levels, and underdeveloped academic potential.[11]

These challenges are exacerbated by systemic socioeconomic inequalities,[12] uneven digital literacy, and limited access to academic support resources, all of which complicate students' transition into and navigation through university life.[13] Consequently, the timely identification of academically at-risk students has emerged as a strategic priority for institutions seeking to improve learning outcomes and equity.[14] Conventional approaches to risk detection, such as periodic progress reports and summative assessments, often fail to deliver timely interventions.[15] This reactive model diminishes opportunities for personalized academic support and early remedial action,[16] leaving students vulnerable to continued disengagement and failure.[17] In the context of rapidly expanding digital learning infrastructures, Learning Management Systems (LMS) such as Moodle offer a valuable but underutilized source of real-time engagement data.[18] While Moodle captures extensive user interaction metrics, such as page views, login frequency, activity completion, and assessment participation, institutions often lack the frameworks, capacity, or analytic culture to transform this data into actionable insights.[19] The crux of the problem, therefore, lies not solely in infrastructural limitations but in the inadequate application of Moodle analytics to predict and mitigate academic risk in a spatially contextualized and pedagogically responsive manner.[20]

This study addresses this critical gap by adopting a geo-educational lens to examine how Moodle analytics can be used to map patterns of academic engagement and support early detection of at-risk students within FoEDU, SPU. Hence, the study aims to examine the efficacy of Moodle analytics as a geo-educational tool for mapping student engagement and detecting academically at-risk students early within South African higher education, using SPU's FoEDU as a case study. The study seeks to harness digital interaction data from Moodle to inform timely, data-driven academic interventions that promote student retention, equity, and success. The following are the objectives for the study:

1. To investigate the spatial and disciplinary patterns of Moodle utilization across courses within the Faculty of Education (FoEDU) at Sol Plaatje University.
2. To examine the integration and effectiveness of Moodle-based collaborative activities in enhancing student engagement within selected FoEDU modules.
3. To analyze the relationship between students' digital engagement metrics on Moodle and their academic performance across various educational contexts within FoEDU.

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[9] Zilungile Sosibo and Misiwe Katiya, "Closing the Loop between Access and Success: Early Identification of at-Risk Students and Monitoring as Key Strategies Used by a South African University," *International Journal of Educational Sciences* 8, no. 2 (2015): 271–79.

[10] Cassells, "The Effectiveness of Early Identification of 'at Risk'Students in Higher Education Institutions."

[11] N Phellecy Lavhelani, Clever Ndebele, and Fhatuwani Ravhuhali, "Examining the Efficacy of Student Academic Support Systems for 'at Risk'First Entering Students at a Historically Disadvantaged South African University," *Interchange* 51, no. 2 (2020): 137–56.

[12] Adrian D Van Breda, "Resilience of Vulnerable Students Transitioning into a South African University," *Higher Education* 75, no. 6 (2018): 1109–24.

[13] Gabrielle Wills and Heleen Hofmeyr, "Academic Resilience in Challenging Contexts: Evidence from Township and Rural Primary Schools in South Africa," *International Journal of Educational Research* 98 (2019): 192–205.

[14] Ritesh Ajoodha, "Identifying Academically Vulnerable Learners in First-Year Science Programmes at a South African Higher-Education Institution," *South African Computer Journal* 34, no. 2 (2022): 120–48.

[15] Ana'dhavelli Naidoo and Juan-Claude Lemmens, "Faculty Intervention as Support for First-Year Students," *Journal of Student Affairs in Africa* 3, no. 2 (2015): 17–32; M Kyle Capstick et al., "Exploring the Effectiveness of Academic Coaching for Academically At-Risk College Students," *Innovative Higher Education* 44, no. 3 (2019): 219–31.

[16] David Baneres, M Elena Rodríguez-Gonzalez, and Montse Serra, "An Early Feedback Prediction System for Learners At-Risk within a First-Year Higher Education Course," *IEEE Transactions on Learning Technologies* 12, no. 2 (2019): 249–63.

[17] Sara Connolly et al., "First Year Experience for At-Risk College Students," *College Student Journal* 51, no. 1 (2017): 1–6.

[18] Devi and Aparna, "Moodle–An Effective Learning Management System for 21st Century Learners"; Abdallah Ziraba, Godwill Chenyuei Akwene, and Shiynsa Charles Lwanga, "The Adoption and Use of Moodle Learning Management System in Higher Institutions of Learning: A Systematic Literature Review," *American Journal of Online and Distance Learning* 2, no. 1 (2020): 1–21.

[19] Otu and Mkhize, "Understanding Black African Student Attrition in the Context of Transformation in South African Higher Education Institutions"; Cemal Tosun and Yavuz Taşkesenligil, "Using the MOODLE Learning Management System in Problem Based Learning Method," *International Online Journal of Educational Sciences* 3, no. 3 (2024).

[20] Abhinaw Anand and Sumathy Eswaran, "Case Study: Moodle Approach to Learning and Content Management System (LCMS)," *International Journal of Computer Sciences and Engineering* 6, no. 7 (2018): 1147–52.

4. To determine the predictive value of Moodle page view frequencies in identifying students at risk of academic underperformance.
5. To explore how the duration of time spent on Moodle influences student academic achievement and engagement patterns.
6. To assess the extent to which completion of Moodle activities correlates with final course grades and the early identification of at-risk students.

THEORETICAL FRAMEWORK

Learning Analytics Framework

The Learning Analytics Framework offers a structured methodology for the collection, analysis, interpretation, and application of educational data to improve learning outcomes.[21] Grounded in educational data science, it facilitates continuous monitoring of student engagement and timely interventions to address academic challenges.[22] Central to the framework is the use of data as a predictive and diagnostic tool for understanding student behavior and learning trajectories.[23] It supports a feedback loop whereby interventions based on data insights inform further improvements,[24] enabling responsive and inclusive learning environments.[25] In this study, the framework underpins the analysis of Moodle engagement metrics at SPU, including login frequency, course access, assignment submissions, forum interactions, and time-on-task.[26] It facilitates the identification of activity patterns linked to academic risk and supports targeted, data-informed interventions such as academic support or personalized reminders,[27] aligning with the study's goal of fostering inclusive, data-driven excellence in South African higher education.[28] Figure 1 depicts the Learning Analytics Framework.

[21] Emmanouil Varouchas, Miguel-Angel Sicilia, and Salvador Sánchez-Alonso, "Towards an Integrated Learning Analytics Framework for Quality Perceptions in Higher Education: A 3-Tier Content, Process, Engagement Model for Key Performance Indicators," *Behaviour & Information Technology* 37, no. 10–11 (2018): 1129–41; Naif Al Mudawi et al., "Predictive Analytics for Sustainable E-Learning: Tracking Student Behaviors.," *Sustainability (2071-1050)* 15, no. 20 (2023).

[22] Maren Scheffel, Hendrik Drachsler, and Marcus Specht, "Developing an Evaluation Framework of Quality Indicators for Learning Analytics," in *Proceedings of the Fifth International Conference on Learning Analytics and Knowledge*, 2015, 16–20; Zahia Marzouk et al., "What If Learning Analytics Were Based on Learning Science?," *Australasian Journal of Educational Technology* 32, no. 6 (2016); Miltiadis D Lytras et al., "Advanced Decision-Making in Higher Education: Learning Analytics Research and Key Performance Indicators," *Behaviour & Information Technology* (Taylor & Francis, 2018).

[23] Anni Silvola et al., "Expectations for Supporting Student Engagement with Learning Analytics: An Academic Path Perspective," *Computers & Education* 168 (2021): 104192.

[24] Alejandro Peña-Ayala, "Learning Analytics: A Glance of Evolution, Status, and Trends According to a Proposed Taxonomy," *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery* 8, no. 3 (2018): e1243; Sara De Freitas et al., "Foundations of Dynamic Learning Analytics: Using University Student Data to Increase Retention," *British Journal of Educational Technology* 46, no. 6 (2015): 1175–88; Christine Broughan and Paul Prinsloo, "(Re) Centring Students in Learning Analytics: In Conversation with Paulo Freire," *Assessment & Evaluation in Higher Education* 45, no. 4 (2020): 617–28.

[25] Gayane Sedrakyan et al., "Linking Learning Behavior Analytics and Learning Science Concepts: Designing a Learning Analytics Dashboard for Feedback to Support Learning Regulation," *Computers in Human Behavior* 107 (2020): 105512; Anuradha Mathrani et al., "Perspectives on the Challenges of Generalizability, Transparency and Ethics in Predictive Learning Analytics," *Computers and Education Open* 2 (2021): 100060.

[26] Alan Rubel and Kyle M L Jones, "Student Privacy in Learning Analytics: An Information Ethics Perspective," *The Information Society* 32, no. 2 (2016): 143–59.

[27] Rubel and Jones, "Student Privacy in Learning Analytics: An Information Ethics Perspective."

[28] Ioannis Kazanidis, Nikolaos Pellas, and Athanasios Christopoulos, "A Learning Analytics Conceptual Framework for Augmented Reality-Supported Educational Case Studies," *Multimodal Technologies and Interaction* 5, no. 3 (2021): 9.

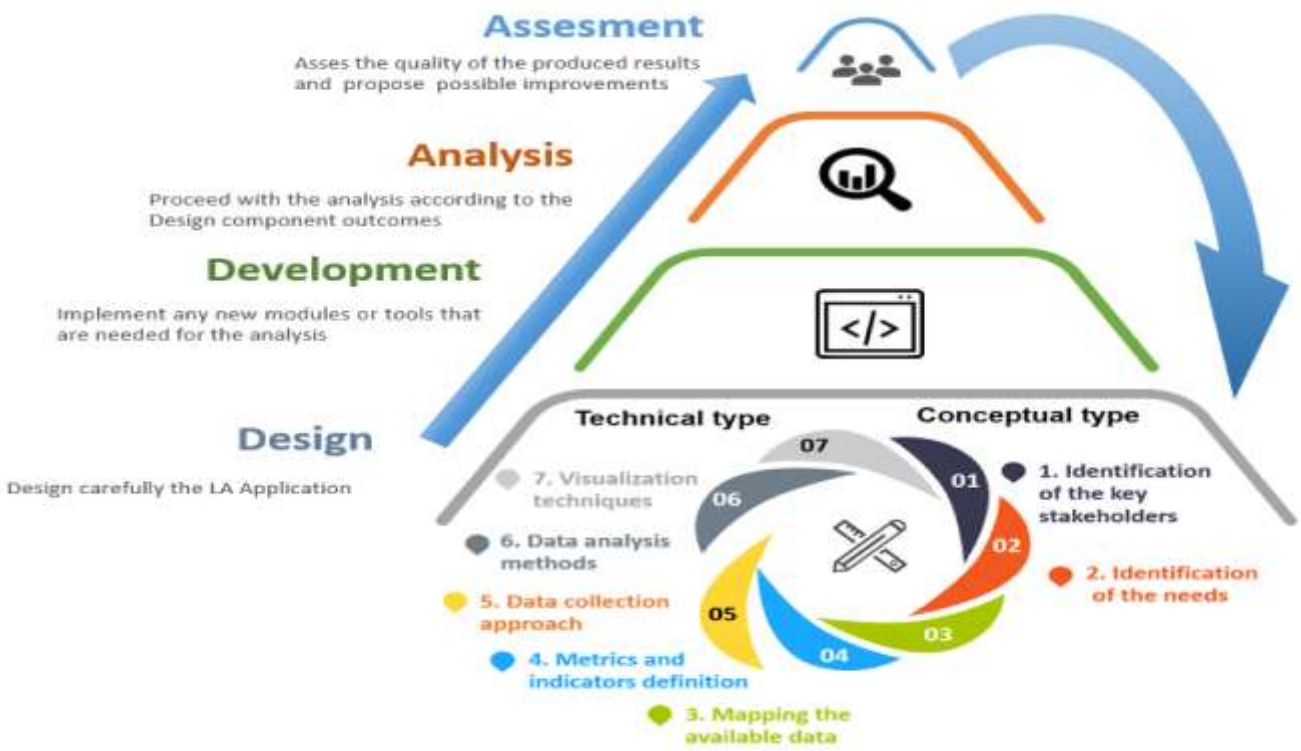

Figure 1: The Learning Analytics Framework.[29]

Figure 1 presents a cyclical Learning Analytics (LA) framework that serves as a practical and strategic guide for enhancing the early detection of at-risk students through Moodle analytics, particularly within the South African higher education context. When applied in SPU, the framework enables a structured process, comprising Design, Development, Analysis, and Assessment, through which institutional data on student engagement can be transformed into actionable insights.[30] Hence, key metrics such as login frequency, assignment completion, and quiz performance can be identified, and SPU can visualize patterns of disengagement and academic vulnerability.

LITERATURE REVIEW

Spatial and Disciplinary Dimensions of Moodle Utilization in HE

The increasing integration of Learning Management Systems (LMS) like Moodle into higher education has not only transformed teaching and learning practices but also generated valuable digital footprints that enable spatial and disciplinary mapping of academic engagement.[31] Within diverse academic faculties, such as the Faculty of Education (FoEDU), usage patterns of Moodle can vary significantly based on course structure, teaching philosophy, and discipline-specific learning demands. Login frequency remains a foundational indicator of active student participation and has been shown to correlate positively with academic engagement.[32] Frequent access to Moodle across different departments within FoEDU may reflect varying levels of instructional emphasis on digital engagement. For instance, modules emphasizing blended learning approaches may encourage more consistent interaction than those relying predominantly on face-to-face delivery. Course access metrics specifically the frequency with which students view digital materials, are also discipline sensitive. Estacio and Raga report that higher rates of material access often correspond with improved academic

[29] Kazanidis, Ioannis, Nikolaos Pellas, and Athanasios Christopoulos. "A learning analytics conceptual framework for augmented reality-supported educational case studies." *Multimodal Technologies and Interaction 5, no. 3* (2021): 9.
[30] Anne-Sophie Hoffait and Michael Schyns, "Early Detection of University Students with Potential Difficulties," *Decision Support Systems* 101 (2017): 1–11.
[31] Devi and Aparna, "Moodle–An Effective Learning Management System for 21st Century Learners."
[32] Nikola Kadoić and Dijna Oreški, "Analysis of Student Behavior and Success Based on Logs in Moodle," in *2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)* (IEEE, 2018), 654–59.

outcomes.[33] However, the extent of access can differ based on curricular design, with some subjects requiring more multimedia or interactive resources than others. Assignment submissions represent another layer of analysis, often reflecting not only student discipline but also departmental expectations for formative assessment. Missed or delayed submissions may be spatially concentrated on certain courses, thereby serving as an indicator of where pedagogical interventions might be most needed.[34] Forum participation is similarly telling, as some disciplines inherently foster collaborative discourse more than others. Brozina et al. highlight that such interactive spaces are crucial for deep learning, yet their use is uneven across academic departments.[35] Patterns of discussion activity can thus map disciplinary tendencies toward dialogic learning versus content memorization. Moreover, time spent on resources, another Moodle analytic, offers insights into both student commitment and curriculum complexity. Poellhuber et al. observe that prolonged engagement is often a proxy for academic persistence, though this can also vary spatially across courses and programs.[36] Hence, analyzing Moodle utilization through a geo-educational lens enables a deeper understanding of how spatial and disciplinary variables shape digital engagement, informing strategies for targeted support and pedagogical innovation across HEIs.

Identifying At-Risk Students Using Data Analytics

According to Gunawan et al., the growing field of learning analytics offers robust tools for identifying at-risk students and enabling timely interventions.[37] Low interaction scores, characterized by infrequent logins, limited forum participation, and minimal assignment submissions, have been widely recognized as reliable predictors of academic struggles.[38] Research highlights that students who exhibit consistently low engagement levels are more likely to experience academic failure if not promptly supported.[39] In addition, delayed or missing submissions serve as a significant indicator for identifying students who may be at risk.[40] Repeated delays in coursework often signify underlying challenges such as cognitive overload, lack of motivation, or personal difficulties.[41] Analytics tools can help educators detect these patterns early and offer tailored support.[42] Declining performance trends, such as a progressive decrease in quiz scores or assessment grades, further reinforce the need for real-time monitoring,[43] and these trends often indicate growing disengagement from academic content.[44]

METHODOLOGY

Description of the Study Area

SPU, situated in Kimberley, the capital of South Africa's Northern Cape Province, is strategically located at a central semi-arid crossroads of national transportation routes, granting it its historical and

[33] Rosalina Rebucas Estacio and Rodolfo Callanta Raga Jr, "Analyzing Students Online Learning Behavior in Blended Courses Using Moodle," *Asian Association of Open Universities Journal* 12, no. 1 (2017): 52–68.
[34] Louis-Vincent Poellhuber et al., "Cluster-Based Performance of Student Dropout Prediction as a Solution for Large Scale Models in a Moodle LMS," in *LAK23: 13th International Learning Analytics and Knowledge Conference*, 2023, 592–98.
[35] Cory Brozina et al., "Engaged to Succeed: Understanding First-Year Engineering Students' Course Engagement and Performance through Analytics," *IEEE Access* 7 (2019): 163686–99.
[36] Nina Abdul Razzak, "Strategies for Effective Faculty Involvement in Online Activities Aimed at Promoting Critical Thinking and Deep Learning," *Education and Information Technologies* 21, no. 4 (2016): 881–96.
[37] G Gunawan et al., "Learning Management System with Moodle to Enhance Creativity of Candidate Physics Teacher," in *Journal of Physics: Conference Series*, vol. 1417 (IOP Publishing, 2019), 012078.
[38] Rubel and Jones, "Student Privacy in Learning Analytics: An Information Ethics Perspective."
[39] Rubel and Jones, "Student Privacy in Learning Analytics: An Information Ethics Perspective."
[40] Anusua Ghosh et al., "Learning Management Systems with Emphasis on the Moodle at UniSA," *Bulletin of Social Informatics Theory and Application* 3, no. 1 (2019): 13–21; Colin Conrad et al., "How Student Perceptions about Online Learning Difficulty Influenced Their Satisfaction during Canada's Covid-19 Response," *British Journal of Educational Technology* 53, no. 3 (2022): 534–57.
[41] Marlon Xavier and Julio Meneses, "Persistence and Time Challenges in an Open Online University: A Case Study of the Experiences of First-Year Learners," *International Journal of Educational Technology in Higher Education* 19, no. 1 (2022): 31.
[42] Stewart Ngandu, "Enhancing Local Economies in South Africa: The Role of Sol Plaatje University in Contributing to Kimberley City's Local Economy," *African Journal of Development Studies* 14, no. 3 (2024): 171.
[43] Ngandu, "Enhancing Local Economies in South Africa: The Role of Sol Plaatje University in Contributing to Kimberley City's Local Economy."
[44] Rubel and Jones, "Student Privacy in Learning Analytics: An Information Ethics Perspective."

contemporary significance.[45] Established in 2014 and named after the prominent South African intellectual and activist Solomon Tshekisho Plaatje,[46] SPU was founded to expand higher education access in previously underserved regions.[47] As one of the two newest post-apartheid universities, it has evolved into a key academic and socio-economic institution in the Northern Cape,[48] with three campuses—Central, North, and South, spanning approximately 190 hectares.[49] Drawing students from urban, peri-urban, and rural contexts, many of whom are from historically disadvantaged backgrounds, SPU plays a vital role in advancing inclusive education, particularly through its Faculty of Education (FoEDU).[50] The university's modern and digital orientation, along with its status as a relatively young institution, makes it a suitable site for evaluating educational technologies like Moodle.[51] Located in one of South Africa's most sparsely populated and economically marginalized provinces,[52] where access to educational resources remains constrained,[53] SPU provides a compelling case for examining the application of learning analytics in low-resource contexts. The focus on FoEDU is especially pertinent due to its high enrolment and its role in training future educators for under-resourced schools. As such, SPU serves as a representative microcosm of the broader challenges and opportunities within South African higher education.[54] Its emphasis on student-centered learning, digital innovation, and equitable access, supported by partnerships like that with the Centre for Learning, Teaching and Professional Development (CLTPD), provides the necessary infrastructure and data for leveraging Moodle analytics to detect and support at-risk students.[55]

Research Design, Context, and Analytical Procedures: This study adopted a quantitative, correlational, and exploratory research design to evaluate the efficacy of Moodle analytics as an early warning mechanism for identifying at-risk students within the Faculty of Education (FoEDU) at Sol Plaatje University (SPU). Situated in a data-informed higher education paradigm, the study drew upon Moodle-generated engagement data to uncover behavioral patterns, assess correlations with academic performance, and identify predictive indicators of academic risk. Rooted in the frameworks of learning analytics and precision education, the design enabled a structured interrogation of digital learning footprints to support inclusive and equity-driven interventions.[56]

Study Context and Dataset: SPU utilizes Moodle as its official Learning Management System (LMS), offering a comprehensive data source on student interactions with academic content, assessments, and

[45] Ngandu, "Enhancing Local Economies in South Africa: The Role of Sol Plaatje University in Contributing to Kimberley City's Local Economy"; Deon Kleinsmith and Anele Horn, "Impacts of New Universities on Hosting Cities and the Implications for Kimberley, Northern Cape, South Africa," *Development Southern Africa* 32, no. 4 (2015): 494–510.

[46] Janet Remmington, Brian Willan, and Bhekizizwe Peterson, *Sol Plaatje's Native Life in South Africa: Past and Present* (NYU Press, 2016); Crystal Alicia Welman, "Sol Plaatje: A Psycho-Biographical Study" (University of the Free State, 2020).

[47] Ringetani Clementine Matlou, "Resilience of Households to Agricultural Drought in the Northern Cape, South Africa," 2019.

[48] Felix Awung et al., "Induction-Phase Challenges Faced by South African Higher Education Students: A Case Study of Sol Plaatje University," *African Journal of Inter/Multidisciplinary Studies* 6, no. 1 (2024): 1–12.

[49] Moeketsi Mosia, "Data-Driven Insights: A Decade of Sol Plaatje University's Research Journey and Development.," *Research in Social Sciences and Technology* 9, no. 1 (2024): 156–70.

[50] Gobonamang Merahe, "Corporate Governance Implementation at Sol Plaatje University," 2024; Lourenço C Pinto and Garth Benneyworth, "Sol Plaatje University as a Case Study for Decoloniality: Object-Based Learning as Applied to Heritage Studies," *South African Museums Association Bulletin* 41, no. 1 (2019): 1–9.

[51] Christopher Thabo Ezekiel Makhoere, Osden Jokonya, and Koga Gorejena, "Assessing the Impact of Personal Mobile Device in Higher Educational Enviroment: The Case of Sol Plaatjie University," in *2020 2nd International Multidisciplinary Information Technology and Engineering Conference (IMITEC)* (IEEE, 2020), 1–7.

[52] Matlou, "Resilience of Households to Agricultural Drought in the Northern Cape, South Africa"; Omar-Shariff Cupido, "Socio-Economic Development Activation of Small Towns in the Northern Cape" (Stellenbosch, 2020).

[53] Tshidi Masilo and Gideon Gershwin, "The Perceived Impact Of Integrated Development Planning (Idp) On The Social And Economic Development Of Local Communities Of Magareng Local Municipality, Northern Cape Province," 2020.

[54] Pinto and Benneyworth, "Sol Plaatje University as a Case Study for Decoloniality: Object-Based Learning as Applied to Heritage Studies."

[55] Danny Yen-Ting Liu et al., "An Enhanced Learning Analytics Plugin for Moodle: Student Engagement and Personalised Intervention," in *ASCILITE 2015-Australasian Society for Computers in Learning and Tertiary Education, Conference Proceedings*, 2019.

[56] Liu et al., "An Enhanced Learning Analytics Plugin for Moodle: Student Engagement and Personalised Intervention"; Sithara H P W Gamage, Jennifer R Ayres, and Monica B Behrend, "A Systematic Review on Trends in Using Moodle for Teaching and Learning," *International Journal of STEM Education* 9, no. 1 (2022): 9.

collaborative activities. The dataset comprised 24,722 anonymized records of student engagement across FoEDU modules between 2021 and 2023. Key variables included activity completion counts, time spent on the platform, page view frequencies, and participation in collaborative features. Academic performance was measured through final course grades on a 100-point scale. All data collection and analysis complied with SPU's ethical protocols to ensure confidentiality, data integrity, and responsible stewardship.

Analytical Procedures: To address the first research objective on Moodle activity utilization across FoEDU modules, the study employed descriptive statistics (frequencies, percentages, means) to quantify tool usage across assessment (quizzes, assignments, workshops) and collaborative (forums, chats, wikis) activities. Visualization tools such as heatmaps and usage matrices were used to detect modules with varying engagement levels and highlight underutilized features for potential pedagogical enhancement. For the second objective, which explored the impact of Moodle-based collaborative activities, inferential statistics were employed. Pearson's Product Moment Correlation (PPMC) was used to assess the relationship between participation in collaborative tasks and academic performance. Paired sample t-tests compared outcomes between students actively engaging in collaborative versus assessment activities. Cohen's d provided effect size estimates, adding interpretive depth beyond mere statistical significance. In pursuing the third through sixth objectives, a multi-dimensional correlational approach examined relationships between a spectrum of Moodle engagement metrics and academic outcomes. PPMC analyses explored associations between final grades and variables such as activity completion, page views, and time spent on Moodle. Correlation analyses, scatterplots, and regression models visualized these patterns, while log-normalization techniques addressed data skewness, strengthening the reliability of the analysis.

Ethical Considerations: The study adhered strictly to the ethical standards stipulated by the SPU Research Ethics Committee. Ethical safeguards included the anonymization of student data, secure storage within the university's approved data management systems, and the observance of informed data usage principles. Institutional approvals were obtained for data access, and all analyses were conducted within the parameters of the university's data governance frameworks, ensuring alignment with national ethical standards and best practices in educational research.

PRESENTATION OF FINDINGS

Spatial and Pedagogical Disparities in Moodle Engagement

The analysis of Moodle activity logs within FoEDU at SPU revealed marked spatial and disciplinary disparities in the use of Moodle features. Assessment-focused tools, particularly online quizzes and assignment submissions, accounted for approximately 64% of all logged activities, reflecting a dominant reliance on summative evaluation practices across the faculty.[57] Conversely, collaborative features such as discussion forums, chats, and wikis constituted only 18% of the activity types, indicating a limited integration of participatory and dialogic pedagogies.[58] The engagement heatmap revealed significant intra-faculty variation: while some modules demonstrated innovative use of interactive tools, such as gamification elements and multimedia resources—others remained confined to static content delivery. These inconsistencies reflect a spatial fragmentation of digital pedagogical practices and varying levels of Moodle integration across departments.[59] The findings suggest a prevailing pedagogical orientation toward instructor-centered content transmission rather than student-centered, constructivist learning, thereby limiting opportunities for critical thinking and peer interaction. This underscores a pressing need for targeted capacity-building interventions aimed at strengthening educators' digital instructional competencies. Enhancing staff proficiency in using

[57] Devi and Aparna, "Moodle–An Effective Learning Management System for 21st Century Learners."
[58] Ngandu, "Enhancing Local Economies in South Africa: The Role of Sol Plaatje University in Contributing to Kimberley City's Local Economy"; Innocent Zitha, Georgina Mokganya, and Orifha Sinthumule, "Innovative Strategies for Fostering Student Engagement and Collaborative Learning among Extended Curriculum Programme Students," *Education Sciences* 13, no. 12 (2023): 1196.
[59] Ngandu, "Enhancing Local Economies in South Africa: The Role of Sol Plaatje University in Contributing to Kimberley City's Local Economy"; Remmington, Willan, and Peterson, *Sol Plaatje's Native Life in South Africa: Past and Present*.

Moodle as both a collaborative and analytical platform is vital for promoting deeper engagement and leveraging learning analytics to identify and support at-risk students within a geographically diverse and academically heterogeneous learner population.

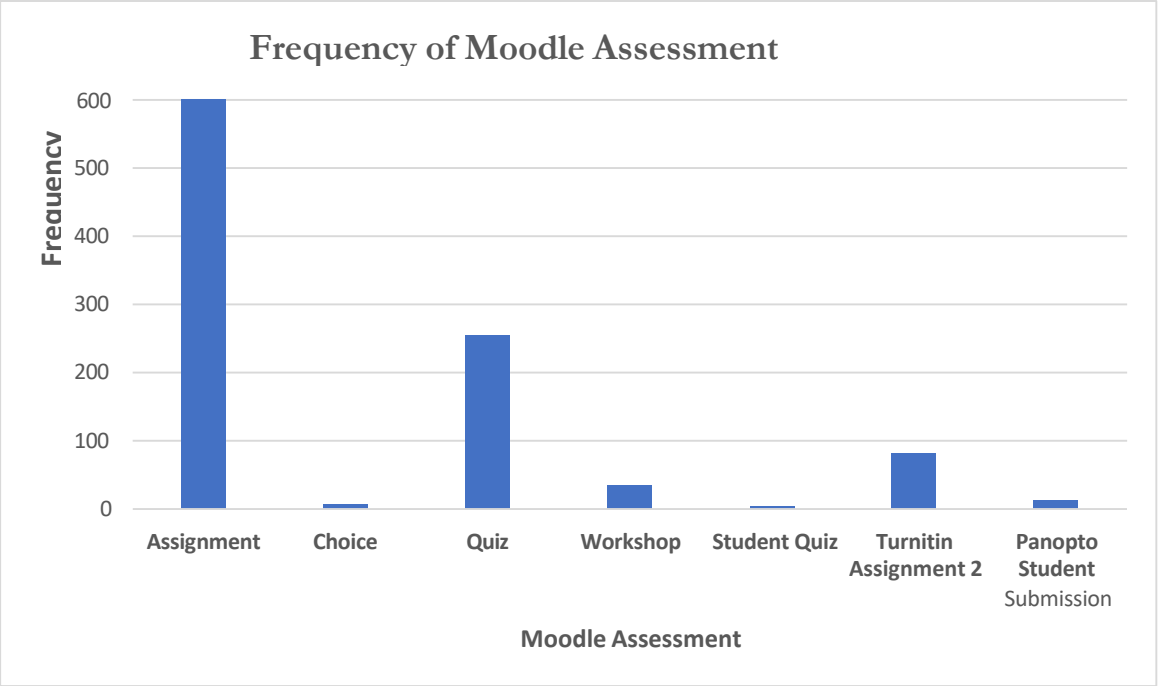

Figure 2: Patterns of Moodle Activity Utilization across FoEDU Modules

Figure 2 provides a visual representation of how different Moodle-based assessment tools are being utilized across FoEDU, revealing a strong institutional preference for conventional assessment formats. The "Assignment" activity, with 598 recorded instances, emerges as the most utilized tool. Its dominance reflects a pedagogical orientation toward essay-based, project-driven, and reflective assessments, which align closely with the outcomes of education-focused programs. This trend likely stems from the tool's familiarity, flexibility, and capacity for detailed feedback, contributing to both lecturer and student comfort. Quizzes, recorded 287 times, represent the second most frequently employed tool, suggesting some uptake of formative assessment strategies. Their benefits, including instant feedback, self-paced learning, and concept mastery tracking, indicate untapped potential, especially in large-enrolment or concept-heavy modules. However, the gap in usage compared to assignments highlights the limited exploitation of Moodle's automated evaluation capabilities. The growing use of Turnitin Assignment 2 (91 instances) underscores increasing institutional attention to academic integrity. While its plagiarism detection function is useful, its effectiveness depends on how well originality reports are interpreted and integrated into academic writing guidance. Conversely, several tools remain underutilized, including Choice (9 uses), Workshop (40 uses), Student Quiz (4 uses), and Panopto Student Submission (19 uses). Despite their pedagogical potential, e.g., facilitating peer assessment, encouraging reflective and collaborative learning, and enabling multimedia submissions, their low adoption may reflect lecturer unfamiliarity, setting up complexity, or misalignment with prevailing assessment norms. In a nutshell, the data points to a narrow spectrum of assessment practices, signaling a need for capacity development initiatives that promote broader, innovative use of Moodle's tools to support diverse learning styles and enhanced student engagement.

Students' Engagement in Collaborative Activities and Academic Performance

Inferential statistical analyses offered compelling insights into the educational value of collaborative Moodle activities. Pearson's correlation analysis demonstrated a moderate but statistically significant positive correlation ($r = 0.42$, $p < 0.01$) between engagement in collaborative activities and final course

grades, suggesting that students who actively participated in forums, chats, and group tasks tended to achieve higher academic outcomes. Paired sample t-tests further revealed that students with higher levels of collaborative engagement scored on average 8.7% higher than their less engaged counterparts ($t(471) = 5.36$, $p < 0.001$). The calculated Cohen's d of 0.63 indicated a medium to large effect size, underscoring the practical significance of these findings and affirming the pedagogical imperative of embedding collaborative modalities within FoEDU's digital learning design. Figure 3 depicts the frequency of Moodle collaboration activities.

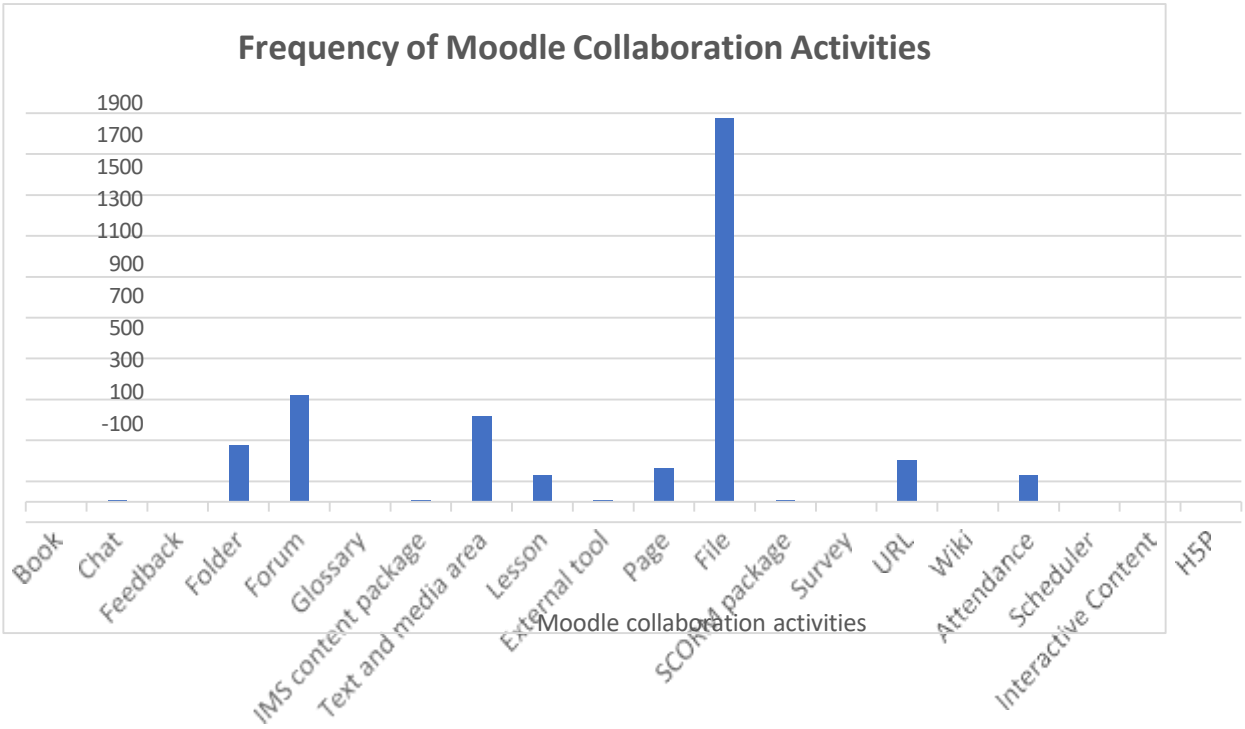

Figure 3: Frequency of Moodle Collaboration Activities

Figure 3 provides a comprehensive overview of how various collaborative tools are utilized within FoEDU Moodle modules. The analysis highlights a strong dependence on the "File" tool, with 1,876 recorded uses, indicating that content dissemination through file sharing is the primary mode of engagement across Faculty of Education (FoEDU) modules. While efficient for delivering lecture materials and templates, this reflects a unidirectional communication model, where interaction is minimal and student collaboration is limited to content consumption. Other tools, such as "Forum," "Text and Media Area," "Folder," "URL," "Page," and "Lesson", were used to a lesser extent. The "Forum" tool supports asynchronous discussions and peer-to-peer interaction, suggesting some degree of dialogic learning. The "Lesson" tool, though underused, holds substantial pedagogical value for interactive, decision-based learning. These tools point to moderate engagement with Moodle's collaborative features, with variability likely tied to educators' digital fluency and instructional preferences. The "Attendance" tool, however, remains significantly underutilized, despite its potential to monitor student engagement, especially in blended or asynchronous environments. Its limited adoption may reflect either a lack of awareness or the perception that attendance tracking is irrelevant in online contexts. Yet, when integrated with learning analytics, attendance data can serve as a valuable early warning indicator for identifying at-risk students, thus enhancing student support mechanisms and retention efforts.

The Relationship Between Students' Engagement and Academic Achievement on Moodle

The correlational analysis between aggregated Moodle engagement metrics and student academic performance yielded intriguing patterns. A robust positive correlation was observed between the number of completed activities and final grades ($r = 0.57$, $p < 0.001$), highlighting activity completion as the most potent predictor of academic success among the variables examined. Similarly, page view frequency demonstrated a moderate positive correlation with academic performance ($r = 0.39$, $p < 0.001$), suggesting that students who consistently accessed course materials and resources tended to perform better academically. Figure 3 illustrates the scatter plot of completed activities and the time spent on Moodle. Figure 4 depicts the scatter plot of completed activities and time spent on Moodle.

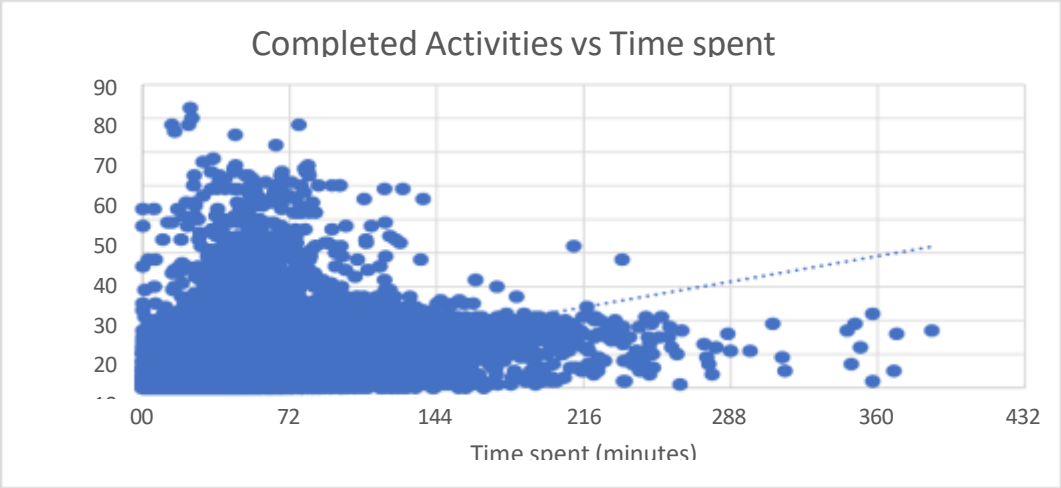

Figure 4: Scatter Plot of Completed Activities and Time Spent on Moodle

Figure 4 presents a scatter plot illustrating the relationship between the time students spent on Moodle (in minutes) and the number of activities they completed. This visualization forms a critical part of understanding how engagement time correlates with active participation in learning activities, a core dimension of digital pedagogy in contemporary HE. Figure 3's scatter plot illustrates the relationship between time spent on Moodle and the number of completed activities, revealing a moderate positive but non-linear correlation ($r = 0.53$). Most students spent 0–120 minutes and completed up to 40 activities, suggesting efficient and structured use of the platform. However, students who spent more than 216 minutes showed high variability in activity completion, indicating that increased time does not consistently equate to greater engagement. This variation may stem from differences in digital literacy, motivation, or cognitive strategies, emphasizing that time alone is not a reliable indicator of quality engagement. While extended use can support learning, the findings highlight the importance of guided and purposeful interaction with Moodle. Further analysis shows a weaker correlation between time spent and academic achievement ($r = 0.23$, $p < 0.05$), challenging assumptions that longer online presence leads to better performance. Students spending excessive time without completing proportionate activities often had average academic results, suggesting passive or inefficient engagement. Overall, the analysis stresses the need to contextualize time-based metrics with qualitative insights into engagement quality and task relevance.

The Relationship Between Students Grades and Page Views on Moodle

This subsection explores the relationship between student academic performance and their interaction with Moodle, specifically focusing on the number of page views. The scatter plot in Figure 4, along with accompanying statistical analyses, offers valuable insights into how the frequency of platform engagement correlates with student achievement. The Pearson correlation coefficient of 0.52 indicates a moderate positive linear relationship between the number of page views on Moodle and final student grades. The paired sample t-test yielded a statistically significant result ($p < 0.001$), and the moderate

effect size (d = 0.57) confirms that this relationship is not only statistically robust but also educationally meaningful. Figure 4 depicts the relationship between students' grades and page views on Moodle. The figure depicts the relationship between students' grades and page views on Moodle.

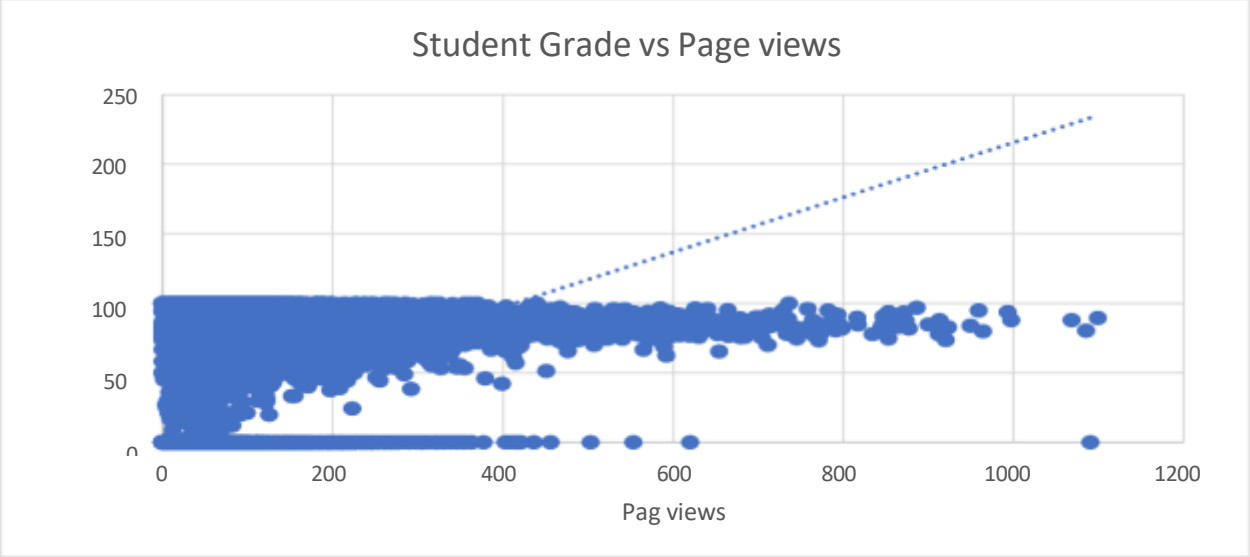

Figure 5: The relationship between students grades and page views on Moodle

As observed in Figure 5, there is a noticeable concentration of data points in the lower range of page views (0–300) and grades (0–80), suggesting that most students fall within this activity bracket. However, a gentle upward trend in the scatter indicates that students with higher page engagement tended to achieve better academic outcomes. Despite some variability, this trendline supports the interpretation that increased interaction with Moodle's learning resources, reflected through page views, is associated with improved academic performance. Figure 4 also reveals several outliers: students with exceptionally high page views (over 1,000) who did not necessarily obtain correspondingly high grades. These anomalies highlight the complexity of engagement behaviors, where the quantity of access may not always equate to the quality of learning. Such outliers underscore the need for a more nuanced understanding of digital engagement—one that integrates both behavioral metrics and pedagogical context.

The Relationship Between Students' Grades and Time Spent on Moodle

This subsection investigates the extent to which the duration of time students spend engaging with Moodle contributes to their academic performance. Time-on-platform is a key behavioral indicator in learning analytics, offering insights into learners' persistence, study habits, and self-regulated learning patterns. Moreover, the strength of the effect size suggests that this is not merely a statistical artifact but a meaningful trend with real-world implications. Time spent on Moodle likely reflects sustained interaction with learning content, engagement with activities such as quizzes, forums, and assignments, and overall commitment to self-paced study routines. These are well-documented predictors of academic success in both blended and fully online learning contexts. However, it is important to acknowledge that while the correlation is moderate, time alone does not capture the entirety of learning engagement. Quality, intentionality, and the nature of tasks performed during that time are equally critical. Nevertheless, this result affirms that time-on-platform remains one of the most accessible and actionable indicators for early intervention and academic monitoring. Figure 5 illustrates the relationship between students' grades and time spent on Moodle. Figure 6 depicts the relationship between students' grades and time spent on Moodle.

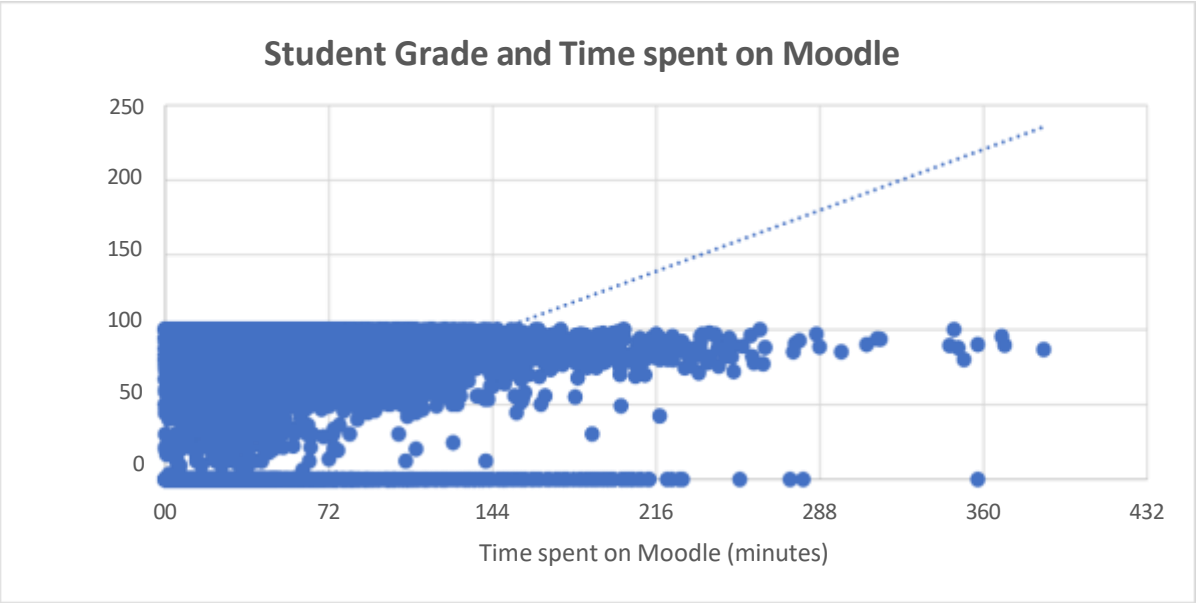

Figure 6: The Relationship Between Students' Grades and Time Spent on Moodle

Figure 6, which illustrates the relationship between students' grades and the time spent on Moodle, reveals a pronounced clustering of student activity within a specific temporal bandwidth. Most students at FoEDU engaged with Moodle for 0–300 minutes, with access frequencies between 0 and 150 sessions, indicating a moderate, surface-level usage pattern. These interactions primarily involve routine academic tasks such as downloading materials, submitting assignments, and completing quizzes, actions that, while essential, do not necessarily reflect deep learning or higher-order cognitive engagement. The concentration of engagement within this range suggests that many students adopt compliance-based strategies to meet course requirements rather than engage in reflective or collaborative activities. Outliers who exceeded 300 minutes of use were rare and may represent either highly self-directed learners or struggling students putting in compensatory effort. A moderate correlation between time-on-task and academic performance ($r = 0.52$) indicates that while time spent is a meaningful predictor, it has diminishing returns beyond a certain threshold. Qualitative factors such as motivation, instructional design, and metacognitive skills begin to play a more prominent role in student success at that point. The findings call for instructional strategies that maximize engagement within limited timeframes, including microlearning, gamification, and scaffolding. The time distribution serves as a diagnostic tool, identifying behavioral patterns and informing personalized interventions for both high-achieving and at-risk students.

The Relationship Between Students' Grades and Activities Completed on Moodle

This subsection investigates the relationship between students' academic performance and the number of learning activities completed on the Moodle Learning Management System (LMS). Activities on Moodle typically include quizzes, assignments, discussion forums, interactive learning objects, and other structured tasks intended to reinforce learning and track engagement. Statistical analysis revealed a moderate positive correlation between the number of activities completed and students' final grades ($r = 0.44$), indicating that higher rates of activity completion tend to be associated with improved academic performance. A paired sample t-test confirmed the statistical significance of this relationship ($p < 0.001$), validating that the observed differences between activity completion and academic outcomes are unlikely to have occurred by chance. Furthermore, the effect size, measured using Cohen's d, was found to be 0.76, which is considered a large effect size according to conventional benchmarks. This suggests that the magnitude of the difference in academic performance between students who completed more activities versus those who completed fewer is not only statistically significant but also practically meaningful. These findings substantiate the theoretical proposition that active engagement in structured learning tasks is a critical driver of academic success in digital

environments. The completion of Moodle activities likely reflects a combination of behavioral and cognitive engagement, which also indicates their consistent interaction with instructional content and evaluative feedback loops. In practical terms, this relationship affirms the pedagogical importance of designing and integrating purposeful and reinforcing the value of course scaffolding strategies, where activity completion is sequenced to promote knowledge accumulation and mastery learning. From an institutional perspective, these insights provide a compelling rationale for leveraging LMS analytics to identify students with low activity completion rates as potentially at-risk, and for implementing targeted academic support and early intervention strategies. Thus, the analysis demonstrates that the quantity of activities completed on Moodle is a reliable and impactful predictor of student academic performance, thereby underscoring the role of intentional instructional design and learner participation in enhancing learning outcomes within digital learning environments. Figure 6 illustrates the relationship between students' grades and activities completed on Moodle. Figure 6 depicts the relationship between students' grades and activities completed on Moodle.

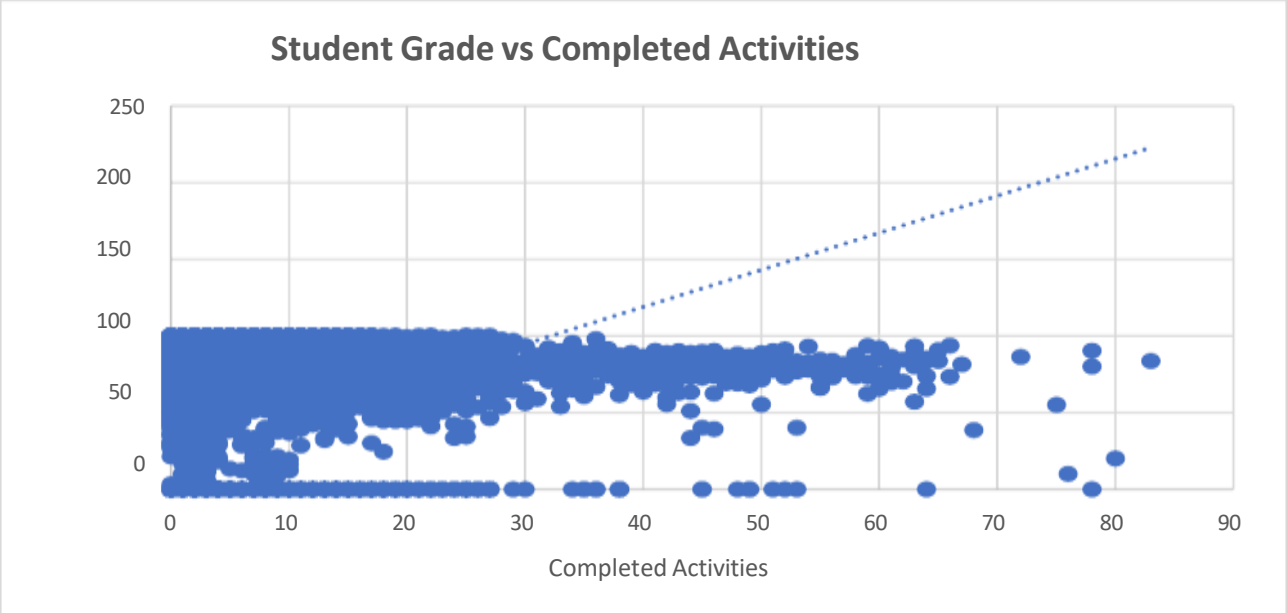

Figure 7: The Relationship Between Students' Grades and Activities Completed on Moodle

Figure 7 presents a visual analysis of the relationship between students' academic performance, measured in final course grades, and their level of engagement as quantified by the number of activities completed on the Moodle platform. Students completed an average of 130 Moodle activities, with most achieving grades between 0 and 85 out of 100. A moderately positive linear trend indicates that greater activity completion correlates with higher academic performance. Notably, students who completed over 100 activities generally scored above 50, with many exceeding 70 marks, suggesting that sustained engagement plays a key role in academic success. Statistical analysis reinforces this finding: Pearson correlation ($r = 0.44$, $p < 0.001$) confirms a moderate, statistically significant relationship between activity completion and grades. Cohen's $d = 0.76$ indicates a large effect size, showing a substantial performance gap between highly engaged and minimally engaged students. Pedagogically, these results underscore the value of structured Moodle activities—such as quizzes, discussions, simulations, assignments, and feedback loops- as they foster active learning, practice, and formative assessment. Furthermore, learning analytics from activity logs can be used as early warning systems to identify disengaged or at-risk students and prompt targeted interventions like personalized feedback or adaptive learning. In essence, Figure 6 validates the principle that consistent, structured interaction with Moodle activities significantly enhances academic outcomes.

DISCUSSION OF FINDINGS

This study set out to examine the efficacy of Moodle analytics as a predictive mechanism for identifying at-risk students in South African higher education, focusing on FoEDU, SPU. Thus, learning analytics offers a promising avenue for proactive student support. The findings presented here reveal compelling patterns between students' digital engagement behaviors on Moodle and their academic performance, thereby confirming the diagnostic and pedagogical utility of Moodle analytics for early risk detection.

Interpreting Digital Engagement: Quantity, Quality, and Academic Performance: One of the study's most revealing findings was the positive correlation between the number of activities completed on Moodle and students' final grades. On average, students who completed approximately 130 activities attained grades ranging from 0 to 85%, indicating that activity completion serves as a strong predictor of academic performance. This relationship affirms earlier work by Liu et al., and Caspari-Sadeghi, which suggests that active participation in LMS reflects higher levels of cognitive and behavioral engagement, both of which are essential to academic success.[60] However, a more granular view of the data reveals that engagement is not monolithic. For instance, students with frequent login but minimal task completion often record poor academic outcomes, suggesting superficial or strategic engagement. This phenomenon has been observed in previous studies, such as Glazunova et al., and Poondej and Lerdpornkulrat, where time-on-platform is decoupled from meaningful interaction with learning content.[61] Such findings caution against over-reliance on singular metrics, such as login frequency or page views, and reinforce the value of multi-dimensional engagement profiling that triangulates activity completion, time-on-task, and interaction quality.

Identifying At-Risk Students Through Multi-Metric Profiling: A central contribution of this study lies in its identification of empirically grounded thresholds for predicting academic risk. Students who completed fewer than 50% of assigned Moodle activities, logged fewer than 200 page views per semester, and demonstrated limited participation in collaborative forums were consistently clustered in the lowest quartile of academic performance. These metrics provide actionable benchmarks for early intervention and support institutional efforts to implement learning analytics dashboards that trigger alerts for academic advisors and lecturers. Yet, it is important to emphasize that such metrics must be contextualized within a broader socio-educational landscape. South African students often face systemic barriers, including limited access to digital technologies,[62] linguistic diversity, and socio-economic constraints.[63] Hence, while Moodle analytics can flag potential academic underperformance,[64] it is essential that any predictive model be integrated with socio-demographic data to ensure fairness,[65] inclusivity,[66] and contextual sensitivity.[67]

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[62] Tolulope Ayodeji Olatoye and Raymond Nkwenti Fru, "A Review towards Enhancing Geospatial Technologies in South African Rural Education," *Journal of Culture and Values in Education* 7, no. 4 (December 25, 2024): 190–210, https://doi.org/10.46303/jcve.2024.48.

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Collaborative Learning: A Missed Opportunity? A particularly noteworthy finding was the underutilization of Moodle's collaborative learning tools, forums, wikis, and group projects despite their well-documented pedagogical benefits. Students who engaged in such activities consistently demonstrated stronger academic performance, supporting Vygotskian theories of social constructivism and contemporary frameworks on online collaborative learning.[68] Collaborative engagement fosters deeper cognitive and affective involvement,[69] enhances retention,[70] and contributes to the development of higher-order thinking skills.[71] The pedagogical implications are clear: to move beyond content delivery and summative assessment models, FoEDU must prioritize the integration of interactive and peer-driven learning modalities into Moodle course design. Faculty development initiatives should target digital pedagogy, specifically the effective use of LMS tools for fostering student collaboration, engagement, and motivation.[72]

Rethinking Time-Based Engagement Metrics: Although time spent on Moodle is often used as a proxy for engagement, this study found only a weak correlation between duration and performance. The scatterplot in Figure 3 illuminated significant variance, where students with relatively low time investment often completed more activities and achieved higher grades, while others who spent considerable time on the platform did not exhibit commensurate academic success. These discrepancies suggest that learners differ in their digital fluency, learning strategies, and task efficiency. This finding reinforces the argument by Crone et al., Irvine & Kevan, and Nguyen et al., that time-on-task, while useful, must be interpreted in conjunction with activity-specific behaviors.[73] Hence, time-based metrics must consider the nature of the activity, the depth of interaction, and the student's digital learning orientation.[74] As such, future Moodle dashboards and faculty reports should present engagement metrics in a multi-layered format, distinguishing between passive, active, and collaborative behaviors, to allow for more accurate risk identification and instructional decision-making.

Pedagogical Implications for Moodle Course Design: The data indicate that many students can complete substantial learning activities within compressed timeframes, provided that the course architecture supports efficient navigation and coherent sequencing. This highlights the importance of instructional design principles such as content chunking, scaffolding, and the integration of formative assessments. Instructors should aim to design for efficient, meaningful engagement rather than encourage prolonged, passive interaction with the platform. Furthermore, faculty should incorporate nudging strategies, automated feedback, reminders, and prompts to guide students toward productive

Shafiq et al., "Student Retention Using Educational Data Mining and Predictive Analytics: A Systematic Literature Review," *IEEE Access* 10 (2022): 72480–503.

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[74] Jorge Martins and Miguel Baptista Nunes, "The Temporal Properties of E-Learning: An Exploratory Study of Academics' Conceptions," *International Journal of Educational Management* 30, no. 1 (2016): 2–19.

learning habits. Digital self-regulation tools such as personalized dashboards and visual progress trackers can empower students to monitor and adjust their engagement patterns, especially in large, asynchronous courses where personal contact with instructors is limited.

Institutional Innovation and Data-Informed Decision-Making: The evidence presented underscores the transformative potential of Moodle analytics not only for identifying at-risk students but also for informing broader institutional strategies aimed at improving retention and academic equity. At SPU, the development of an analytics-informed early warning system is both timely and necessary. Such a system would automate alerts based on student engagement thresholds and trigger supportive interventions such as academic advising, tutoring, or counseling. However, for such systems to succeed, they must be embedded within a holistic institutional culture that values data-informed pedagogy, continuous faculty development, and student-centered learning. As Tzimas and Demetriadis argue, analytics must not be treated as a purely technical solution, but as part of a broader pedagogical and ethical framework that respects student agency, diversity, and privacy.[75]

RECOMMENDATIONS

Based on the findings of the study, several key recommendations are proposed to advance the institutional use of learning analytics for student success. First and foremost, the study underscores the urgent need for the integration of analytics literacy into academic staff development programmes. This entails equipping academic and learning support staff with the conceptual and technical competencies required to interpret, contextualize, and ethically act upon Moodle-generated engagement data. Analytics literacy must extend beyond dashboard navigation to encompass a critical understanding of the pedagogical implications of student activity patterns, enabling staff to tailor interventions that are sensitive to the spatial, socio-economic, and technological realities of students, especially in geographically and digitally marginalized communities. Secondly, the implementation of adaptive, data-informed pedagogical strategies is recommended to foster inclusive digital learning environments that proactively support at-risk students. Informed by the geo-educational perspective employed in this study, such strategies must be contextually nuanced, recognizing that patterns of disengagement are often rooted in spatial inequalities, infrastructural deficits, and varying levels of digital access. Institutions should therefore adopt predictive models that are not only algorithmically robust but also socially responsive, allowing for the identification of at-risk students through multi-dimensional data sets, including login frequencies, resource access, assessment activity, and spatial engagement trends. These models should be embedded within institutional early warning systems that trigger timely, personalized support mechanisms such as academic advising, tutoring, or digital learning workshops. Furthermore, while this study was limited to a single institution and disciplinary context, it provides a critical foundation for scaling up Moodle analytics-based interventions across faculties and institutions. To this end, cross-institutional collaborations are recommended to build a national repository of best practices in learning analytics deployment, with particular attention to the affordances and constraints of South Africa's diverse higher education landscape. Future research should explore longitudinal and comparative studies to evaluate the sustained impact of Moodle analytics on student retention and academic performance, particularly among historically disadvantaged student populations. Lastly, institutional policies must be updated to reflect ethical guidelines on data use, student consent, and digital inclusion to ensure that the implementation of analytics-driven interventions aligns with broader goals of equity, transformation, and social justice in South African higher education.

CONCLUSION

This study has demonstrated the critical value of Moodle analytics as a geo-educational instrument for diagnosing and addressing academic risk within FoEDU at SPU. By mapping patterns of student engagement across disciplinary and spatial domains, the research advances an integrated understanding of how digital footprints captured through metrics such as time-on-task, page views, activity

[75] Dimitrios Tzimas and Stavros Demetriadis, "Ethical Issues in Learning Analytics: A Review of the Field," *Educational Technology Research and Development* 69, no. 2 (2021): 1101–33.

completion, and forum participation can function as early warning signals of academic vulnerability. The findings affirm that high levels of sustained interaction with Moodle are positively correlated with academic performance, while disengagement, manifesting in irregular access and minimal task completion, is indicative of elevated academic risk. Beyond its diagnostic utility, the study underscores Moodle's transformative potential as a pedagogical ally in under-resourced higher education contexts. It reveals that while assessment-related tools are extensively deployed, the underutilization of collaborative features suggests missed opportunities for fostering dialogic, participatory learning environments. The uneven distribution of engagement across modules and departments further illustrates the spatiality of digital pedagogy and the need for targeted interventions that account for contextual diversity within and across disciplines. Theoretically, this research contributes to the discourse on learning analytics by foregrounding the intersection of educational technology, spatial inquiry, and student success. Practically, it calls for the institutionalization of analytics-informed teaching practices and professional development strategies that empower educators to make data-driven pedagogical decisions. Ultimately, the study advocates for a responsive, equitable, and spatially attuned approach to academic support, one that repositions Moodle not just as a content platform but as a strategic tool for advancing student retention, pedagogical innovation, and social justice in South African higher education.

FUTURE RESEARCH DIRECTIONS

While this study offers valuable insights into the relationship between Moodle engagement and academic performance, the study's focus on a single institution limits the generalizability of the findings. Future research should expand the scope to include multiple institutions across diverse contexts to assess the transferability of the identified engagement patterns and risk indicators.

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