Leveraging Learning Analytics to Model Student Engagement Behavior in Graduate Statistics: A Problem-Based Learning Approach in Agricultural Education

Fahmida Husain Choudhury
Graduate Student
Texas A&M University
600 John Kimbrough Blvd, Texas A&M University, College Station, TX 77843,
979-862-1979, fahmida15.alec@tamu.edu

Shuai Ma
Graduate Student
Texas A&M University
600 John Kimbrough Blvd, Texas A&M University, College Station, TX 77843
979-845-6923, shuai_ma2021@tamu.edu

Zhihong Xu*
Associate Professor
Texas A&M University
600 John Kimbrough Blvd, Texas A&M University, College Station, TX 77843
979-321-5742, xuzhihong@tamu.edu

Theresa Pesl Murphrey
Professor
Texas A&M University
600 John Kimbrough Blvd, Texas A&M University, College Station, TX 77843
979-321-5740, Theresa.Murphrey@ag.tamu.edu

Kim E Dooley
Professor
Texas A&M University
600 John Kimbrough Blvd, Texas A&M University, College Station, TX 77843
979-321-5743, k-dooley@tamu.edu

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Introduction

Statistics is an essential yet challenging course across disciplines, and agricultural education is no exception. Many students experience anxiety due to limited mathematical backgrounds, negative perceptions of the subject, and fear of seeking help, which can hinder both performance and confidence (DeVaney, 2010). Learning Management Systems (LMSs) can help address these challenges by facilitating online learning, improving communication between instructors and students, and providing structured access to learning resources (Hariri, 2014). At the same time, Problem-Based Learning (PBL) has been shown to improve learning outcomes and promote better attitudes toward statistics by encouraging active, applied engagement with course material (Armanta et al., 2019; Jauhari et al., 2023). This mixed-methods study uses LMS data and interviews to explore how students with different performance levels engage and learn in a PBL supported graduate statistics course.

Conceptual Framework

In alignment with the student-centered structure of this graduate statistics course, Problem-Based Learning (PBL) was used to engage students in solving realistic problems through guided support, peer collaboration, and critical thinking (Barrows, 1986). Rather than receiving content passively, students were encouraged to explore, apply, and reflect on statistical concepts within meaningful contexts. This instructional approach has been widely applied across disciplines and situates instructors as facilitators who monitor progress and provide feedback throughout the learning process (Schmidt et al., 2011).

Methods

The study used an explanatory sequential mixed-method design where LMS log data was collected from 19 graduate students in a PBL-supported statistics course. The data then was analyzed by using k-means clustering and independent t-tests. Students were grouped based on interaction behaviors (i.e., content, instructor, and system use) and midterm scores. Qualitative data was gathered through 43 semi-structured interviews conducted across three times within the semester. Thematic analysis was performed using open and axial coding, and themes were visualized with MAXQDA to compare low- and high-performing student experiences.

Results

We found two main engagement patterns among students. High-performing students tended to interact with the LMS less frequently but in a more focused and consistent way, for example, keeping regular study routines and completing assignments early. In contrast, low-performing students showed much higher LMS activity, often using it reactively to catch up, review recordings before deadlines, or respond to confusion. Low-performing students showed the most growth in confidence, supported by repeated exposure and guidance. Both groups valued course elements that included live coding, organized modules, and supportive teaching, but low performers depended more on these to succeed.

To understand these differences more deeply, six key themes emerged from the interview responses: Behavioral Engagement, Role of Assessment, Emotional Struggle, Self-Efficacy, Knowledge or Skill Gain, and Instructional Support. These themes helped us see that high performers were generally more self-regulated, while low performers needed more external prompts to stay on track.

Behavioral Engagement captured differences in LMS use, as high performers followed a steady routine. For example, one of the high performer students noted, “I would do like 30 minutes each day before, leading up so that it wasn't all the night before or the day of…” Meanwhile, low performers engaged more reactively, saying, “I didn’t really organize my time well. I just did stuff when it was due, not before.” Similarly, Role of Assessment showed both groups increased LMS activity near exams, but high performers used assessments to confirm understanding, whereas low performers used them to seek help or catch up. In contrast, Emotional Struggle appeared more in low-performing students, who described confusion, stress, and early anxiety with statistics software, often needing more time or repetition. Moreover, Self-Efficacy improved for both groups, but more noticeably for low performers, who shared that their confidence increased by the end of the course. In terms of Knowledge or Skill Gain, this was reported across both groups. Low performers noted growth in basic understanding and use of R, while high performers emphasized applying deeper statistical reasoning. Finally, Instructional Support was appreciated by all, but especially by low performers, who relied on structured materials, reminders, and consistent feedback to stay on track and reduce stress.

Conclusions/Implications

This study identified two student groups with distinct engagement patterns: high-performing students who interacted with the LMS less frequently but in a consistent and focused manner, and low-performing students who engaged more often, typically around deadlines or in response to confusion. While both groups reported knowledge and skill development, low-performing students described greater shifts in self-efficacy and relied more on structured support. Six key themes emerged from the interview responses: Behavioral Engagement, Role of Assessment, Emotional Struggle, Self-Efficacy, Knowledge or Skill Gain, and Instructional Support.

We recommend using LMS data to identify students who may require more structured support early in the semester. Providing layered instructional support such as live coding, reminders, and self-paced practice materials helped students succeed. Instructors should encourage proactive engagement by scaffolding assignments and integrating reflection activities. The use of learning analytics with qualitative insights is integral for designing equitable and student-centered PBL environments.

References

Armanta, A. Y., Mustaji, M., & Suryaman, S. (2019). The influence of problem-based learning and attitudes towards learning outcomes for mathematics. Edcomtech: Jurnal Kajian Teknologi Pendidikan, 4(1), 1–7. https://doi.org/10.17977/um039v4i12019p001

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. Medical Education, 20(6), 481–486. https://doi.org/10.1111/j.1365-2923.1986.tb01386.x

DeVaney, T. A. (2010). Anxiety and attitude of graduate students in on-campus vs. online statistics courses. Journal of Statistics Education, 18(1). https://doi.org/10.1080/10691898.2010.11889472

Hariri, M. M. (2014). Students' perceptions of the utilization of learning management system (LMS) features: A case study of a geology course at KFUPM, Saudi Arabia. International Journal of Technology Diffusion, 5(4), 50–62. https://doi.org/10.4018/ijtd.2014100104

Jauhari, A. L. R., Herman, T., Juandi, D., & Negara, H. R. P. (2023). Differences in the improvement of statistical reasoning ability based on students' self-regulated learning level in online learning using LMS. JTAM (Jurnal Teori dan Aplikasi Matematika), 7(4), 899–913. https://doi.org/10.31764/jtam.v7i4.16830

Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. Medical Education, 45(8), 792–806. https://doi.org/10.1111/j.1365-2923.2011.04035.x