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A multivariate approach to predicting student outcomes in web-enabled blended learning courses

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ABSTRACT

This study aimed to develop a practical model for predicting students at risk of performing poorly in blended learning courses. Previous research suggests that analyzing usage data stored in the log files of modern Learning Management Systems (LMSs) would allow teachers to develop timely, evidence-based interventions to support at risk or struggling students. The analysis of students' tracking data from a Moodle LMS-supported blended learning course was the focus of this research in an effort to identify significant correlations between different online activities and course grade. Out of 29 LMS usage variables, 14 were found to be significant and were input in a stepwise multivariate regression which revealed that only four variables – *Reading and posting messages*, *Content creation contribution*, *Quiz efforts* and *Number of files viewed* – predicted 52% of the variance in the final student grade.

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1. Introduction

Internet-based information and communication technologies have opened up new potentials in higher education. Most universities today offer some coursework online and some have converted programs of study in order to make them entirely available online (Ward, Peters, & Shelley, 2010). Distance students can now use an assortment of online resources and learn at their own pace, collaborating with other learners rather than working in isolation. By their very nature, web-based learning modules offer the flexibility of self-directed learning and the opportunity to move away from teacher-directed approaches to teaching and learning. There are many instructional design models available to guide course design processes, but alignment among learning goals, assessment strategies and instructional activities is essential to a well-designed, student-centered learning course (Rubin, 2013).

Facilitating such a learning process in the online classroom is particularly challenging for the instructor due to the fact that most communication is asynchronous and lacks many of the emotional cues of the face-to-face environment (Sheridan & Kelly, 2010). Students with inadequate knowledge of the technologies being employed or with poor time management skills may experience delays in getting prompt feedback, feel unmotivated and procrastinate. Reflecting and in response to the students' specific experiences in the online classroom, instructors need to create an environment that encourages student feedback and engage students in intensive and fruitful interactions with the instructor, the material and the other learners (Mahle, 2011).

Activities promoting critical thinking, collaborative learning and self-directedness contribute to students' engagement and learning (Ishtaiwa & Abulibdeh, 2012).

Inspired by social constructivist theories of learning and development, online learning environments have evolved to specialize in the provision of networked tools that allow learners to determine and direct their learning activities according to their personal needs and goals. A variety of nearly synchronous or synchronous communication and collaboration tools, combined with media-rich resources and classroom materials, are used to engage students in meaningful learning online. However, although online student enrolment rates are drastically moving upward in all schools which offer online education (Allen & Seaman, 2009), research indicates that students are substantially less likely to complete fully online courses and their dropout rates are higher compared to students who took the same course face-to-face (Jaggars, 2011; Jenkins, 2011; Xu & Jaggars, 2011).

In contrast, online learning platforms enhanced by conventional teaching methodologies that include instructor led meetings and seminars, have been found to be at least as effective, in terms of learning outcomes, as the face-to-face courses (Bowen & Lack, 2012). Although the lack of self-regulatory learning skills remains a serious impediment to the success of learning in the blended learning context, the higher student–instructor interaction results in higher levels of students' motivation, engagement and achievement (Xu & Jaggars, 2011; Zacharis, 2011). Because a blended teaching model shifts instructors' focus away from more traditional curricular and administrative tasks in the direction of working with data and providing more individualized support to students, the analysis and interpretation of tracking data of students' activities online should be a seamless part of a blended learning classroom workflow.

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Many empirical studies have been carried out so far to examine the relationship between LMS usage and student academic achievement. By analyzing specific subsets extracted from the large datasets stored in the LMS (e.g. discussion messages posted, files viewed, time spent online, total hits), researchers try to identify online activities/variables that provide a predictive view of student performance in order to inform instruction or to determine strategies to help students at risk of course failure (Ashford-Rowe & Malfroy, 2009; Milne, Jeffrey, Suddaby, & Higgins, 2012). However, choosing the right set of variables to build a predictive model that works as an early warning system for instructors is a difficult task. Usually, the researchers have determined beforehand which variables are the most important ones to be plugged into the model and the only thing remaining is to test its predictive power.

In this study, all the pertinent LMS data concerning online activities during the blended learning process were extracted and each activity was treated as the independent variable in a bivariate correlation analysis with student course grade. From a total of 29 potential explanatory variables, 14 variables with significant univariate association with course grade were chosen for inclusion in a multivariate regression analysis. View of resources, quiz engagement, reading and posting of messages (in forum, email and chat) and content creation (in wiki and blog) were the variables that best predicted final grade, explaining over 50% in variability in the data set. These findings support the viewpoint that few LMS-based online learning activities are able to accurately predict educational outcomes in blended learning courses. Therefore, the provision of online tools and resources that promote engagement with content, collaboration with team mates and connectedness with both peers and teachers, should be of high priority during the design and practice of blended learning.

2. Blended learning through LMS

With the prevalence of web applications, online learning has gained increasing popularity over the years and has evolved as a viable and flexible alternative to traditional brick-and-mortar academic approaches. Nowadays, colleges and universities worldwide are using various forms of electronic distance media to transmit educational courses to students without the limitations of location or time. Both synchronous and asynchronous communication and collaboration online tools provide learning opportunities that are flexible and responsive to learners' needs, learning styles and backgrounds. Although research on the comparative effectiveness of online instruction and traditional, face-to-face learning in higher education reveals no significant difference in learning outcomes (U.S. Department of Education, 2010), it is common sense that the higher dropout rates for full-time online students are mostly due to their poor self-regulating skills and a lack of interaction with tutors and other learners.

2.1. Blended learning course design strategies

As higher education institutions adopt learning platforms as part of their educational delivery portfolio, educators seeking to effectively serve individual students' needs and learning styles are turning to blended learning instruction as a way to provide opportunities for self-paced and self-directed learning. Blended learning systems combine face-to-face instruction with computer mediated instruction (Graham, 2006). Blended or hybrid courses integrate online learning with traditional face-to-face class activities in a planned, pedagogically valuable manner that not just supplement, but transform and improve the learning process. Surpassing the conventional role of delivering knowledge, the teachers' new roles include facilitation, student mentoring and differentiating instruction for individual learners. By moving learning resources online, educators can easily track students' progress, freeing up time in the face-to-face meetings to engage students in collaborative work and troubleshoot difficult concepts.

Blended learning courses employ active learning strategies through using a variety of pedagogical approaches (Glazer, 2012), ranging from fully online curriculums with face-to-face interaction to courses in which traditional, face-to-face, classroom instruction is integrated with online components that extend learning beyond the classroom (Eduviews, 2009). How much of the face-to-face instruction must be replaced by online coursework will vary greatly by class, discipline, and learning objectives. A simple, but inefficient to cover every blended learning configuration, guideline defines blended learning as a course where 30%–70% of the instruction is delivered online (Allen & Seaman, 2009).

No matter what the blend of technologies or learning approaches, properly designing and implementing blended learning starts with a re-examination of the intended learning outcomes of the course (Garrison & Vaughan, 2008). Intended learning outcomes should be clearly stated, meaningful and measurable. Content should be divided into suitable learning chunks and presented in various formats to students, taking into account their different backgrounds and diverse ways of learning. Authentic learning activities and assignments should engage students in active learning, promote the achievement of the intended learning outcomes and be aligned with each other (Reaburn, Muldoon, & Bookallil, 2009). The sequence of learning events should involve the right mix of student–content, student–instructor, and student–student interaction (Gradel & Edson, 2010). Regular feedback about student performance should be provided in a timely manner throughout the course (Salmon, 2013).

Searching for the most appropriate model for a particular blended learning setting, Moskal, Dziuban, and Hartman (2013) conclude that "there is no singular best model, and most institutions can achieve success with nearly any of them" (Moskal et al., 2013, p. 16). They argue that mode of delivery in general, and blended learning in particular, has a very weak statistical correlation with student success. Rather, a set of institutional variables (institutional goals and objectives, administrators and faculty members' goals alignment, organizational capacity, faculty development and course development support, support for online students and faculty, robust and reliable infrastructure, longitudinal data collection and assessment, proactive policy development and an effective funding model) has come to be accepted as critical factors for blended learning success (Moskal et al., 2013).

2.2. Using LMS tools to facilitate blended learning

Campuses have adopted LMSs, like Blackboard and Moodle, to facilitate online, onsite and hybrid courses through their functionalities for content creation, communication, assessment and administration (Piña, 2010). Besides centralizing and automating administration tasks, like creating and managing user accounts, creating syllabi and assignments, grading, etc., LMSs assemble and deliver learning content rapidly, personalize content and enable knowledge re-use (Ellis, 2009). In an LMS environment, teachers can create and maintain a learning structure or sequence (Hirumi, 2012), load and replace resource files, control access to resources, organize and support group activities, track activity of learners, customize learning sequences, mark and provide feedback. Based on advanced relational database software such as Oracle, Microsoft SQL, or MySQL, which emphasize data independence, interconnectedness and security, LMSs incorporate a variety of login roles (instructor, student, guest) permitting the instructor to interact privately with one student or create discussion groups and teams with different profiles (Kats, 2010).

Through LMS platforms, students can access learning materials, like documents, spreadsheets PowerPoint presentations, hyperlinks, audio or video of lectures, submit assignments, track their progress and interact with professors and peers. All the social and collaborative aspects of blended learning can be facilitated by both the asynchronous and synchronous LMS tools. Asynchronous (non real-time) tools include email, threaded discussion boards, wikis, blogs, calendars, course