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Research notes

Improving students' performance in quantitative courses: The case of academic motivation and predictive analytics

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ABSTRACT

This 5 years longitudinal study explores and tests the effect of the combined use of some principles from the motivation achievement theories of educational psychology and predictive analytics (pedagogical innovation) on enhancing students' academic self-monitoring, engagement, and performance in a junior level quantitative business course. If and when unsatisfied with their class performance, or their predicted grade and likelihood of success of the pedagogical innovation, students in the post-innovation group were directed to either self-regulate their class engagement, and/or seek the intervention of the instructor for remedies to facilitate their success. Results show the post-innovation group outperforming the pre-innovation group with more As (+43%), Bs (+35%), with fewer Cs (−20%) supporting the hypothesis that the suggested innovation significantly improved students' performance. However, no significant improvement in the failure rate of the at-risk students (DFWs) was observed. While most students with high predicted probability of passing were able to self-regulate their academic engagement, only few of the at-risk students sought the intervention of the instructor, with the majority eventually succeeding in passing the course (some after several trials) due to their improved class engagement, and their perceptions of the instructor's positive role in facilitating their success.

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1. Introduction

Students' negative attitude and anxiety toward mathematics and their far reaching implications on their academic performance and career opportunities are well documented in the literature (Bessant, 1995; Meece, Wigfield, & Eccles, 1990; Wigfield & Meece, 1988). With only 26% of graduating high school students meeting the minimum ACT College Readiness Benchmark¹ in all testing subject matters, e.g., English, Algebra, Social Science, and Biology (ACT, 2013), higher education institutions have been prompted to develop interventions strategies to facilitate learning, and guide their students toward continually improving their academic performance (Handel, 2009).

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¹ The Benchmarks are scores on the ACT subject-area tests that represent the level of achievement required for students to have a 50% chance of obtaining a B or higher or about a 75% chance of obtaining a C or higher in corresponding credit-bearing first-year college courses. <http://www.act.org/solutions/college-career-readiness/college-readiness-benchmarks/>.

1.1. Literature review

Educational psychologists assert that most human actions are thought to be goal-directed toward either achieving desired outcomes or avoiding dreaded ones (Bandura, 1986). As such, this study posits that the combined use of motivation achievement theories and predictive analytics (pedagogical innovation), will facilitate students' academic self-monitoring and self-regulation, and assist in linking current actions to future goals for the purpose of improving their academic performance.

Although several definitions exist for academic engagement, this research adopts Kuh's and Hu's view which defines academic engagement as the "quality of effort students devote to educationally focused activities that contribute directly to desired outcomes" (Kuh & Hu, 2001). It is a multi-dimensional construct involving students' emotion, behavior, and cognition (Fredrick, Blumenfield, & Paris, 2004), and a robust predictor of students' learning, test scores, retention, and graduation (Appleton, Christenson, & Furlong, 2008; Patrick, Ryan, & Kaplan, 2007; Skinner & Pitzer, 2012). Students who were positively engaged in their course work and with instructors tend to be highly motivated (Ryan & Deci, 2009), are able to develop a better perspective about their academic progress and achievements (Finn & Zimmer, 2012; Fredricks et al., 2004), tend to score higher grades (Astin, 1993; Darling-Hammond, 1997; Kuh, 2003; Roderick & Engel, 2001), and experience lower drop-out rates (Croninger & Lee, 2001; Mangum, Baugher, Winch, & Varanelli, 2005). In contrast, unmotivated and disengaged students are at risk of lower performance and dissatisfaction which might lead to academic failure (Curwin, 2010; Willingham, Pollack, & Lewis, 2002; Uekawa, Borman, & Lee, 2007), and students' dropout (Bridgeland, Dilulio, & Morison, 2006). Hence, educators are expected to motivate students to help them achieve their educational goals (Miller & Brickman, 2004), and to self-monitor and self-regulate their own progress (Ames, 1992; Brophy, 2010; Covington, 1992).

Self-monitoring is the act of observing and recording one's own behaviors (Hallahan, Kauffman, & Pullen, 2011). It is an effective behavioral intervention to actively engage students (Blick & Test, 1987), enhance their academic skills (Maag, Rutherford, & Digangi, 1992), improve their productivity and accuracy (Rock, 2005), and positively impact student-teacher relationship (Reid, 1996). Successful self-monitoring requires students to self-regulate their academic progress and meet stated academic goals or complete required tasks (Porter & Ronit, 2006), where self-regulation is defined as "self-generated thoughts, feelings, and behaviors that are planned and cyclically adapted based on performance feedback to attain self-set goals" (Zimmerman, 1990).

The mechanisms through which students' cognitively manage their academic learning and engagement level are primarily influenced by four sets of psychological variables such as competence, autonomy and control, values and goals, and relatedness (Bandura, 1997; Dweck, 2000; Pintrich, 2003; Ryan & Deci, 2000).

- 1.1.1 Competence refers to the individual's ability to complete a specific task (Elliot & Dweck, 2005; Harter, 1978) such as students' belief about their academic competence and how it relates to their engagement, learning, and academic performance (Bandura, 1997; Dweck, 2000; Harter, 1982; Skinner, 1996; Skinner, Zimmer & Connell, 1998). Competence is determined by previous performance, vicarious learning, verbal encouragement, and physiological reactions (Bandura, 1977, 1997). Competence is addressed in the self-efficacy theory (Bandura, 1977, 1997); self-concept and self-worth theories (Covington, 1992; Harter, 1982), where the vision of one's self of the future can motivate behavior (Garcia & Pintrich, 1994; Markus & Wurf, 1987).
- 1.1.2 Autonomy and control refers to the motivation and willingness of individuals to engage in a specific task when feeling in control and are able to link required actions to desired outcomes. Pioneered by Deci and Ryan, the Self-Determination Theory (SDT) argues that students with greater sense of autonomy show high levels of academic engagement, persistence, and achievement (Deci & Ryan, 2002; Grolnick & Ryan, 1987), and their reasons for engaging are fully internalized (Ryan & Deci, 2000). To that extent, a study of differently structured reward programs by Fryer (2011) determined that rewarding students to increase their test score did not produce better results, in part because students had no control over their test scores, while on the other hand rewarding students for performing specific tasks such as reading books and taking a corresponding quiz, which students knew how to control, produced excellent results that persisted well past the duration of the study. Furthermore, Connell and Wellborn (1991) linked control beliefs to competence needs by concluding that individuals who believe they control their achievement outcome should feel more competent.
- 1.1.3 Values and goals refer to students' motivations to perform some academic tasks that are influenced by their perceived value, and students' goals for performing these tasks. Eccles and Wigfield (1995) defined four motivational components of task value: attainment value, intrinsic value, utility value, and cost. Wigfield, Eccles, Schiefele, Roeser, and Davis-Kean (2007) defined attainment value as the importance of doing well in a task, while intrinsic value is the enjoyment achieved from performing a task. Extrinsic value is the desire to achieve because of a certain objective and not so much for the enjoyment of the activity, while utility value is defined by how well a task relates to current and future goals, and reasons for engaging in terms of the lost opportunities resulting from making one choice rather than another.

Achievement goals theorists have identified two different types of achievement goals: mastery goals, and performance achievement goals (Ames, 1992; Dweck, 1986). Bandura and Schunk (1981), Bandura (1997), and Schunk (1991) argued that specific proximal goals combined with somewhat challenging goals promoted both self-efficacy and improved performance.

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