



## Life-long learning, conscientious disposition, and longitudinal measures of academic engagement in engineering design teamwork



Thomas A. O'Neill<sup>a,\*</sup>, Amanda Deacon<sup>a</sup>, Nicole L. Larson<sup>a</sup>, Genevieve C. Hoffart<sup>a</sup>, Robert W. Brennan<sup>b</sup>, Marjan Eggermont<sup>b</sup>, William Rosehart<sup>b</sup>

<sup>a</sup> Department of Psychology, University of Calgary, 2500 University Dr NW, Calgary, AB T2N 1N4, Canada

<sup>b</sup> Schulich School of Engineering, University of Calgary, Canada

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### ABSTRACT

The capability of life-long learning is a stable set of attributes and skills related to interest in and self-regulation of continuous learning. This and other attributes related to professional skill development have been increasingly viewed as a priority for the development in post-secondary education, rather than solely focusing on technical and discipline-specific knowledge acquisition. In the current study we examined the role of life-long learning as an antecedent of academic engagement in a university course using student engineering project teams with extensive team-related deliverables. We adopted multilevel longitudinal methodology and analytics to support several novel contributions. First, the general trend over the course of the semester was a decrease in academic engagement, but only for students low on the attribute of life-long learning. Second, life-long learning was a significant predictor of all 12 indicators of academic engagement over three time periods. Third, life-long learning was more important for academic engagement than other dispositional variables known to be relevant, namely conscientiousness and its facet of achievement-striving. As such, this adds unique evidence in support of recent accreditation initiatives, interventions, and learning structures that promote life-long learning development.

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### 1. Introduction

During the last decade, engineering and other technical education fields such as the natural sciences have increasingly emphasized the need to supplement the acquisition of discipline-specific knowledge with more general professional, interpersonal, and learning self-management skills throughout post-secondary education (Easa, 2013; Seat, Parsons, & Poppen, 2001). In particular, *life-long learning* has become an increasingly prevalent capability to develop in students. Life-long learning represents a set of attributes and skills related to interest and self-regulation of continuous learning (Guglielmino, 1997). The Canadian Engineering Accreditation Board (CEAB) now requires that graduates learn process and awareness skills involving the attribute of life-long learning (Canadian Engineering Accreditation Board, 2013). Similarly, student outcomes defined in the ABET accreditation criteria include life-long learning (ABET, 2014).

Numerous studies report on the development and implications of life-long learning with classroom interventions. Litzinger, Wise, and Lee (2005) linked problem-based learning to increases in life-long learning (see also Shankar et al., 2011; Shin, Haynes, & Johnson, 1993). Dyanan, Cate, and Rhee (2008) found that life-long learning increased when students were presented with unstructured learning environments and were required to plan, organize, and take responsibility for knowledge

acquisition. Jiusto and DiBiasio (2006) reported that participation in experiential interdisciplinary projects involving local agencies was related to increases in life-long learning. Sharples (2009) laid out a comprehensive theory explaining how personal mobile technologies can be used to promote life-long learning. As such, it appears that life-long learning is a construct that can and should be cultivated in students.

An important unanswered question involves the value, advantage, and implications of building life-long learning attributes in engineering students. Although engineers need to constantly learn and adapt to rapid advances in technical knowledge through their careers (Cervero, Miller, & Dimmock, 2003), relatively little is known about how life-long learning is related to academic outcomes (but see Litzinger et al., 2005). This is an important gap given accreditation standards and the search for educational methodologies and techniques that increase life-long learning (e.g., Jiusto & DiBiasio, 2006). Moreover, scholars have argued attributes should be considered in addition to standardized ability testing and high school academic achievement for post-secondary admissions (Hedlund, Wilt, Nebel, Ashford, & Sternberg, 2006). Together, this suggests it would be valuable to build an understanding of how life-long learning impacts academic outcomes through empirical research.

In the current study we sampled first-year university engineering students in a design and communications course over three time points. During these time periods we asked participants about indicators of academic engagement, as we expected that the primary role of life-long learning would be to sustain perseverance, motivation, and

\* Corresponding author. Tel.: +403 220-5207; fax: +403 282 8249.

meaningful personal integration of course content throughout the duration of the semester. Indeed, motivation and engagement with course material is a direct antecedent of knowledge and skill acquisition (e.g., Guthrie & Anderson, 1999; Handelsman, Briggs, Sullivan, & Towler, 2005; Skinner, Wellborn, & Connell, 1990), and life-long learning should be instrumental to the maintenance of focus and attention on academic demands over time. Importantly, in the general education and the psychology literature it is well known that the personality trait of conscientiousness and its facet achievement-striving are powerful predictors of academic success (O'Connor & Paunonen, 2007; Paunonen & Ashton, 2001). For comparison purposes, therefore, we examined the relative impact of both life-long learning and conscientiousness-related personality variables on indicators of academic engagement to evaluate which was of greatest consequence. Finally, we note that the course deliverables were 80% team-based; therefore, we examined indicators of academic engagement within a design team context.

### 1.1. Indicators of academic engagement

We considered engagement, intrinsic value, motivation, and satisfaction as indicators of academic engagement in engineering student team design projects. Engaged students are involved with the course content, apply the course to their life, see the course as relevant, and often think about the course (Carini, Kuh, & Klein, 2006). Engagement is needed to generate learning and academic achievement, as it has been related positively to goal setting and exam performance (Handelsman et al., 2005). Intrinsic value has also been linked to academic performance because students need to feel that the material being taught has relevance and implications to help them solve important challenges and problems they are facing (Pintrich & De Groot, 1990), thereby creating a feeling of internal importance. Motivation itself is an indicator of academic engagement, as it underscores direction, intensity, and persistence of effort (Muchinsky, 2009). Moreover, motivation has been linked to learning in academic environments (e.g., Christophel, 1990; Steinmayr & Spinath, 2009). Finally, satisfaction with the team involves feelings of happiness, contentment, and pleasure as opposed to unhappiness, discontentment, and displeasure as a result of being part of the team (Mason & Griffin, 2003). When satisfaction is low the team will be less and less viable over time as members seek to avoid each other and the adversity present in the team project (cf. Hackman, 1987).

### 1.2. Hypothesis development

#### 1.2.1. Life-long learning, conscientiousness, and achievement-striving

Life-long learning has strong conceptual ties to indicators of academic engagement. Life-long learning, according to Guglielmino (1977), can be summarized as the following:

A highly self-directed learner, based on the survey results, is one who exhibits initiative, independence, and persistence in learning; one who accepts responsibility for his or her own learning and views problems as challenges, not obstacles; one who is capable of self-discipline and has a high degree of curiosity; one who has a strong desire to learn or change and is self-confident; one who is able to use basic study skills, organize his or her time and set an appropriate pace for learning, and to develop a plan for completing work; one who enjoys learning and has a tendency to be goal-oriented.

Importantly, the Self-Directed Learning Readiness Scale used in this study is a content-valid measure of the aforementioned attributes and skills (Guglielmino, 1977; Lounsbury, Levy, Park, Gibson, & Smith, 2009). Attributes involve learning styles, such as industriousness, interest, and confidence with respect to the acquisition of information. Skills involve the application of appropriate study techniques, such as spaced over massed learning, organization, planning, and self-management.

Clearly, students with attributes that predispose them toward learning and personal growth along with the complementary skills to see these desires through will tend to stay engaged, see intrinsic value in course material, maintain motivation, and feel satisfied with their learning environment. Indeed, Lounsbury and colleagues reported positive relations with college student life satisfaction and negative relations with intention to withdraw from college (Lounsbury, Saudargas, & Gibson, 2004; Lounsbury, Saudargas, Gibson, & Leong, 2005). As such, we expected the following:

**Hypothesis 1a.** Life-long learning will be positively related to indicators of academic engagement.

One of the most robust individual difference variables related to academic achievement is the trait conscientiousness (Poropat, 2009). This might not be surprising, as conscientious individuals are dutiful, achievement-oriented, organized, and cautious (Costa & McCrae, 1992). Indeed, O'Connor and Paunonen (2007) meta-analyzed the literature and found that the population-level correlation involving conscientiousness and academic achievement was .24, whereas other traits exhibited trivial relations. The facet of conscientiousness known as achievement-striving has been a particularly powerful predictor, with Paunonen and Ashton (2001) reporting a relation of .26 and Chamorro-Premuzic and Furnham (2003) reporting a relation of .35 (see also Lounsbury, Sundstrom, Gibson, & Loveland, 2003). Given the strong empirical basis for both conscientiousness and the narrow trait achievement-striving for predicting academic-achievement, we felt investigating these traits in addition to life-long learning would be valuable for comparison and benchmarking reasons.

**Hypothesis 1b.** Conscientiousness will be positively related to indicators of academic engagement.

**Hypothesis 1c.** Achievement-striving will be positively related to indicators of academic engagement.

#### 1.2.2. Indicators of academic engagement over time

Given the longitudinal nature of the current study in which indices of academic engagement were assessed across three time points, we were able to examine the extent to which indicators of academic engagement were correlated over time. A perfect correlation would indicate that the rank-ordering of students' indicators of academic engagement is static over time, whereas a less-than-perfect correlation would indicate that rank ordering changes. If some students experience decrements in indicators of academic achievement while others experience gains and still others experience stability (i.e., a less than perfect correlation), it would be valuable to identify factors that lead to these particular changes. Evidence suggests that academic engagement is predictive of outcomes over time (Handelsman et al., 2005) and that correlations in engagement over time are approximately .50 (e.g., Hughes, Luo, Kwok, & Loyd, 2008). Accordingly, we predicted the following:

**Hypothesis 2a.** Indicators of academic engagement will be moderately correlated over time.

If there are changes in rank-ordering of indices of academic engagement over time as a result of less than perfect auto-correlation, we suspect that the main driver of these changes would occur during the later stages of the semester. Early in the semester indicators of academic engagement would likely be uniformly high, especially considering the current study context is within a first-year design course. As the semester progresses, however, and when energy dwindles and students juggle course loads and deadlines, we expect that there will be increasing levels of variability in students' indicators of academic engagement. Determined, motivated, learning-oriented individuals may maintain a high level of enthusiasm whereas their peers who are less determined,

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