

Motivating students to not sleep through Statistics: The power of inquiry

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Introduction/Need for Study

Instructors want positive outcomes for the students who are enrolled in their courses. While many desired outcomes may be context or content specific, many instructors aspire to develop motivated students with critical thinking skills. Motivated learners are individuals who possess the desire to acquire new knowledge and skills, rather than merely completing tasks (Schunk, 2008). Facione (2000) states that being internally motivated or self-regulated is a disposition needed to support critical thinking skills. However, Rugutt and Chemosit (2009) found that critical thinking skills were a predictor of student motivation. While the connection between critical thinking and motivation has been established, researchers are divided on whether motivation precedes critical thinking or if critical thinking possesses an inherently motivating structure (Lai, 2011).

Instructors utilize student centered teaching methods, such as inquiry-based learning, to help students meet desired outcomes. Inquiry-based learning is a student-based approach to learning, where instructors evaluate the students' current knowledge and then encourages them to develop new knowledge using problem-solving and higher-level thinking (NRC, 2000). Previous research has shown that inquiry-based learning has allowed students to apply concepts to real-world situations, has resulted in higher knowledge assessments, and has facilitated understanding of the scientific process (NRC, 2000; Pearson, Young, & Richardson, 2013; Skelton, Blackburn, Stair, Levy, & Dormody, 2018; Thoron & Myers, 2011). While several studies have linked inquiry-based learning to higher level thinking, few have made the connection to motivation. Spronken-Smith (2012) states the complexity and relatability of inquiry-based learning is likely to be motivating to students. By assessing student motivation and critical thinking skills instructors can better address learning outcomes by altering current curriculum or by introducing new instructional practices.

Conceptual Framework

The conceptual framework used to inform this study was The General Model of College Teaching and Learning (McKeachie, Pintrich, Lin, & Smith, 1986). This model postulates that students possess entry characteristics which create the foundation of the teaching and learning process. Within the teaching and learning process, task characteristics, instructional methods, student motivation, and student cognition, all influence each other, the students' ability to self-regulate learning, and academic performance.

Methods

The purpose of this quantitative descriptive study was to establish instrument reliability and describe preliminary pilot data. The purpose is driven by the following objectives: (1) establish instrument reliability within the context of an undergraduate statistics course, and (2) describe student motivation and critical thinking within an undergraduate applied statistics course following the completion of an inquiry project. At a large land grant institution, a census was conducted within two undergraduate agriculturally based applied statistics courses ($n = 61$), with a response rate of 88.5%, ($n = 54$). The average participant was female ($n = 28$, 51.9%), 21 years old ($M = 21.06$, $SD = 4.25$), held sophomore rank ($n = 29$, 53.7%), and was an Agriscience Education major ($n = 20$, 32.79%).

The course is required for undergraduate students majoring in agricultural education, communication, or leadership and was taught at both a main and regional campus during the semester of data collection. The final project in the course required students to develop an applied statistics inquiry-based project. The students had the option of completing three different inquiry-based projects: a research proposal, data collection and analysis, or statistical discovery

and application project. A panel of experts ($n = 4$) reviewed the project descriptions and classified the research proposal and data collection projects as high inquiry and the statistical discovery and application project as moderate inquiry.

The survey instrument asked students about their motivation, task value, and critical thinking toward the course materials. These items were adapted from the Motivated Strategies for Learning Questionnaire (MSLQ; McKeachie, Pintrich, Lin, & Smith, 1986). The instrument has previously been found to display a range of reliability estimates ($\alpha = .53 - .93$; Duncan et al., 2015). Students were invited to participate in the study following the completion of the statistical project and two reminder emails were sent before the course term ended (Dillman, Smyth, & Christain, 2014). To address objective one, Cronbach’s Alpha was computed for motivation, and critical thinking. For objective two we ran descriptive analyses for mean, standard deviation, and range. To categorize the students’ perceived motivation and critical thinking we set real limits (Fife-Schaw, 2006).

Findings

Objective 1. A Cronbach’s Alpha was computed on the motivation and critical thinking constructs to establish instrument reliability. The motivation construct included four statements and the critical thinking construct included five. Both were measured on a seven-point scale ranging from Not True of Me to Very True of Me. The motivation construct had a Cronbach’s Alpha of .738 and the critical thinking construct had a Cronbach’s Alpha of .882.

Objective 2. Participants reported moderate motivation and critical thinking toward applied statistics after completing an inquiry-based project (Table 1). Those completing the high inquiry project reported higher motivation and critical thinking than those completing the moderate-inquiry project. Additionally, the variability in motivation was smaller among the students who completed the high inquiry project. The critical thinking standard deviation was lower in the high-inquiry group, but the range of scores was higher.

Table 1
Motivation and Critical Thinking Descriptive Analyses

	<i>Motivation</i>			<i>Critical Thinking</i>		
	<i>n</i>	<i>M(SD)</i>	Range	<i>n</i>	<i>M(SD)</i>	Range
Sample	54	4.99(1.08)	4.00	54	5.13(1.10)	4.40
Moderate Inquiry Project	14	4.43(1.25)	4.00	14	4.57(1.13)	3.60
High Inquiry Project	40	5.19(0.96)	3.25	40	5.32(1.03)	4.40

Note. Real limits: very low (1.00-1.50), low (1.51-2.50), slight (2.51-3.50), neutral (3.51-4.50), moderate (4.51-5.50), high (5.51-6.50), and very high (6.51-7.00)

Conclusions

The results show that the instrument is reliable for measuring motivation and critical thinking in an applied statistics course. Additionally, results show that completing a statistics project that required higher inquiry resulted in higher levels of motivation and critical thinking, which supports previous research and further argues that inquiry-based learning could have an impact on student motivation (NRC, 2000; Pearson et al., 2013; Skelton et al., 2018; Spronken-Smith, 2012; Thoron & Myers, 2011).

Implications and Recommendations

The adapted MSLQ instrument should be used to measure motivation and critical thinking in undergraduate applied statistics courses. Future research should continue to examine the link between inquiry-based learning and student motivation. Finally, a pre-test post-test design would further validate the impact of the inquiry project on changes in critical thinking and motivation.

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