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Investigation of Academic Self-Concept of Undergraduates in STEM Courses

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Abstract. Academic self-concept is an important component of undergraduate student success. Academic self-concept refers to an individual's perception about their academic aptitude in a particular academic field. The purpose of this science education research study was to examine the effects of online and traditional (face-to-face) courses on academic self-concept. Undergraduate students enrolled in online and traditional science, technology, engineering, and mathematics (STEM) courses were administered the academic self-concept scale (ASCS). The ASCS measures students' perceptions of their capacity to attain academic success. Research findings indicate that online students were more likely to report a higher academic self-concept than traditional students enrolled in STEM courses. Future research studies will reveal the factors that underpin academic self-concept for students enrolled in STEM courses. Additional research on the mediators that influence positive academic self-concept are necessary to further inform online and traditional pedagogical strategies.

Keywords: academic self-concept, web-based, online education, STEM, education research

INTRODUCTION

The term academic self-concept has been an important educational and psychological construct in educational settings for several decades. In general, academic self-concept is a psychological construct employed to describe a students' belief regarding their ability in a particular academic area (e.g., biology). Wigfield &

Karpathian (1991) suggest that academic self-concept refers to an individual's understanding and perceptions about themselves in academic achievement situations. Valentine and associates (2004) argue that academic self-concept is a student's self-perception of their ability developed through specific endeavors and academic interactions. The Academic Self-Concept Scale (ASCS) is the major quantitative instrument employed to measure academic self-concept (Reynolds, 1988). Test items on the ASCS such as, "If I try hard enough, I will be able to get good grades.", "Most of the time while taking a test I feel confident.", "I feel that I am better than the average college student.", and "I consider myself a very good student." are used to explore student confidence in their academic capabilities and clearly illustrate the major purpose of ASCS. Marsh (1999) noted that in addition to having a cognitive component, academic self-concept also has a motivational and affective component, although this view is not fully accepted (Eccles, Wigfield, & Schiefele, 1998). The ASCS is however a widely used instrument and therefore validity and reliability issues regarding the ASCS have been thoroughly examined in previous pschyometric and social psychological research studies (Cokley, Komarraju, King, Cunningham, & Muhammad, 2003; Cokley & Patel, 2007; Dedonno & Fagan, 2013; Griffore & Samuels, 1978; Marsh, 1993; Reynolds, 1988) and therefore provided an appropriate test instrument for the issue addressed in this study.

Previous research has also demonstrated that academic-self-concept can serve as a predictor of academic performance and academic achievement (Choi, 2005; Marsh & Yeung, 1997) as well as provide fundamental insights about different types of college students. In one such study, Cokley et al. (2003) reported on the racial differences of academic self-concept among African American and European American college students. Results from their study revealed substantive differences regarding college students' perceptions about their academic ability based on ethnicity. More recently, Huang (2011) investigated the relationship between self-concept and academic achievement by analyzing 39 independent and

longitudinal samples utilizing meta-analysis and path analysis procedures. Results indicate that high self-concept is directly related to high academic performance and that self-enhancement and skill development may have high pedagogical value.

While the research on validity and reliability of the ASCS is valuable and the reports on the predictors and mediators of academic self-concept across several demographic lines is interesting, there is a lack of research that focuses on academic self-concept of students enrolled in online STEM courses. Moreover, there are very few studies that seek to elucidate whether there are differences in students' academic self-concept when completing traditional STEM courses versus online STEM online courses. Researchers of this study contend that noncognitive factors (e.g., academic self-concept, academic self-efficacy) must continually be addressed and investigated by
STEM faculty to broaden student educational attainment and extend student learning gains. Based on the scarcity of previous research in the area of STEM online learning and academic self-concept the following research question was explored: Controlling for differences in precollege characteristics, institutional characteristics, academic experiences, and nonacademic experiences, to what extent does the learning environment (online vs. traditional) influence academic self-concept for students in STEM courses?

METHODOLOGY

Research Study Participants

Six hundred seventy students attending a small Southeastern four-year academic institution who also enrolled in basic (100-level) introductory STEM courses (online and traditional) participated in the Institutional Review Board (IRB) approved research study. The study consisted of both non-science majors and science majors from all four classification groups. The majority of the research study participants

were female (sixty-one percent). An Internet-based quantitative survey instrument (ASCS) was administered to measure undergraduate students' academic self-concept. Student participants completed the survey at the end of the semester. Surveys were administered after the course withdrawal period to ensure a sample of students that were committed to course completion. Participants were free to withdraw their consent to participate and were instructed that they could discontinue their participation in the research study at any time without consequence. The entire research project involved the use of 18 years old or above college students, who were offered incentives to participate in the research study.

Data Analysis Methods

The Academic Self-Concept Scale was the primary data collection instrument employed in this research study. The Academic Self-Concept scale is a 40-item, Likert-type scale. It measures students' perceptions of their ability to attain academic success. Data generated from the Academic Self-Concept Scale yielded valid measurements for the constructs of interest. Descriptive statistics and regression analysis were used to analyze the data. Statistical results were shown to be nonsignificant. Effect sizes were also computed by dividing the regression coefficient by the pooled standard deviation of the outcome measure to examine the practical significance of the regression coefficient (Cohen, 1988).

RESULTS

To determine students' academic self-concept, students enrolled in online and traditional courses in STEM were administered the Academic Self-Concept Scale at the end of the semester. The Academic Self-Concept Scale is shown in Table 1. Statistically controlling for differences in precollege characteristics, institutional characteristics, academic experiences, and nonacademic experiences, students in

online STEM courses reported higher academic self-concepts than students who took online STEM courses, but the results were not statistically significant.

Table 1

Academic Self-Concept Scale

1. Being a student is a very rewarding experience.
2. If I try hard enough, I will be able to get good grades.
3. Most of the time my efforts in school are rewarded.
4. No matter how hard I try I do not do well in school.
5. I often expect to do poorly on exams.
6. All in all, I feel I am a capable student.
7. I do well in my courses given the amount of time I dedicate to studying.
8. My parents are not satisfied with my grades in college.
9. Others view me as intelligent.
10. Most courses are very easy for me.
11. I sometimes feel like dropping out of school.
12. Most of my classmates do better in school than I do.
13. Most of my instructors think that I am a good student.
14. At times I feel college is too difficult for me.
15. All in all, I am proud of my grades in college.
16. Most of the time while taking a test I feel confident.
17. I feel capable of helping others with their class work.
18. I feel teachers' standards are too high for me.
19. It is hard for me to keep up with my class work.
20. I am satisfied with the class assignments that I turn in.
21. At times I feel like a failure.
22. I feel I do not study enough before a test.

23. Most exams are easy for me.
24. I have doubts that I will do well in my major.
25. For me, studying hard pays off.
26. I have a hard time getting through school.
27. I am good at scheduling my study time.
28. I have a fairly clear sense of my academic goals.
29. I'd like to be a much better student than I am now.
30. I often get discouraged about school.
31. I enjoy doing my homework.
32. I consider myself a very good student.
33. I usually get the grades I deserve in my courses.
34. I do not study as much as I should.
35. I usually feel on top of my work by finals week.
36. Others consider me a good student.
37. I feel that I am better than the average college student.
38. In most of the courses, I feel that my classmates are better prepared than I am.
39. I feel that I do not have the necessary abilities for certain courses in my major.
40. I have poor study habits.

Table 2 summarizes the direct effects of taking an online STEM course (versus a traditional STEM course) on students' academic self-concept. A multiple regression analysis demonstrated that taking an online STEM course had positive direct effects (B = 1.457, NS) on students' scores on the Academic Self-Concept Scale.

Table 2

Effects of Online STEM Courses on Academic Self-Concept [a,b]

Scale	Regression Coefficient	R^2

Academic Self-Concept Scale	1.457[c] (.042)	.012

[a]Top number is the unstandardized regression coefficient, number in parentheses is the standardized regression coefficient.

[b]Statistically controlling for: age, gender, year in school, grade point average, residence status, hours spent studying per week, and hours spent working on-campus and off-campus per week

[c]Nonsignificant (NS) statistical result

DISCUSSION

Since the introduction of distance learning, the number of students earning college degrees through online education initiatives continues to increase at a remarkable rate. For example, it was reported in 2011 that over 30% of college students have taken at least one online course (Allen & Seaman, 2011). Despite incremental growth in student enrollment in online learning over the last ten years, there continues to be resistance toward online learning initiatives on college campuses. In a recent report in which over 2800 higher education academic leaders across the country were surveyed about their perceptions and attitudes toward online learning it was reported that only thirty percent of the chief academic officers believed that the faculty at their institution have confidence in online learning initiatives (Allen & Seaman, 2011). Although the specific reasoning for their beliefs were not clearly discussed in the report, these data highlight the notion that much work remains to be done to provide sound evidence regarding the legitimacy of online education methods. Quality concerns can be overcome with studies of this type that continue

to show the advantages of online learning on psychological, sociological, and cognitive dimensions.

Research findings from this study indicate that students who were enrolled in online STEM courses had a greater belief in their academic ability than students who were enrolled in traditional STEM courses (Table 2). This result is meaningful for science education stakeholders for a number of reasons, despite the fact that is was shown to be nonsignificant following statistical analysis. First, it provides the initial experimental basis for further studies regarding online STEM education and academic self-concept. Second, the current data provides the impetus for continued studies to measure other factors that may affect student performance and student retention in undergraduate degree programs that utilize both online and traditional content delivery methods. A major limitation in this research design is that it did not include a pre-test. Pre-test results would have better illustrated the change in academic self-concept over the course of the entire semester. The problem with a methodology that only includes a single time point is that it reduces the ability to assess the modifications or incremental changes in students' perceptions that take place during the semester. It could be that in the beginning of the semester academic self-concept was the same for both populations under study (e.g., online students and traditional students) and that over the course of the semester student perceptions changed, however with the current methodology it is difficult to determine formative changes in academic self-concept. Additionally, another limitation in this study is the use of an unmodified ASCS. The ASCS used in this study did not contain discipline-specific questions rather contained general questions which forced student participants to make broad decisions regarding their academic ability in their respective STEM course.

Pedagogical Implications

An important element in online course development is the meticulous design of teaching modules and online assignments that contain clear instructions, alternative electronic submission strategies, and a carefully constructed rubric. Rubrics must be created to provide preset criteria to students. Rubrics help clarify student learning goals and provide the foundation for enhancing student learning. As online instructors we have observed firsthand the impact of creating highly organized instructional environments to promote student confidence in their academic ability (e.g., academic self-concept). Moreover, previous research by Flowers, Moore, and Flowers (2010) demonstrated that students in online science and engineering courses tended to prefer instructional environments that had more structure than students who took traditional courses. Guay, Marsh, and Boivin (2003) also noted that academic self-concept develops when students receive feedback on academic assignments. Research also suggests that course assignments that reinforce students' positive experiences in STEM disciplines can have dramatic affects on their academic self-concept. Thus, online STEM instructors can enhance students' academic self-concept by developing course assignments in which appropriate student feedback is a central component. Online assignments in which students are given positive and thorough feedback while the assignment is being completed or after the assignment has been submitted may strengthen student confidence in their academic ability and in their ability to be successful in the course. One such assignment could involve an essay-based assignment in which the online instructor asks students to discuss their previous successes in earlier science classes or to write an essay about ways that scientific principles are used in their daily life. Similarly, assignments could involve the use of online discussion boards to facilitate course-wide communication. In terms of positive or productive feedback in the online classroom, a helpful suggestion is to provide assignment feedback to students immediately after an assignment has been administered. This feedback could come in the form of providing additional assignment instructions or serve as an invitation for questions about the assignment.

Future Science Education Research

A complete understanding of the factors that affect academic self-concept is extremely important for college instructors in all disciplines, especially STEM instructors. STEM courses are historically associated with negative academic self-concept in many students which leads to poor academic performance and poor undergraduate retention rates. Research-based methods employed to identify the underlying basis of negative academic self-concept in STEM students would provide meaningful data that could be used to aid in the development of beneficial online and traditional teaching strategies as well as institutional policies designed to enhance students' academic self-concept. Lastly, future science education research studies should also explore whether the nature of the online course delivery method (e.g., online, blended, web-facilitated) affects students' academic self-concept. Since most STEM faculty utilize a variety of online course delivery methods to communicate with students and assess their learning, qualitative or quantitative research studies investigating differences in academic self-concept could provide valuable information used to inform pedagogical strategies.

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