A Mathematics Self-Efficacy Questionnaire for College Students

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Abstract

We are developing a Mathematics Self-Efficacy Questionnaire (MSEQ) that provides college mathematics instructors and mathematics-education researchers with information about students' self-efficacy (specific confidence) in their ability to learn mathematics. In a pilot administration, students responded to 30 Likert-type items that provided information about students' self-efficacy in relation to factors such as their gender, previous mathematics achievement, previous mathematics experiences, their use of self-regulation learning strategies, and their perceived level of mathematics anxiety. Preliminary results will be reviewed: The MSEQ data are interpreted using students' interviews about their mathematics self-efficacy. The findings are viewed in terms of Bandura's social-cognitive theory of learning, and future research is suggested to refine the MSEQ in terms of its reliability, validity, and convenience of online administration.

Introduction

As instructors of college mathematics courses respond to the need for fostering students' "mathematics literacy," the important role of students' mathematics self-efficacy has received increased attention (Hannula, 2006; Pape & Smith, 2002). Students' mathematics self-efficacy has been shown to impact their college major selections, course decisions, and which mathematical problems or tasks they are willing to attempt (Lent, Brown, & Larkin, 1984). At many colleges, the required (core curriculum) mathematics courses for non-mathematics majors often have hundreds of students enrolled in each section, making it difficult to address the

specific needs of individuals. Anecdotal evidence suggests that many of these students have low mathematics self-efficacy, do not see the relevance of mathematics to their careers, and find mathematics frustratingly difficult.

Poor self-efficacy in non-mathematics majors often leads to low achievement. But who are the students who have low mathematics self-efficacy, and why do they have it? These are important questions for instructors who wish to improve their students' mathematics self-efficacy. Answering these questions is difficult, particularly at institutions with large-enrollment classes, where it is difficult to know students personally. To help answer these questions, the Mathematics Self-Efficacy Questionnaire (MSEQ) is being developed, guided by Bandura's (1997) social-cognitive learning theory, which connects characteristics of the individual (e.g., gender and prior experience) with characteristics of a learning environment (e.g., a core-curriculum mathematics course) to determine behavior (e.g., mathematics achievement).

Method

At a public university with 25,204 undergraduate students in the southern United States, a pilot administration of the MSEQ was conducted with 70 undergraduate non-mathematics majors enrolled in a core curriculum mathematics course. The questionnaire was made available online using Fathom software, which aided in administration and data analysis. To explore the participants' interpretations of the MSEQ items, interviews were conducted with 5 participants who ranged in their levels of mathematics anxiety and mathematics self-efficacy.

The 30 MSEQ items were developed based on the social-cognitive learning literature, and interviews and focus groups—with mathematics majors, non-mathematics majors, and mathematics instructors. The pilot version contains three subscales: academic habits, mathematics anxiety, and mathematics self-efficacy. The academic habits items explored the

behaviors and habits students engaged in during their mathematics classes. The mathematics anxiety and mathematics self-efficacy items were intended to pinpoint the specific areas where students felt anxiety or self-efficacy in their mathematics classes. This initial pool of items was administered on a pilot basis to 70 non-mathematics majors because this population was believed to have the most students with low mathematics self-efficacy.

Results

Preliminary findings based on the 70 students who have responded to date suggest that the MSEQ is reliable, valid, and convenient to administer by means of an online procedure. For the entire scale, the Cronbach's coefficient alpha of .928 was considered to be very high and satisfactory. We also looked at the Cronbach's coefficients for the mathematics anxiety subscale and the mathematics self-efficacy subscale, which were .903 and .916, respectively. We therefore consider the MSEQ to be reliable in terms of its internal consistency. Furthermore, the online administration format proved to be convenient for administration by instructors, response by students, and analysis by researchers.

To explore the academic habits of students with high mathematics anxiety or high mathematics self-efficacy, we calculated correlations between the academic habits items and the mathematics anxiety items and correlations between the academic habits items and the mathematics self-efficacy items. Although the correlations we discuss here are significant, we acknowledge that they are lower than satisfactory. Once items have been refined and a larger sample of participants have been surveyed, we expect the correlations to increase.

Only two of the academic habits were found to be significantly correlated with any of the anxiety items. First, students who rated themselves as frequently working hard in their college mathematics courses were more likely to experience anxiety when working on mathematics

homework (r = .341) and when preparing for mathematics tests (r = .342). To get a better understanding of what students meant by working hard in a mathematics class, we considered some of the typical responses from the student interviews, such as "By spending so much time on the homework. Sometimes I'll go to tutoring…three hours. Or just by spending, like, all your time. Spending more time on your math classes than any other class." Students often referred to the amount of time spent working on coursework outside of class as an indication that they were working hard. Also, students mentioned that they were working hard in their mathematics classes because they made those classes a priority: "You have to prioritize and say this is more important than the other classes I'm taking and like, you're making the extra effort."

Also, students who reported frequently seeking help from their mathematics instructors were more likely to report mathematics anxiety. These students felt more anxiety about preparing for mathematics tests (r = .330), sitting in mathematics lectures (r = .433), future mathematics coursework (r = .553), performing on tests (r = .448), and understanding mathematics (r = .428). When asked about seeking help from instructors outside of mathematics classes, students often remarked that the attitude of the instructor affected how likely they were to request help: "I'm not as nervous to ask questions when instructors seem really willing to answer my questions."

The only academic habit that was significantly correlated with students' mathematics self-efficacy was seeking help from mathematics instructors outside of class. Students who were more confident in getting an A in a mathematics course (r = -.251), doing mathematics (r = -.309), and being the type of person who is good at mathematics (r = -.393) were also less likely to seek help from their mathematics instructors. These results were confirmed by students' responses in the interviews: "I feel like, a lot of times, when you go see them outside of class, that's the better way to get a better grade." Students indicated that they would seek help from

mathematics instructors when they were not feeling confident about their grades in the class or when they were unsure about their mathematics abilities.

Implications

The results of this study demonstrate the importance of the mathematics instructor on his or her students' level of mathematics anxiety and mathematics self-efficacy. Students who felt more anxious about mathematics were more likely to meet with their instructors for assistance, which indicates that mathematics instructors have the opportunity to work individually with these students. Also, students who felt anxious while working on mathematics perceived themselves as working hard. Therefore, mathematics instructors need to ensure that their students are spending their time effectively and not wasting time on fruitless study habits, which can lead to students' frustration.

Although the pilot version of the MSEQ was found to be extremely consistent and reliable, there are additional changes that we feel might benefit the questionnaire and the instructors who decide to administer the questionnaire. Due to the number of mathematics anxiety items and mathematics self-efficacy items that were correlated with the frequency of students seeking help from instructors, we believe it would be informative to include items that explore what type of help students seek outside of class. For example, if students are simply going to their instructor's office hours, or if they are scheduling appointments to meet with their instructors. Also, because students with high anxiety in mathematics courses felt like they were working hard, we would like to include items that investigate how students are spending their time in their mathematics courses.

Once the aforementioned changes have been made to the MSEQ, we will administer the questionnaire to a larger group of non-mathematics majors and establish the reliability of the

modified version of the MSEQ. Ultimately, the MSEQ is intended for the following application: The MSEQ, designed to provide knowledge of a student's mathematics self-efficacy, and the basis for that self-efficacy, can be useful to mathematics instructors and mathematics-education researchers in fostering a student's mathematics self-efficacy, and thereby, achievement. The MSEQ can help instructors of large-enrollment mathematics courses identify those students with low mathematics self-efficacy who would benefit the most from individual and group advisement designed to increase their mathematics self-efficacy and achievement.

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