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Connecting teaching practice to student efficacy in undergraduate mathematics

Sandra Becker

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CONNECTING TEACHING PRACTICE TO STUDENT EFFICACY IN UNDERGRADUATE
MATHEMATICS

by

Sandra Becker

Thesis

Submitted to the Department of Teacher Education

Eastern Michigan University

in partial fulfillment of the requirements

for the degree of

MASTER OF ARTS

in

Educational Psychology

Thesis Committee:

Alane Starko, PhD, Chair

Nelson Maylone, PhD

Patricia Pokay, PhD

Ypsilanti, MI

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Dedication

To my great-aunt Ruth Kaarlela,
whose pioneering work and tremendous support of education
have made such a positive difference
in my life and many others

Acknowledgements

First and foremost, I would like to thank my thesis committee of Dr. Alane Starko, Dr. Pat Pokay, and Dr. Nelson Maylone for all of their excitement and encouragement throughout my studies in Educational Psychology.

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Thank you to Elaine Lande, Lindsay Ryan, and Alex Smith for their assistance with the analyses for this project.

And finally, thank you to my amazing friends and family for supporting me through nearly six years of graduate studies in education. It has been a long haul and I could not have started or completed the journey without the best cheerleaders anyone could ever hope for.

Abstract

Academic efficacy plays a critical role in student success in math learning at all levels due to its impact on persistence, motivation, and academic performance. This research aimed to connect student efficacy with key aspects of the instructional environment in six undergraduate math classes. Student surveys indicated significant differences in mean efficacy between classes, as well as significant differences in student perceptions of teacher behavior between the efficacy groups. Findings from observations of the classes revealed that key aspects of the instructional discourse varied by efficacy group. Instructors in higher efficacy classes tended to have more personal connections with students and used more positive and encouraging language, particularly in response to student errors. These findings mirror the results of similar studies at the K-12 level and have important implications for teaching practice in higher education.

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Chapter 1: Introduction and Purpose

Teaching is an inherently interpersonal act, with teachers and students each contributing to an environment that may encourage or impede learning for students in the classroom.

Emotions are present in teachers' responses to students, and in students' beliefs and actions, and are therefore a critical aspect of classroom interactions (Meyer & Turner, 2002). In math classrooms, which tend to be particularly emotionally charged, teachers at all levels must be attentive not only to the content that they teach, but also to the complicated dynamics that arise from subject matter that can cause many students to feel incompetent (Cherkas, 1992; Williams-Johnson et al., 2008).

Purpose and Significance

Students in remedial or developmental math courses at the university level, as well as pre-service elementary teachers, tend to have particularly low levels of confidence in their math abilities and demonstrate high levels of math anxiety (Goolsby, Dwinell, Higbee, & Bretscher, 1988; Jackson & Leffingwell, 1999; Tooke & Lindstrom, 1998). Many report prior negative experiences in math classes and previous failures (Harper & Daane, 1998). However, some students succeed against seemingly long odds, given their prior history. What drives these successes? Are there differences in the ways instructors teach or interact with students that allow students who are at high risk for math anxieties and low efficacy to succeed?

My goal with this project was to identify key aspects of instructional practice that may help otherwise at-risk student groups feel a high sense of self-efficacy in undergraduate math classes. The research literature is clear that interpersonal relationships and classroom dynamics have a powerful impact on students, but there are gaps in the literature about observed instructor behavior and student efficacy at the university level.

Understanding the dynamics between instructional environments and efficacy can raise awareness of these issues and help higher education instructors learn to implement practices that contribute to student success in developmental mathematics and elementary mathematics education courses. This can open dialogue about innovative practices and discussions that can only deepen our understanding of how to help students be successful and sustain success in the future.

Research Question

In order to further explore the connections between practice and efficacy-related issues in undergraduate math classrooms, I studied such classes to begin answering the following question:

How do instructional environments differ in undergraduate math classrooms with various levels of student efficacy?

The term “instructional environment” was chosen deliberately to encourage a broad focus on many aspects of the classroom experience, including teaching practice, interpersonal dynamics, and student perceptions. The research plan was to collect data that would allow for any number of phenomena to emerge as important differences, including time allocation, patterns of interaction, tone of interaction, and student affective experiences. All of these aspects of the classroom environment were studied through surveys and observations.

Through this research study, I aimed to identify positive instructional practices in university classrooms in which at-risk students are learning math. I hope to share those findings with the goal of positively impacting other instructors and students.

Chapter 2: Review of Literature

Self-efficacy is deeply entangled within social, cognitive, and emotional facets of human life. Research literature from psychology and many areas of education (including math education and higher education) offer insights into efficacy as it arises in school settings and the unique circumstances of adult students who bring prior history into their college math courses as well.

Self-efficacy

Self-efficacy is the belief in one's own ability to be successful at a particular task. It is not an objective measure of capabilities but is a measure of anticipated success given individuals' current sense of their own abilities (Friedel, Cortina, Turner, & Midgley, 2007).

Bandura's (1997) social-cognitive theory states that there are four sources of high self-efficacy:

- Mastery experiences - previous personal successes
- Vicarious mastery experiences - witnessing a peer's success
- Social/verbal persuasion - convincing, authentic praise and encouragement
- Physiologic cues – such as a lack of stress or anxiety

Usher and Pajares (2009) used survey methods to successfully verify Bandura's theories, and agreed with Bandura (1997) that the primary source of high self-efficacy is mastery experiences. That is, people who have achieved success in an area, from athletics to neurosurgery, are likely to have a strong sense that they can be successful in that area in the future.

Efficacy beliefs influence optimism, goal setting, and persistence at completing a task even when challenges arise (Bandura, 2006). People who have low efficacy may experience anxiety, stress, and depression in the face of a challenge and ultimately give up. For these reasons, efficacy plays a powerful role in many life experiences, particularly in education.

A Model of Efficacy and Motivation

Harter (1981) produced a model of mastery motivation that illustrates connections between negative experiences (i.e., the opposite of mastery experiences) and decreased efficacy and motivation. Mayer (2007) would add a link from decreased efficacy to decreased help-seeking, and from decreased help-seeking to negative experiences, completing a cycle. A model illustrating these pathways is depicted in Figure 1.

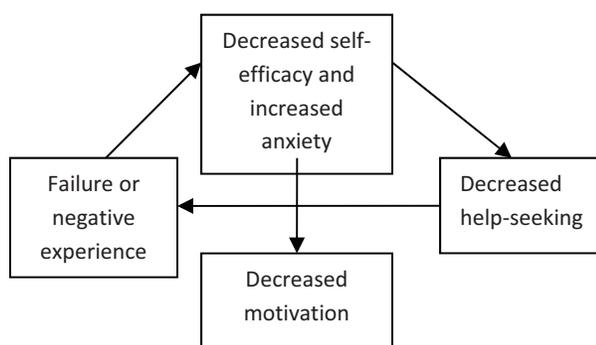


Figure 1. A model of efficacy and motivation.

Students end up in this cycle and have a difficult time escaping from it. Failure or other negative experiences lead to anxiety and low self-efficacy, which erode their motivation and decrease their persistence and willingness to ask for help. All of this contributes to more failure (Cifarelli, Goodson-Espy, & Chae, 2010; Mayer, 2007), starting a downward spiral.

Math Self-efficacy

Academic self-efficacy is believed to be a prerequisite to motivation and achievement in schools (Jerusalem & Hessling, 2009). In research studies, high math self-efficacy has been shown to be a strong predictor of math performance, above and beyond general mental ability (Pajares & Kranzler, 1995).

Low math self-efficacy, on the other hand, has a powerful negative impact on students. Hekimoglu and Kittrell (2010) conducted a study of 295 undergraduate students and noted how difficult it is to motivate students to learn mathematics once their mathematical self-efficacy is destroyed. Goolsby et al. (1988) studied developmental math students at the college level and found that many of the students lacked confidence in their ability to do math and rarely had success in math. These seem to be students who are stuck in the cycle of failure (Figure 1) in college mathematics courses.

Math anxiety, which has been studied extensively for several decades (Ma & Xu, 2004; Richardson & Suinn, 1972; Wigfield & Meece, 1988), was once thought to be a unique predictor of low achievement in math. However, math anxiety may simply be a by-product of low efficacy (Pajares & Kranzler, 1995).

Low efficacy in mathematics also has implications beyond schooling, as college students may avoid choosing careers that require a more extensive math background (Hembree, 1990; Sloan, Daane, & Giesen, 2002). This could have implications beyond the individual student, as Hembree (1990) says, “when otherwise capable students avoid the study of mathematics, their options regarding careers are reduced, eroding the country's resource base in science and technology” (p. 34). Understanding what causes low self-efficacy in students in math, and understanding how teachers play a role in student self-efficacy, could change practice in ways that positively impact student learning and career choice.

The Role of the Teacher in Student Self-efficacy

Teachers who encounter students who are stuck in a cycle of low efficacy and low achievement may not know what to do, and their actions could impact students in negative ways. A teacher may see a student who is unmotivated and fall back on beliefs that motivation is a

personality trait and not something that is situated or that the teacher has any control over, and they may not act to improve the situation (Pintrich, Marx, & Boyle, 1993). A teacher may express pity and reduce the demands on the student, which can cause a further decline in the student's self-efficacy (Mayer, 2007). When a student makes an error, the teacher might brush it aside and not discuss the error in an attempt to preserve the student's self-esteem (Santagata, 2004), when in fact discussing the error could be key to the student's understanding and mastery. In the worst case scenarios, a teacher's response to a student's error may confirm the student's negative beliefs about his or her ability or may embarrass the student. That type of interaction has been reported as a root cause of anxiety for some college math students (Harper & Daane, 1998), and anxiety is negatively related to efficacy.

However, teachers who recognize that self-efficacy is, at least in part, socially constructed may see opportunities to implement practices that improve student efficacy. Prior research highlights both instructional practices as a whole and individual teacher-student interactions as key factors that impact student self-efficacy.

Several researchers have found that specific teaching strategies and choices may help reduce anxiety and increase efficacy among math students in particular. Harper and Daane (1998) found that group work, use of manipulatives, and presentation of multiple strategies for problem solving reduced anxiety and increased positive outcomes for pre-service elementary teachers. In math methods courses, college students seem to benefit from a type of emotional deflection by focusing away from themselves and talking about young students struggling with their mathematics and how to help support their learning (Tooke & Lindstrom, 1998). Simple practices such as offering students a handout about what to expect on an exam, and more complicated practices such as differentiated assessment, are also sources of higher efficacy for

students (Jerusalem & Hessling, 2009). Some of these practices are more feasible in certain types of undergraduate math courses than in others, but the presence of any of these may contribute to students' successes.

On a broader scale beyond specific classroom practices or activities, Fast et al. (2010) found that upper elementary students who perceive their classroom environments as mastery oriented, challenging, and caring reported higher levels of math self-efficacy. These findings are consistent with theories and prior research on mastery experiences (Bandura, 1997; Friedel et al., 2007) and a wealth of literature on teacher caring (Pianta, Belsky, Vandergrift, Houts, & Morrison, 2008).

Students who perceive positive regard and caring from their teachers tend to be more engaged and motivated and have positive feelings about school (Juvonen, 2006; Murdock & Miller, 2003; Skinner & Belmont, 1993). In various studies, positive regard has been reported and/or observed as manifesting in positive feedback (verbal or written), encouragement, and positive instructional discourse in classrooms (Green, 1990; Schweinle, Meyer, & Turner, 2006; Turner, Meyer, Midgley, & Patrick, 2003). Students pick up on positive relational cues from their teacher, such as the teacher initiating a one-on-one conversation with them, calling them by name, showing respect and empathy, and telling the students directly that they care (Teven, 2001). Most of the research on teacher caring has been completed at the K-12 level, and the implications of teacher caring are not clearly understood in the context of university classrooms (de Guzman et al., 2008). However, there is little doubt that interpersonal relationships play a key role at the college level as well (Kane, Sandretto, & Heath, 2004).

All of this highlights the possibility that students may have better outcomes arising from circumstances that are not directly related to the academic content, but that come out of their

relationship with their teacher and the environment of their classroom. Thus, the instructional and interpersonal aspects of classroom life that impact motivation and efficacy should be taken seriously as valid contributors to student success.

Studies at the K-12 Level

Schweinle, Meyer, and Turner (2006) conducted a study at several elementary schools in rural Pennsylvania that directly connected the instructional environment with student affect and motivation. The researchers observed math lessons in each classroom on eight occasions during a school year, and they surveyed students on the same days as the observations. The surveys included questions related to motivation, affect, and efficacy. The researchers used the survey results to group classes by their motivation patterns, and then they looked for key features of instruction in the groups of classes. They found that in classes in which students reported low motivation, the teachers emphasized speed, failed to explain reasoning, and used threatening language. In contrast, in classes in which students reported high motivation, teachers spent a great deal of time explaining concepts, helping students understand their errors, and pushing students with challenging problems while also supporting them. Thus, it seems the teachers' behaviors and instructional decisions were driving the motivational experiences of their students.

Similar findings were reported in a study of science teachers and students at an urban middle school (Bolshakova, Johnson, & Czerniak, 2011). In this small study conducted over an entire school year, the researchers found that teacher effectiveness and classroom dynamics (including the teacher having welcoming relationships with students) were directly linked with student efficacy. Interviews with students highlighted the fact that the students were eager to learn at the beginning of year but, in cases where the teachers used ineffective strategies such as

focusing on book learning (e.g., copying definitions) but engaging in no hands-on activities, the students lost their eagerness and motivation and had poor outcomes on year-end exams.

Studies that connect observed classroom practices with motivational and efficacy beliefs of students have not been conducted in math classrooms at the university level. This highlights a gap in the literature and an opportunity for this research to examine whether similar findings emerge in undergraduate math courses.

Chapter 3: Design and Methodology

I conducted a mixed-methods study using observations and student surveys in three sections each of developmental math courses and math content for elementary education courses at a large comprehensive Midwest university in February 2014.

Participants

Six math instructors at one Midwest university participated in the observation portion of this study. The instructors were recruited via an e-mail sent to every instructor (N=12) teaching a daytime section of a three-credit hour developmental math or math content for elementary education course. The instructors who volunteered to participate included tenure-track faculty members and part-time lecturers. All instructors had a high level of content knowledge (common for higher education instructors), and they all had at least one year of experience teaching higher education math courses.

All students who attended class (N=121) on the second day of observation were asked to sign a consent form and participate in an anonymous survey, if age-eligible. A total of 118 students agreed to participate, and three students declined because they were under 18 years of age. Seventy-six percent of the students were female and most (86%) were between 18 and 22 years of age.

Measures and Procedures

Surveys. The survey administered to students (Appendix A) contained four demographic and background questions and 27 items from the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) and the Programme for International Student Assessment (PISA; Ferla, Valcke, & Cai, 2009). Due to time constraints, the survey needed to be short enough to complete

in 15 minutes or less at the end of class, and thus only subscales containing questions that were central to this research project were included.

The PALS instrument contains 21 subscales, and the four subscales most relevant to this project (academic efficacy, student mastery goal orientation, teacher mastery goal orientation, and academic press) were used in this study. All items in the scales are worded to pertain to the class that the student is taking the survey in. Academic efficacy and student mastery orientation questions included “I’m certain I can master the skills taught in class this semester” and “It’s important to me that I thoroughly understand my class work.” These items contribute to scores that classify students for their efficacy and motivation characteristics. The other scales, teacher mastery and academic press, are intended to capture the students’ perceptions about their teachers’ motivation and behavior. The items, such as “My teacher really wants us to enjoy learning new things” and “My teacher presses me to do thoughtful work”, can pinpoint key factors in the student-teacher relationship. The mathematical self-concept scale from PISA represents the only questions in the survey that specifically mention math. The self-concept subscale items (such as “I have always believed that math is one of my best subjects”) tap into the overlap between self-concept and efficacy, specifically within the math domain.

The format of all PALS and PISA items was a 5-point scale with response options from strongly agree to strongly disagree. These survey items and scales have been used in previous research on students in math courses, including developmental math, at the postsecondary level (Mesa, 2012). Cronbach’s alphas of greater than 0.8 have been reported on all subscales used (Ferla et al., 2009; Mesa, 2012), indicating good internal consistency for each subscale.

Class observations. The purpose of the class observations was to identify salient features of the teacher’s practice and discourse that may contribute to different levels of efficacy. During

the second month of the semester, all classes were observed on two consecutive class days. I observed and audiotaped each 75-minute class period with a goal of capturing patterns that occurred across both days of instruction, so it would be clearer if the observed class periods represented typical days in that class. I told the instructors that I was looking for instructional practices that are used in classes where students typically exhibit high levels of math anxiety and low efficacy.

On the observation days, I sat in the back of the classroom and took field notes that supplemented the audio recordings. The field notes included details of what was written on the board, which students spoke, and what was occurring in the classroom during periods in which whole-class instruction or discussion were not the main activity. I transcribed the audio recordings to capture specific instances of discourse and to assess overall patterns of instruction and communication in the classroom.

Codes were used to identify the instructor on the field notes and in the file name of each digital recording, so none of the recordings or notes from any observations contained information that identifies the instructor for the course by name.

Chapter 4: Data Analysis

Data analyses included quantitative analyses of student surveys and observation transcripts, as well as qualitative analyses of transcripts to provide an overview of classroom practices.

Surveys

The data analysis began with quantitative analysis of the student surveys for the purpose of ranking classes by student efficacy. The subscale for academic efficacy was computed, and the classes were ranked and sorted into pairs and then labeled low efficacy, medium efficacy, or high efficacy based on the pair rankings. Subscales were also computed for math self-concept, student mastery goal orientation, teacher mastery goal orientation, and academic press by averaging the appropriate items from the surveys. Statistical tests, including ANOVAs, were used to examine group differences with the primary focus on the differences by efficacy groupings. Many of the additional analyses focused only on the two classes reporting the highest efficacy and the two classes reporting the lowest efficacy.

Class Observations

The primary goal of the classroom observations was to explore differences in the instructional environment. At a broad level, many similarities existed in these classes. The instructors all chose to split class time between whole-class instruction (lecture with or without student participation) and individual/group work. They all used either a chalkboard/whiteboard or a document projector to write words and math as they lectured. All of the instructors focused mostly on working through math problems during their lecture, with a small amount of time on definitions or related theory. Therefore, finding the differences in these classes required a more

fine-grained look at the instructional environment through analyses of transcripts, supplemented by field notes.

Classroom observation narrative. I used my field notes and the transcripts to create a narrative of class activities, instructor behavior, and student behavior from one of the classes in which students reported higher efficacy and one of the classes in which students reported lower efficacy. The overall impressions from these observations helped to highlight the major differences in instructor behavior and tone in the classes.

Transcript analyses. The transcript analyses consisted of both purely qualitative and mixed-methods approaches to explore a variety of aspects of the classroom environments.

Qualitative analyses. Four classes (two lower efficacy, two higher efficacy) were studied closely through transcript analyses. An educational research doctoral student and I each read through transcripts for the first day of observation for each class. We discussed salient features of the instructional discourse that were obvious in the transcripts, such as language use (positive language, encouragement, praise), response to student errors, and the presence of student voice in the classrooms. We also discussed my overall impressions as an observer in each classroom, toward developing some themes that best captured the tone and differences in the classes.

Mixed-methods analyses. To increase validity of the themes noted during the qualitative analyses, I quantified some aspects of instruction that were obvious from the comparisons, including noting the supportiveness of language use in the class, response to student errors, and the patterns of interaction using the methods described below.

Coding discourse for student/affective support. Schweinle et al. (2006) coded math classroom interactions for Affective Support by noting instances in which the instructor used language to encourage effort and persistence, alleviate frustration, encourage cooperation, and

acknowledge student affect. Mesa, Celis, and Lande (2014) coded math classroom interactions for Student Support by noting instances in which the classroom discourse revealed that the instructor knew student names, praised students, was flexible and understanding about life circumstances, and used humor and personal stories.

These two ideas overlap in many ways, and I combined the ideas and instructions from those researchers into one code called Student/Affective Support. A statement was to be coded as Student/Affective Support if the instructor praised students (such as exclamations of “good” or “awesome” in response to a student’s efforts), encouraged persistence (such as “you can do it”), acknowledged student affect (such as “I know this is frustrating”), used humor, or referred to a student by name.

I randomly selected a 10-minute segment of whole-class instruction to code for each instructor. I used the same length of class time to allow a fair comparison across classes, and I used whole-class instruction only due to audio quality (which was significantly poorer for group/individual work portions of class).

A trained research assistant and I each coded the 10-minute segments of transcripts. On the first round of coding, I highlighted 16 instances of Student/Affective Support across the four segments of transcripts. The research assistant had highlighted 11 of the same 16, and no additional instances. This was deemed sufficient for reliability purposes.

Responses to student errors. There was at least one instance of student error during the whole-class instruction portion of each class observation. During an overall conversation with an educational research doctoral candidate about the transcripts, we noted the types of responses each instructor exhibited to student errors and our impressions of those responses as positive or

negative. I chose examples to illustrate the differences in responses to student errors between instructors in each efficacy group.

Student voice/participation. Student voice or participation emerged as an important theme in some of the analyses. One quantitative measure of student participation used in prior research on college-level math instruction is turns per minute (Mesa & Chang, 2010). A *turn* is a term used in discourse analysis to indicate the number of times the speaker changed during a class period. For example, if a teacher asked a question, a student responded, and then the teacher spoke again, that would be three turns. I computed turns per minute for the entirety of the whole-class instruction portion of each transcribed class observation to quantify the patterns of interaction in this way.

Chapter 5: Results

The results of the data analyses are presented in this chapter. The survey results, which determined the groupings for the rest of the analyses, are presented first. Narratives of classroom observations and additional analyses of the transcripts for a subset of the classes are presented later in the chapter.

Surveys Results

The full sample of 118 students reported relatively high averages on all five subscales (Figure 2), with means ranging from 3.69 (self-concept) to 4.37 (academic efficacy) on a 5-point scale. These results are consistent with prior research using the PALS surveys at the college level (Mesa, 2012).

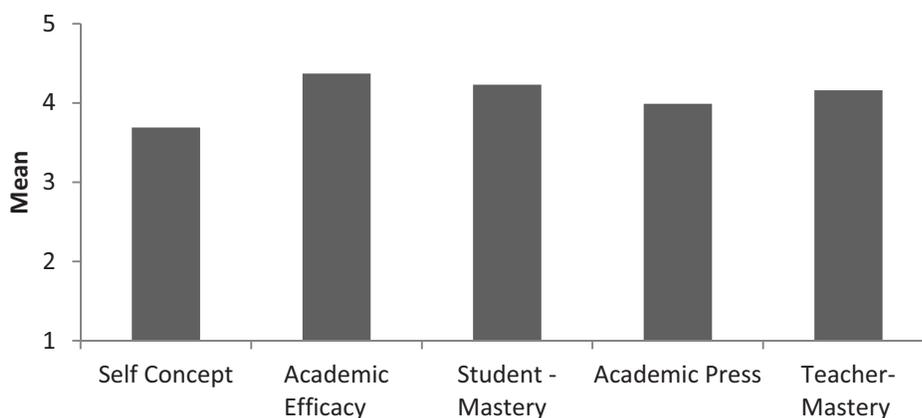


Figure 2. Subscale means for full sample (N=118).

However, when the classes were ranked and then grouped in tertiles by academic efficacy, clear differences emerged. The three groups had significantly different mean efficacy levels ($F(2,115) = 5.34, p = 0.006$). Tukey post-hoc testing revealed that the two classes reporting the lowest efficacy ($M = 4.12, SD = 0.76$) had significantly lower efficacy than the two classes reporting the highest efficacy ($M = 4.55, SD = 0.47$). While there were not significant

differences in student mastery goal orientation or math self-concept between the two extreme efficacy groups, as indicated in Figure 3, there were significant differences between groups on the academic press ($F(2, 115) = 39.51, p < 0.001$) and teacher mastery goal orientation ($F(2, 115) = 43.68, p < 0.001$) subscales.

These results suggest that the students in classes reporting the lowest efficacy perceive differences in their teacher's behavior and goals for learning than students in classes reporting the highest efficacy. The rest of the results focus on analyses of only these two efficacy groups.

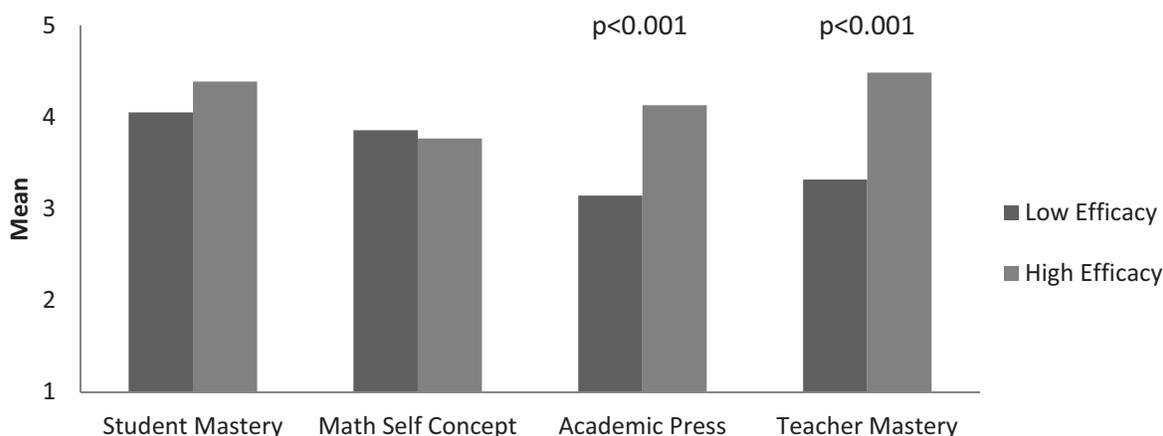


Figure 3. Subscale means by efficacy group.

Classroom Observation Narratives

In the narratives that follow, I describe the activities, instructor behavior, and student behavior in one of the classes in which students reported the highest efficacy and in one of the classes in which students reported the lowest efficacy.

Description of one of the highest efficacy classrooms. The instructor arrived early and greeted students as they arrived with a “Good morning!” and talked with some students

individually, while returning student work. The class period was divided into a few alternating segments of lecture (with student participation) and individual work time.

During lecture periods, the students' voices were part of the learning process. Students answered questions and several students asked lengthy questions, sometimes following a prompt from the instructor ("Questions before I move on?") but also without such a prompt. Students appeared comfortable saying that they had a different approach to a problem or that they were wondering about a pattern they noticed (e.g., in story problems, it seemed to one student as though "of" always signaled a need to use multiplication as a strategy). The instructor asked the student questions or asked the student to repeat ("Say that again") if anything was unclear. When students made errors, the instructor took time to explain the problem and solution strategy, sometimes providing an alternate representation (e.g., a drawing), and would check back with the student to see if the new explanation was adequate.

During individual work time, the instructor walked around the class, touching base with students individually and occasionally saying something to the entire class (e.g., mentioning a goal of the activity or encouraging students to consult with their peers). The instructor talked with most of the students in class, regardless of whether they asked for help or not. Each time the instructor noticed that a student had raised his/her hand to ask a question, the instructor made eye contact with the student, smiled, and walked quickly to get to the student. The instructor often called the students by name, encouraged them ("Keep going!"), reassured them ("Everyone will have that question so I will go over it"), and recalled some prior knowledge about the student ("I know, you missed all of last week").

The general tone of the class was positive and welcoming, the instructor was calm and happy, and the students generally stayed on task throughout all variations of the class activities (lecture or individual work).

Description of one of the lowest efficacy classrooms. The instructor did not interact with students prior to class time beginning but began class asking if there were questions about the homework, and this was followed by lecture. The lecture portion of class did not involve a lot of student interaction. In fact, there were 18 minutes of lecture during the first day of observation when no student voice was invited or heard. When students did participate in lecture, it was only to answer questions with one to five words (e.g., “Ten” or “Two groups of 12”). If students made errors, the instructor seemed to ignore or dismiss the errors and did not offer further explanation. Students did not initiate questions during lecture at any point.

About half of each class period was spent doing group work. The instructor checked in with each group at least once, and students asked questions at that time if they were having difficulty. The instructor had a variety of responses to the students’ questions, including telling students to explain concepts to each other, asking the group a question (“Where do you place the units?”), or inquiring about their strategies (“Do you think that would work?”). At no time did the instructor use encouraging or positive language or have a positive affect (e.g., smiling) when interacting with groups. The students seemed to be frustrated often with tasks and would stop working on the math at hand, instead chatting about work or the weather. Their lack of efficacy was palpable in those moments. In fact, when one group did not receive needed help from the instructor, two of the students had the following exchange:

Student 1: I don’t understand.

Student 2: I don’t know, and I want to go home.

(Transcript 311, Line 402-403)

The general feel of the class was often tense and quiet, without a clear sense of connection between the instructor and the students.

Themes from these narratives. Comparing these two classroom observations, three main themes emerged as highlighting differences in these classes:

- Instructor knows the students
- Instructor encourages the students
- Students have a voice during lecture

In the higher efficacy class, the instructor demonstrated several aspects of knowing students including calling them by name, remembering if they had been absent in a prior class, and remembering their work on exams. There was no evidence during the observation in the lower efficacy class that any of this was true in that class. The instructor did not call students by name during either day of observation and did not make any personal connections to students (e.g., noting a prior effort or absence).

In the higher efficacy class, there are numerous instances of the instructor encouraging students by saying “You’ll get it” and “Keep on going!” Praise, defined as positive language with an excited intonation (Brophy, 1981), was also a frequent part of both the whole-group instruction (lecture) periods and the one-on-one interactions between the instructor and the students. In the lower efficacy classroom, the instructor did not ever use encouraging or praising language.

In the higher efficacy class, the students had a strong voice throughout the class period, which included raising questions and consulting with each other. When students made errors, their ideas were explored and corrected. The student’s voices and ideas appeared to be valued whether the ideas were correct or incorrect. The instructor frequently said, “Do you have

guesses?” to students as they worked on problems, indicating that ideas or thoughts toward a solution were fine at this stage of learning. In the lower efficacy class, the student voices were nearly silent during lecture, with only the occasional utterance of a brief response to a question.

Overall, there was a sense that the students’ presence and contributions mattered a great deal to the instructor in the higher efficacy course. This aligns well with literature that points to teacher caring and encouragement as sources of positive affect, motivation, and efficacy (Juvonen, 2006; Murdock & Miller, 2003; Teven, 2001).

Mixed-methods Analyses of Transcripts

Further analyses of the observation transcripts for all four classes yielded findings that largely support the themes noted in the qualitative analyses of the two classes above, in relation to student/affective support and response to student errors. However, results from analyzing the general patterns of interaction were not consistent with the student voice comparisons above.

Student/affective support. Content analysis of the transcripts revealed a stark contrast between the instructional practices of the two lowest and the two highest efficacy groups in relation to supportive remarks and behaviors of their instructors. Analyses of whole-class instruction segments of class indicated that there were 16 instances of student/affective support (praise for effort, encouragement of persistence, calling students by name, etc.) in the ten-minute class segments analyzed for the highest efficacy courses. There were no such instances in the lowest efficacy courses.

A simple word search for positive words (good, great, wonderful, awesome, perfect, nice) on the entirety of each transcript yielded similar findings. The instructors in the lowest efficacy courses never used any of these words when responding to or interacting with students during

whole-class instruction or individual/group work time. The instructors in the highest efficacy classes used these words more than a dozen times during lecture and individual/group work time.

A word search for “[name]” (used in place of student names in the transcripts) on the entirety of each transcript also confirmed prior findings. The search revealed that, except when taking attendance or handing back papers, there was only one instance of an instructor in either of the lower efficacy classes calling a student by name, and it was while pointing out the student’s error (“Don’t forget the percent symbol, [name]”) during whole-class instruction.

Therefore, students in both of the lowest efficacy classes may have been missing an important positive and personal dynamic in their instructional environments. The absence of these supportive interactions could impact their experience in a negative way and ultimately lead to the lower efficacy that the students are reporting.

Response to student errors. In all four classes, student errors occurred during whole-class instruction and the instructors varied in their responses to these errors. Examples for each instructor follow, with the instructor’s initial response to the error bolded in each excerpt.

The first two examples are from the classes in which students reported the lowest efficacy.

Excerpt 1:

Teacher: How many [decimal] places?

Student: Two.

Teacher: Two, to the right or the left?

Student: Right.

Teacher: To the right? So this is going to become *this*? Is that right?

Student: No.

Teacher: It’s gotta move to the left, doesn’t it?

(Transcript 511, lines 47-53)

In the first excerpt, the instructor asked three questions in response to the student’s error, the second of which was said in a tone that could indicate to the student that he/she is crazy to think

that the decimal would go to the right. The excerpt concluded with the rhetorical question, “It’s gotta move to the left, doesn’t it?” Rhetorical questions have been cited in the literature as a type of teacher questioning meant primarily to align students with the teacher’s thought and may discourage students from speaking further (Mesa, 2010).

Excerpt 2:

Teacher: When we add A and B, what do we get? When we put together A and B?

Student: 21.

Teacher: Ok, we don’t get twenty-one.

(Transcript 311, line 255-259)

In this second excerpt, the instructor responded to the student to say the answer is wrong and then moved on to another student. While this pattern of brushing off student errors and moving on is typical in U.S. math classrooms (Santagata, 2004), opportunities were missed for further exploration. With further probing, the instructor may have realized the student was making a logical error based on his/her prior learning.

The next two examples are from the classes where the students reported the highest efficacy. In the example below (Excerpt 3), a student raised his hand and volunteered that he had used a different (incorrect) strategy to solve a story problem related to grades.

Excerpt 3:

Teacher: So you did it as a division problem?

Student: Well, 27 divided by 4 over 9, so I got a different answer.

Teacher: Right. Because, since I want to know how many students got an A. In this picture, you have 27 people altogether, let me just give you a diagram for this one, [Name].

(Transcript 611, line 146-150)

It was typical in the above classroom for the instructor to try to untangle the student’s error and to demonstrate a different way to approach the problem that might make more sense to the student. The instructor taking class time to do this may signal to the student that his idea or

misunderstanding is important to explore and clarify. This type of response may help other students feel more comfortable to take similar risks if they are unsure (Borasi, 1994).

A similar type of interaction occurred in the final class, which was also one of the highest efficacy classes.

Excerpt 4:

Teacher: So will 9 squares go on the top or bottom do we think?

Several students: Bottom.

Several students: Top.

Teacher: Ooh, I heard a mix! So, nine squares means we have ‘out of’ nine, so nine goes on the bottom. So whatever is in the bottom is how many total things you have, how many total equal size pieces you need. OK?

(Transcript 411, line 98-103)

In Excerpt 4, the instructor expressed some excitement that there were multiple answers given, and used the opportunity to explain again how to think through what the right answer may be. The instructor concluded by saying “OK?” to check for understanding.

These differences in how instructors responded to student errors were clear throughout the transcripts. The instructors in the lowest efficacy courses either dismissed or responded in seemingly negative ways when students made errors. Their responses seemed to carry a tone of expectation that the students should be proficient with this material already and not making such errors. In contrast, in the classes where students were reporting significantly higher efficacy, the instructor responses more typically involved some explanation and the students’ errors seemed to be viewed as opportunities to explore ideas further.

Student voice. One way to quantify the presence of student voice in classes is to look at patterns of interaction. The patterns of interaction in this case were analyzed by looking at the number of turns per minute, which is used as a measure of student participation. Lower turns per minute arise from one person (usually the teacher) talking for longer periods of time. The results

indicate that, while there were differences among the four classes, the differences are not between the efficacy groups (Figure 4).

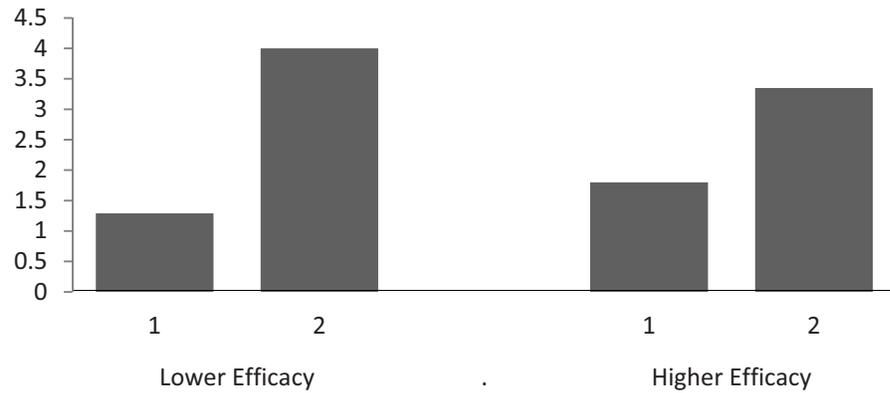


Figure 4. Number of turns per minute during whole class instruction, by efficacy group.

The findings of this analysis would not support a hypothesis that student voice or participation emerged as a key finding in relation to academic efficacy.

Chapter 6: Discussion and Implications

Student efficacy may be one of the most critical prerequisites to success in school, particularly in mathematics courses where low efficacy and related anxiety are commonplace. To ignore these powerful emotions would do a disservice to students who are struggling, and who are having a normal human experience of emotions. If students are working hard and learning, it would be unfortunate for low efficacy to get in the way of their ultimate success, especially when the literature certainly supports multiple strategies for improving efficacy. Many of the strategies are centered on teaching practice and the classroom environment over which teachers, in particular, have a great deal of control.

Through this study, I aimed to identify teaching practices that may help at-risk students experience higher efficacy. Using methods similar to Schweinle et al. (2006), I allowed the students' self-reported efficacy to determine the average efficacy level for each class and then compared groups. How were the instructional environments similar and different when ranked by efficacy?

Overall, the findings were remarkably similar to findings at the K-12 level that indicate higher efficacy is connected with classroom environments that are mastery oriented, challenging, and caring. Students in classes reporting higher efficacy on surveys also reported significantly higher perceptions of the teacher's mastery orientation and academic press than students in classes reporting lower efficacy. Mastery-oriented teaching was also observed in these classrooms, especially by instructors taking time to unpack and explore student errors.

Though the student surveys did not include a scale for teacher caring, the main findings from the class observations are consistent with K-12 literature on what students report as caring behaviors. In the classes that I observed, the instructors in classes in which students reported

higher efficacy were heard having one-on-one conversations with students, using student names, and encouraging students. The atmospheres in those classes were welcoming and warm. As Garza, Ovando, and Seymour (2010) noted, “when teacher behavior reflects an attitude that is inviting, rather than discouraging, students are more apt to attend class and participate in the learning process because they want to be there” (p. 17).

Bandura’s (1997) theories are exemplified in these findings, with mastery orientation and social/verbal persuasion as key factors that were visible in the higher efficacy classes that I observed. Fast et al. (2010) proposed a model (based on research at the upper elementary level) that indicated that mastery orientation, challenges, and teacher caring predict academic efficacy, which in turn predicts academic achievement (Figure 5). My research findings would support the first part of this model at the college level.

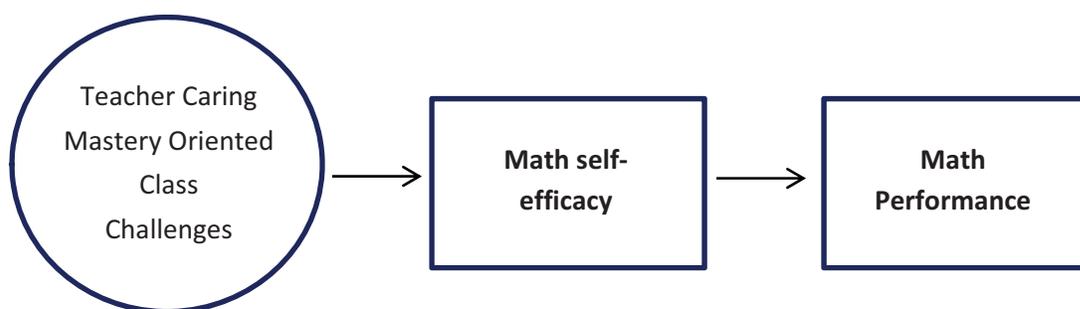


Figure 5. Positive efficacy model (Fast et al., 2010)

Implications for Practice

The implications for practice from this research could be far-reaching. The findings from this study support prior research indicating that teacher caring and positive instructional discourse, in particular, seem to be connected with student efficacy. These ideas may be

intuitive to some teachers but clearly are not the practice in every classroom. Sharing these findings with other instructors could open minds to a whole new way of helping students succeed, by focusing on the interpersonal and psychosocial aspects of the classroom experience.

Teachers may need to look at their own practice with questions about how they are promoting a mastery learning environment, challenging students appropriately, and demonstrating their caring. Caring is work and not just an emotion, and thus requires a commitment on the part of the teacher to perform this “emotional labor” (Isenbarger & Zembylas, 2006). It can be enlightening for instructors to study their own practice and discourse with a foundation in the research literature on related topics, and teachers who want to improve their practice can do so (Herbel-Eisenmann & Cirillo, 2009). If teachers could understand how the instructional environment is impacting each student and how much control they have over many aspects of that environment, they may be empowered to change.

Limitations

This study has limitations. The small sample size limits our opportunity to make broad, general conclusions about teaching practices and student efficacy. In addition, the limited scope of the data collected made some conclusions more difficult to draw. Although the students participated in surveys that drew out significant differences in expected directions (aligning well with class observation data), the connections between these issues would be stronger if the students were directly involved in making those connections. The students also did not participate in any conclusions about teacher caring, and their perceptions would be an important addition to this type of research.

Future Research

Additional research could be done with a similar protocol but adding student interviews to gain further information about how students are taking up all aspects of the instruction in the classrooms. The students could speak about what aspects of instruction prompt them to conclude a teacher is mastery oriented or challenging, and what caring behavior from a university instructor looks like. This would add rich detail on the student experience to further validate these kinds of findings.

In addition, an experimental design, with before and after measures of student efficacy, would add value to the conclusions made here. If students begin the semester with low efficacy and report a marked increase in efficacy, it is likely that the instructor played a significant role in that change. If this type of research could be completed among an even larger population of students and instructors, it could have powerful implications for teacher training and practice.

Conclusions

Teaching is an inherently interpersonal act. The results of this research highlight the profound impact that interpersonal dynamics may have on students in undergraduate math classes. In classrooms in which students were learning similar content and experiencing similar math teaching methods, they reported significantly different levels of efficacy. Analyses of the classroom environments point to the overall tone and instructional discourse (two key aspects of teacher caring) as major differences between classes reporting high and low efficacy. It is my hope that instructors will use this information to examine and improve the interpersonal dynamics in their classroom toward increasing student efficacy and achievement.

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Student Survey

Here are some questions about you as a student and about your teacher in this course.

Please circle the response that best describes what you think.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I'm certain I can master the skills taught in class this semester.	SD	D	N	A	SA
2.	It's important to me that I learn a lot of new concepts this semester.	SD	D	N	A	SA
3.	I'm certain I can figure out how to do the most difficult class work.	SD	D	N	A	SA
4.	My teacher makes sure that the work I do really makes me think.	SD	D	N	A	SA
5.	My teacher accepts nothing less than my full effort.	SD	D	N	A	SA
6.	My teacher recognizes us for trying hard.	SD	D	N	A	SA
7.	My teacher really wants us to enjoy learning new things.	SD	D	N	A	SA
8.	I get good grades in math.	SD	D	N	A	SA
9.	My teacher wants us to understand our work, not just memorize it.	SD	D	N	A	SA
10.	My teacher thinks mistakes are okay as long as we are learning.	SD	D	N	A	SA
11.	In my math class, I understand even the most difficult work.	SD	D	N	A	SA
12.	My teacher gives us time to really explore and understand new ideas.	SD	D	N	A	SA
13.	When I've figured out how to do a problem, my teacher gives me more challenging problems to think about.	SD	D	N	A	SA
14.	My teacher presses me to do thoughtful work.	SD	D	N	A	SA
15.	I learn math quickly.	SD	D	N	A	SA
16.	My teacher asks me to explain how I get my answers.	SD	D	N	A	SA
17.	When I'm working out a problem, my teacher tells me to keep thinking until I really understand.	SD	D	N	A	SA
18.	My teacher doesn't let me do just easy work, but makes me think.	SD	D	N	A	SA
19.	I am just not good at math.	SD	D	N	A	SA
20.	One of my goals in class is to learn as much as I can.	SD	D	N	A	SA
21.	One of my goals is to master a lot of new skills this semester.	SD	D	N	A	SA

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
22.	It's important to me that I thoroughly understand my class work.	SD	D	N	A	SA
23.	It's important to me that I improve my skills this semester.	SD	D	N	A	SA
24.	I can do almost all the work in class if I don't give up.	SD	D	N	A	SA
25.	Even if the work is hard, I can learn it.	SD	D	N	A	SA
26.	I have always believed that math is one of my best subjects.	SD	D	N	A	SA
27.	I can do even the hardest work in this class if I try.	SD	D	N	A	SA

28. What is your gender?

Female

Male

29. What is your age?

18-22

23-27

28-39

40-54

55+

30. How many math courses have you completed in college?

0

(this is my first)

1-2 prior courses

3+ prior courses

31. How would you rate your prior experiences with math on a scale of 1 (very negative) to 5 (very positive)?

Very Negative

Very Positive

In high school?

1

2

3

4

5

In college?

1

2

3

4

5