Prospective Secondary Mathematics Teachers' Expectancy and Value for Teaching Practices: Comparing Across Content Areas

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Abstract

There is increasing demand on secondary mathematics teachers to enact mathematically intensive core teaching practices that center instruction on student thinking in an increasingly diverse set of content areas. Expectancy-value theory suggests that if teachers have high expectancy and high value for enacting core practices, they are more likely to carry them out. We examine how changes in expectancy and value for prospective secondary teachers who learn mathematics using MODULE(S^2) materials *compare* across algebra, geometry, modeling, and statistics courses and *correlate* with teaching practices enacted in the courses. One-hundred seventy-four prospective teachers participated in this study that found increases in expectancy and value across the board, with the largest practical significance in expectancy change occurring in modeling and statistics courses. We conclude that prospective teachers' past experience learning algebra and geometry and lack of experience with modeling and statistics likely contribute to the expectancy gains observed in this study. These results, paired with previous research showing MODULE(S^2) provides opportunities for prospective teachers to develop knowledge for mathematics teaching, suggests that MODULE(S^2) can serve as a useful tool for teacher preparation programs seeking to shift their programs to meet the growing demands placed on secondary mathematics teachers.

Keywords: expectancy-value theory, secondary mathematics teacher preparation, mathematics teaching practices

Comparing prospective secondary mathematics teachers' expectancy and value for teaching practices across different content areas

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"Americans expect more than ever from schools," wrote Deborah Ball and Francesca Forzani, ten years ago. This sentiment still applies today, as does their argument that "students' learning depends fundamentally on what happens *inside the classroom*" (Ball & Forzani, 2011, p. 17). Thus, the more educators learn about how students learn mathematics, the more expectations are thrust upon teaching. Teaching well includes cultivating mathematical proficiencies (National Research Council (NRC), 2001), mathematical practices (National Governors Association Center for Best Practices and the Council of Chief State School Officers (CCSSO), 2010), and essential concepts of mathematics (National Council of Teachers of Mathematics (NCTM), 2018). On top of a disciplinary agenda, teaching must also attend to the culture of a classroom environment and the cultural perspectives that students bring (National Academies of Science, Engineering, and Medicine, 2018). Demands on teachers have only increased, with respect to both their mathematical knowledge and their knowledge of and facility with core mathematics teaching. In this climate, teacher preparation programs must continually adapt to position teachers to succeed and thrive.

This need for adaptation is not new. A quarter century ago, Smith (1996) identified challenges of centering teaching practice on student thinking when the competing practice of teaching through telling often reinforces teachers' belief that they will be successful as teachers. With respect to the preparation of prospective teachers, Smith argued that we might get at the "cracks" in the commitment to teaching through telling by providing prospective mathematics teachers (PSMTs) with opportunities to "link new mathematical experiences to their future practice" (p. 399). At the MODULE(S^2) Project, which focuses on the mathematical education of prospective secondary teachers, we center our work on this notion. We contend that the connection between university content courses and teaching must be stronger and that the connection to core mathematics teaching practices must be stronger. Specifically, the university mathematics courses that secondary mathematics teachers take are key spaces for PSMTs to develop their knowledge and confidence for implementing mathematically intensive teaching practices by giving them opportunities to apply the knowledge they develop to secondary teaching situations across the diverse content discussed in *Catalyzing Change* (NCTM, 2018). Accordingly, and we have created materials that provide these opportunities in algebra, geometry, modeling, and statistics courses.

We have reported on MODULE(S^2) activities to develop PSMTs' knowledge for teaching mathematics elsewhere (Lai et al., 2018; Lischka et al., 2020). In this paper, we focus on the impacts of learning with MODULE(S^2) materials on secondary PSMTs' expectancy and value for using core mathematics teaching practices (Grossman, Hammerness, & McDonald, 2009) that are mathematically intensive and center secondary students' mathematical and statistical reasoning. Eccles and colleagues used expectancy to refer to one's perceived expectation of probability of success on an upcoming task (Eccles, 1983). Value refers to the personal importance a person attributes to that task. Expectancy-value theory posits that performance, persistence, and choices are linked to individuals' beliefs about expectancy and value related to particular tasks. We examine PSMT's expectancy and value for enacting particular teaching practices as a predictor of their performance, persistence, and choices related to enacting core teaching practices. The MODULE(S^2) project focuses on the following core practices:

(CP1) regularly asking questions so that secondary students make conjectures,

(CP2) regularly asking questions and leading discussions to help secondary students come up with justifications,

(CP3) regularly asking questions that help secondary students understand how to build on their thinking and what to revise, and

(CP4) regularly analyzing secondary students' responses to understand their reasoning.

We seek to compare and contrast PSMTs' expectancy and value for enacting core practices CP1-CP4 when teaching algebra, geometry, modeling, and statistics, and to understand the impact of PSMTs' experiences with MODULE(S^2) materials on their expectancy and value for enacting these core practices across the different mathematical areas. The following research questions guided our study:

1. How do PSMTs' value and expectancy for enacting CP1, CP2, CP3, and CP4 change, if at all before and after experiences with MODULE(S^2) materials?
2. How do shifts in PSMTs' value and expectancy for enacting CP1-4 when teaching subjects that traditionally have been in the curriculum (algebra and geometry) compare to those for teaching subjects introduced more recently (modeling and statistics)?
3. Are there associations between PSMTs' shifts in expectancy for enacting core practices and their perception of the degree to which their instructor enacted those core practices?

Broader Context and Background Literature

The Unites States educational system is in the midst of a major shift in mathematical standards and curricular recommendations. As institutions have worked to support teaching to the Common Core State Standards (CCSSO, 2010), professional organizations have offered detailed recommendations for effecting real change in how mathematics is taught (e.g., *Catalyzing Change* (NCTM, 2018) and *MET II* (Conference Board of the Mathematical Sciences (CBMS), 2012)), how statistics is taught (e.g., *GAISE II* (Bargagliotti et al., 2020) and *SET* (Franklin et al., 2015), and how modeling is taught (Consortium for Mathematics and Its Applications & Society for Industrial and Applied Mathematics, 2019). Mathematicians and mathematics teacher educators alike recognize it is imperative that we utilize this deepening knowledge to improve the mathematical preparation of secondary teachers. At the MODULE(S2) Project, we focus on what these advances mean for the mathematics content courses that PSMTs take.

Both pre- and in-service teachers have reported their perception that university content courses are ineffective with respect to instructional practices for high school teaching for two reasons: (1) the content seems irrelevant, and (2) the norms and skills for mathematical communication seem inapplicable (Deng, 2007; Moreira & David, 2008; Ticknor, 2012; Wasserman et al., 2015). Even if content courses address content, norms, and skills that are useful for teaching, teachers are unlikely to draw on resources they view as irrelevant. These factors point to the need for content courses to cultivate *mathematical knowledge in the context of instructional practices*. We propose that secondary teacher preparation programs should engage PSMTs in learning mathematical knowledge and then using that knowledge *for teaching*, in the context of simulations of core teaching practices. Following Grossman, Hammerness, and

McDonald (2009) and Ball, Sleep, Boerst, and Ball (2009), we take core practices to be those that: (1) benefit the learning of the teachers' future students in equitable ways; (2) are learnable by prospective teachers; (3) depend on knowledge of mathematical structures and connections to carry out; and (4) when carried out skillfully, they equip teachers to improve their teaching. Further, the CPs are practices that secondary mathematics teachers have been documented to value, yet do not often carry out due to lack of confidence in their ability to enact them (Banilower et al., 2013).

Teacher's lack of confidence in teaching with CPs can be further complicated by the content they will teach in their future classrooms. For example, PSMTs have reported a significantly lower level of confidence in their ability to teach statistics when compared to more traditional topics such as algebra (Lovett, 2016). At the same time, university statistics courses provide a key place for providing opportunities for PSMTs to increase their confidence in and knowledge for teaching statistics (Azmy, 2020; Lovett, 2016). We find a similar account when it comes to teachers' sense of preparedness to teach modeling. The broad and deep mathematical approaches that students utilize when completing mathematical modeling tasks (Doerr, 2007) and the messy nature of the modeling process itself all serve to hamper PSMTs' confidence levels when it comes to teaching modeling (Zbiek, 2016).

We seek to gain an understanding of how the documented patterns in PSMT confidence in teaching secondary content might be disrupted by learning with MODULE(S^2) materials. Utilizing expectancy-value theory, we posit that PSMTs' future teaching choices are linked to their perceived expectation of success (expectancy) at teaching tasks and the personal importance (value) they place on those tasks (i.e., core teaching practices (CPs)) (Eccles, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). According to the theory, when both expectancy and value are high, the likelihood the teacher will make choices that lead to the desired performance of the task (teaching with CPs) is high. We know that if either expectancy or value levels are low, then the other cannot compensate enough to lead to the desired outcome (Meyer et al., 2019; Trautwein et al., 2012). If MODULE(S^2) materials have an impact on raising expectancy and value for PSMTs' enactment of CPs in their future classrooms, then perhaps they can be a useful tool for colleges and universities seeking to improve their secondary teacher preparation programs.

Methodology

Context

MODULE(S^2) instructional materials are designed to promote the implementation of mathematically intensive core teaching practices (CPs) while PSMTs learn algebra, geometry, modeling, and/or statistics. This is accomplished as university instructors teach with the materials while implementing instruction that focuses on enabling PSMTs to explore conjectures and justifications as the instructor learns about PSMTs' understandings and uses their explanations, justifications, and representations during instruction. Additionally, the materials provide instructors with opportunities to have PSMTs apply their developing advanced mathematical understandings of secondary mathematics and statistics content to teaching situations. Structurally, each content area has a semester's worth of materials and is broken up into three modules.

The MODULE(S^2) team recruited faculty from across the United States to pilot a semester's worth of materials and collect PSMT data. The total time period for the data collection reported in this report is three years. Instructors piloting MODULE(S^2) materials met the following requirements: (1) the course where materials were used was mathematics content intensive and was a course that pre-service secondary teachers took, (2) two of the three modules within the content area were used during classroom instruction, (3) the piloting faculty participated in a 4 day professional development experience prior to teaching with the materials, and (4) the piloting faculty participated in an ongoing instructor professional learning community throughout the academic year.

Participants

Students enrolled in college and university mathematics courses that used MODULE(S^2) materials to learn algebra, geometry, modeling, or statistics content at 22 different college or universities across the United States agreed to participate in this study. These participants fully completed the pre- and post-expectancy and value instruments, and 95-100% were PSMTs. Based on information gathered from the instructors, we know that 95%-100% of the students in the algebra, geometry, and modeling were PSMTs (i.e., majoring in secondary education mathematics). Those students who did not major in secondary education mathematics were mathematics majors who took the course as an elective—many had interest in teaching at some point in their future experiences (e.g., as a GTA in a future master's program). For statistics courses, there was a smaller percentage (63%) of PSMTs. Therefore, we added a question to the statistics instrument so that we would only include PSMTs in the statistics data. Thus, although 70 statistics university students agreed to participate in the study, we only used data from the 44 who identified as PSMTs. The total number of participants in this study is 174, and we will refer to them as PSMTs. The participating institutions ranged from large public research universities to small private colleges to Hispanic Serving Institutions to Historically Black Colleges and Universities to regional public universities.

Research Instruments

Research questions one and two address expectancy and value, and research question three focuses on expectancy. We measured PSMTs' expectancy and value for implementing the CPs of interest at the beginning and end of the term using items adapted from Banilower (2013) for expectancy items and from Markow and Pieters (2012) for value items. Specifically, expectancy items identified either 3 big ideas (algebra and geometry) or 4 big ideas (modeling and statistics) in each content area and asked PSMTs to rate on a Likert scale from 0 to 5 how confident they were that they could teach that big idea through implementing each of the CPs (0 being not at all and 5 being very much). For example, one of the algebra expectancy items for CP1 states (underlining is added here to indicate the big idea and bold is added to indicate the CP):

> *Suppose you are teaching middle or high school algebra students how to think about functions in terms of how changes in the value of one variable may impact the value of the other variable. How well does this statement describe how you feel?* ***I would be comfortable regularly asking questions so that middle or high school students make conjectures****.*

All of the expectancy items follow this structure—"Suppose you are teaching middle or high school [content area] students [about this big idea]. How well does this statement describe how you feel? I would be comfortable [engaging in CP1, 2, 3, or 4]."

The value items were not focused on specific content big ideas. Rather, they ask PSMTs to rate on a Likert scale from 1 to 5 how important it was to them to teach the content area in general using each of the CPs (1 being not at all and 5 being very much). For example, the algebra value item for CP1 states (bold is added to indicate the CP):

> *How much do you personally agree with these ideas about teaching algebra in middle or high school?* ***I think it is important to regularly ask questions so that middle or high school students make conjectures***.

All of the value items follow this structure—"How much do you personally agree with these ideas about teaching [content area] in middle or high school? I think it is important to [engage in CP1, 2, 3, or 4]."

Because we measured expectancy for each core practice using either 3 or 4 big ideas in each content area, the analysis of the data must occur at the item response level rather than the participant level. The choice of number of big ideas on which to focus rested with the materials writing team for each content area based on the big ideas on which they desired data collection. Because we averaged PSMTs' responses according to each CP, the number of big ideas on which data was collected for expectancy did not adversely affect our ability to compare across content areas. Table 1 reports how many PSMTs completed the expectancy and value instruments, how many colleges and universities these PSMTs were from, and how many PSMTs' item responses are included in the data set for each core practice. The number of PSMTs who completed all pre and post expectancy and value items was 174, and because there was one item response for each CP on the value instrument, there were 174 total item responses per CP for value. Because there were 3 or 4 item responses for each CP on the expectancy instrument, there were 592 total item responses per CP to analyze for expectancy.

Table 1

Number of Participants and Number of Expectancy-Value Item Responses for each Core Practice

Content Area	*# of PSMTs*	*# of Colleges / Universities*	*Total # of Expectancy Item Responses for each CP*	*Total # of Value Item Responses for each CP*
Algebra	54	5	162	54
Geometry	50	7	150	50
Modeling	26	4	104	26
Statistics (PSMTs)	44	6	176	44

To address research question three, we measured PSMTs' perception of the extent to which they experienced a learning environment where the four CPs of interest were enacted. We adapted items from Markow and Pieters (2012) to measure student perceptions (SPs). Table 2 reports each SP item and the theorized associations between those SPs and the CPs of interest in this study. We hypothesized that if a PSMT perceives that a CP was implemented while they learned mathematics, then their expectancy for utilizing that CP in their future classroom will increase. If this is the case, we should observe a significant positive correlation between each SP item and the expectancy increase for the CP items theorized to be associated with it. In our data collection, the SP instrument was administered following the expectancy and value instruments, and some PSMTs who completed the expectancy and value instruments did not click through to complete the SP instrument. Additionally, some PSMTs only partially completed the SP instrument. Therefore, the number of item responses was slightly smaller when calculating correlation data—varying from between 137 and 149 total item responses.

Table 2

Student Perception Items and Theorized Associations with Core Practices

Student (PSMT) Perception Item		*Theorized CP Associations*
How much do you personally agree with these descriptions of your class this term?		
SP1	My class participated in many discussions where we made conjectures.	CP1
SP2	My class participated in many discussions where we made mathematical justifications.	CP2
SP3	My instructor regularly asked us questions that helped us come up with conjectures.	CP1, CP3, CP4
SP4	My instructor regularly asked us questions that helped us make mathematical justifications.	CP2, CP3, CP4
SP6	My instructor regularly asked questions that helped us understand each other's ideas.	CP1, CP2, CP3, CP4
SP7	My instructor understands our explanations.	CP1, CP2
SP8	I came up with mathematical conjectures throughout the course.	CP1
SP9	I made mathematical justifications throughout the course.	CP2

Statistical Methods

This investigation utilized pre- and post-test measures of PSMTs' expectancy and value for implementing core mathematics teaching practices, along with a student perception inventory at the end of the term. Participants from multiple colleges and universities provided responses from multiple terms across two years of data collection. We cleaned the data using R to remove blank responses and responses of all 0, whose few instances we treated as input errors. We began our analysis by creating stacked bar graphs of expectancy and value responses using Common Online Data Analysis Platform (CODAP) software. These displays show the movement from pre- to post-test for expectancy and value items at the categorical level. This allowed us to compare similarities and differences between the core mathematics teaching practices as well as between the four content areas. Next, we computed descriptive statistics on the expectancy and value Likert scale data to compare pre-test means with post-test means across the four CPs for each content area. We conducted paired t-tests to determine statistically significant differences in means and computed Cohen's *d* effect size to determine the practical significance of mean differences for each CP within each content area. Finally, we computed correlation coefficients between each SP and the expectancy pre-post difference for the theorized associated CPs.

Results

In this section, we report the results of a three-part analysis designed to investigate: (1) how PSMTs' value and expectancy for utilizing CPs compare across the four CPs and the four content areas and (2) how PSMTs' perceived experiences of their instructors using CPs while they learned with MODULE(S^2) materials are correlated with the pre-post difference in their expectancy scores. Specifically, we first report the results of categorical shifts from pre- to post-test on the expectancy and value instruments across CPs and content areas. Second, we test the hypothesis that the mean difference between pre- and post-tests for each CP on the expectancy and value instruments is equal to zero (H_0) versus that the claim that mean difference between pre- and post-tests for each CP on the expectancy and value instruments is different from zero (H_A). Finally, we report the Pearson correlation coefficients calculated for the change in expectancy for CPs of interest and the theorized associations with each SP listed in Table 2. In these calculations, we also report on the *p*-values for each correlation coefficient to test the hypothesis that there is no correlation between each SP and change in CP expectancy pair (H_0) versus the claim that there is a correlation between each SP and change in CP expectancy pair (H_A).

Figure 1 shows a display of stacked bar graphs of the value item responses at the beginning of the term administration of the instrument and the end of term administration. When looking across all content areas and core teaching practices, the value results are very similar. We see that the relative frequency of the combined five and four responses is between 80% and 90% for the beginning of term administration. At the end of term administration, the frequencies stayed in approximately the same range, with a noted difference that two of combined five and four responses reached above 95%. Although most of the levels are very similar, we do see that the modeling group showed the most movement in value from beginning to end, with CP1 and CP4 moving from 80% level to 95% for the combined four and five response.

A display of stacked bar graphs of the expectancy item responses at the beginning of the term and end of term administrations of the instrument is shown in Figure 2. Expectancy for all CPs showed meaningful migration toward the five, four and three categories at the end of term administration compared to the beginning. The proportional breakdown of five, four and three categories at the end of term administration look remarkably similar across all core practices and content areas alike. Patterns of note include that Modeling and Statistics showed a larger number of zero, one, and two expectancy responses in the beginning of term administration of the instrument. Additionally, the end of term administration showed a larger percentage of four and five responses for Algebra, Modeling, and Statistics when compared to Geometry. Specifically, the combined five and four responses for Geometry at around 70% compared to Algebra, Modeling, and statistics, which has combined four and five response levels at between 80% and 90%. The beginning of term administration for Algebra shows a combined five and four response between 60% and 70%. Geometry and Statistics are similar to one another, with a combined five and four response right at 50%. Modeling has the lowest beginning of term administration combined five and four response at closer to 40%. With these patterns noted, we observe the largest migration of scores from pre to post in the Modeling data for the expectancy items.

Table 3 reports the descriptive and inferential statistics for the paired *t*-tests used to examine mean differences in value and expectancy items for each CP within each content area. All but one mean difference is positive across the entirety of the items. As the stacked bar graphs showed, there was not much room for increase in post-test scores, and the lack of statistically or practically significant improvement in value item scores (i.e., all but one of the Cohen's *d* effect sizes are below 0.4) reflects this. The expectancy items, however, tell a different story. Every increase in expectancy for each CP is statistically significant. Moreover, the effect sizes show that for modeling, the increase for every CP has high practical significance (i.e., effect sized are at 0.7 or more) and statistics increases show a moderate level of practical significance (i.e. all effect sizes are at 0.5 or 0.6). Effect sizes for algebra and geometry show only three of the eight differences with effect sizes between 0.4 and 0.5).

Figure 1

Responses for Value Items Across Content Areas and Core Mathematics Teaching Practices (CPs)

Figure 2

Responses for Expectancy Items Across Content Areas and Core Mathematics Teaching Practices (CPs)

Table 3

Results of Paired *t*-tests for Value and Expectancy Items

Algebra (Value)	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*	*Algebra (Expectancy)*	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*
Pre-Mean	4.296	4.278	4.444	4.519	4.384	Pre-Mean	3.722	3.698	3.938	4.000	3.840
Post-Mean	4.537	4.574	4.574	4.574	4.565	Post-Mean	4.296	4.284	4.265	4.327	4.293
Mean difference	0.241	0.296	0.130	0.056		Mean difference	0.574	0.586	0.327	0.327	
SD_d	0.751	0.882	0.912	0.738		SD_d	1.152	1.193	1.097	1.136	
n	54	54	54	54		*n*	162	162	162	162	
p-value	0.022	0.017	0.301	0.582		*p*-value	0.000	0.000	0.000	0.000	
effect size	0.321	0.336	0.142	0.075		effect size	0.498	0.491	0.298	0.288	

Geometry (Value)	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*	*Geometry (Expectancy)*	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*
Pre-Mean	4.280	4.500	4.480	4.560	4.455	Pre-Mean	3.593	3.520	3.527	3.693	3.583
Post-Mean	4.460	4.580	4.380	4.620	4.510	Post-Mean	3.967	4.047	4.000	4.147	4.040
Mean difference	0.180	0.080	-0.100	0.060		Mean difference	0.373	0.527	0.473	0.453	
SD_d	0.873	0.752	0.789	0.682		SD_d	1.277	1.180	1.268	1.229	
n	50	50	50	50		*n*	150	150	150	150	
p-value	0.151	0.455	0.374	0.537		*p*-value	0.001	0.000	0.000	0.000	
effect size	0.206	0.106	0.127	0.088		effect size	0.292	0.446	0.373	0.369	

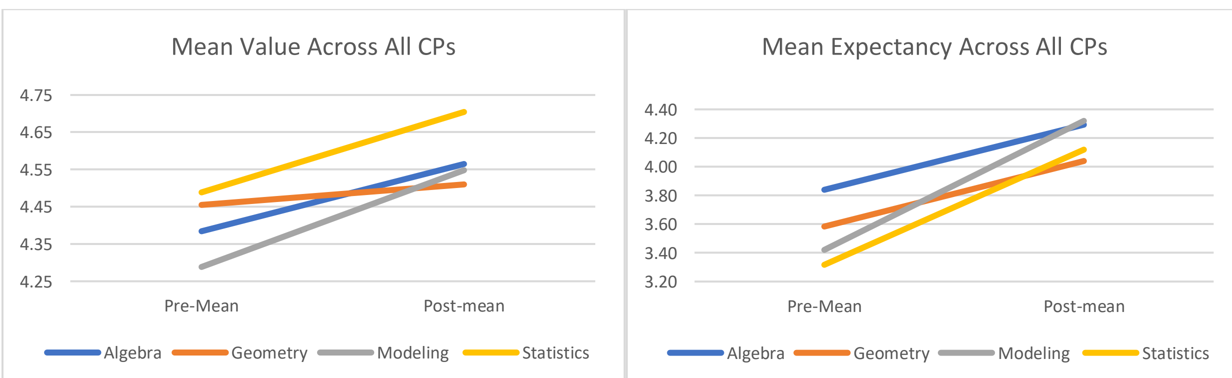
Modeling (Value)	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*	*Modeling (Expectancy)*	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*
Pre-Mean	4.231	4.269	4.269	4.385	4.29	Pre-Mean	3.288	3.462	3.404	3.529	3.421
Post-Mean	4.500	4.615	4.500	4.577	4.55	Post-Mean	4.346	4.298	4.327	4.308	4.320
Mean difference	0.269	0.346	0.231	0.192		Mean difference	1.058	0.837	0.923	0.779	
SD_d	1.116	1.018	0.863	0.981		SD_d	1.261	1.239	1.196	1.106	
n	26	26	26	26		*n*	104	104	104	104	
p-value	0.230	0.095	0.185	0.327		*p*-value	0.000	0.000	0.000	0.000	
effect size	0.241	0.340	0.267	0.196		effect size	0.839	0.675	0.772	0.704	

Statistics (Value)	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*	*Statistics (Expectancy)*	*CP1*	*CP2*	*CP3*	*CP4*	*Total Mean*
Pre-Mean	4.409	4.386	4.636	4.523	4.489	Pre-Mean	3.307	3.216	3.403	3.341	3.317
Post-Mean	4.705	4.705	4.705	4.705	4.705	Post-Mean	4.136	4.131	4.102	4.108	4.119
Mean difference	0.295	0.318	0.068	0.182		Mean difference	0.830	0.915	0.699	0.767	
SD_d	0.878	0.708	0.728	0.756		SD_d	1.448	1.492	1.392	1.522	
n	44	44	44	44		*n*	176	176	176	176	
p-value	0.031	0.005	0.538	0.118		*p*-value	0.000	0.000	0.000	0.000	
effect size	0.336	0.450	0.094	0.241		effect size	0.573	0.613	0.502	0.504	

Producing a line graph of the pre and post means in total across all CPs for each content area provides another aggregate view of how increases from pre to post compare across content areas. We can see in Figure 3 that Modeling and Statistics follows a similarly sloped increase in value and expectancy. Geometry's increase in expectancy is similar to Algebra, but is flatter when it comes to value. The most dramatic improvement occurs for the Modeling data, which has the smallest pre-mean for value and the second smallest for expectancy. We see that modeling almost ties Algebra in the post-mean value score and has the highest expectancy post-mean value.

Figure 3

Pre- and Post-Means for Value and Expectancy Across All CPs for Each Content Area



Pearson correlation coefficients were computed for each of the sixteen theorized SP and CP expectancy difference pairs as listed in Table 2 for each of the four content areas. This results in a total of 64 correlation coefficients. Rather than reporting all of those coefficients, we summarize the results in Table 4. Because fewer students completed the student perception inventory, there are a fewer number of SP items to match up with the expectancy items, and some students did not answer every item on the SP inventory. Thus we see slight variations in *n* for this analysis. With regard to results, we note that although the correlation coefficients were small overall (i.e., only three *r* values reached the moderate level threshold of 0.3 for practical significance), the vast majority (53 out of 64) were positive and 14 had statistically significant *p*-values.

Table 4

Correlation Coefficient (*r*) Results for Student Perception and Core Practice Difference Data

Content Area	*Minimum r*	*Maximum r*	*Number of $r < 0$*	*Number of $r > 0$*	*Number of SP item responses in data set*	*Number of r with $p < 0.05$*
Algebra	-0.055	0.331	2	14	90	6
Geometry	-0.091	0.212	2	14	126-132	3
Modeling	-0.136	0.203	7	9	80	1
Statistics	0.002	0.218	0	16	48-144	4

In summary, results show a clear indication that the PSMTs learning with MODULE(S^2) materials increase in their expectancy for all four CPs in all four content areas. Even though pre-scores are high for both value and expectancy, we still observed statistically and practically significant increases in expectancy. Additionally, value levels were high in both the pre and post-administrations of the expectancy-value instrument. This is promising because high levels of both expectancy and value are predictors of the PSMTs will make choices in their future classrooms associated with persistence in the enactment of CPs (Meyer et al., 2019; Trautwein et al., 2012).

With regard to how PSMT's perception of use of CPs in their classroom experience correlated with an increase in their expectancy for utilizing CPs in their own future classrooms, we observe an overwhelmingly positive number of correlations. Although the practical significance of these correlations is not high, PSMTs' experience of the CPs that MODULE(S^2) prioritize may serve as a foundation for the opportunity for PSMTs to increase their expectancy for utilizing these CPs in their future classrooms.

Discussion

In this study, we compared changes in prospective secondary teachers' expectancy and value for enacting core teaching practices across different content domains. We examined and found weak but overwhelmingly positive correlations between expectancy increases and PSMTs' perceived perceptions of learning in a course that utilized those core practices. More importantly, we found that there were increases, however modest, in both expectancy and value across the board. The most illuminating results pertained to the differences in gains across the content areas. In particular, there were larger practically significant increases in teachers' expectancies, for all core practices, in modeling and statistics than for algebra and geometry.

The problem that motivated this report is the increasing demand on teachers, including content demand. Not only are core teaching practices demanding with regard to application of content knowledge, but PSMTs across the US are also likely to come into their teacher preparation programs with little if any modeling or statistical experience. In contrast, they likely enter their program with years of experience with algebra and geometry.

Based on our experiences working with prospective teachers and instructors of these courses, we hypothesize that one explanation for the differences we observed for gains in expectancy is that prospective teachers entering a modeling or statistics class have no prior reason to feel confident in that content, let alone teaching that content. However, prospective teachers will be more likely to have previously done well in their algebra and geometry classes, and perhaps even tutored or assisted other students in these topics. So, they may enter teacher preparation programs perceiving themselves as capable of teaching algebra and geometry -- whether or not they understand what teaching mathematics entails.

In interpreting these results, we must consider alternative reasons for these gains. For instance, it may be that simply learning more content helped teachers feel more confident in enacting core practices. Alternatively, there may be a time effect, where teachers were going to increase in expectancy and value over time, regardless of the course taken or instruction provided. However, these potential alternative reasons for gains cannot completely explain the observed differences in changes in only expectancy across the domains.

In our future work, we intend to expand our understanding of differences in expectancy and value gains across domains by providing an opportunity for PSMTs to retrospectively report their expectancy and value of core teaching practices coming into the course. We observed in this study that administrations of the instruments resulted in rather large value and expectancy scores at the beginning of the term. This potentially hampered the instrument's ability to measure gains because it is common for people to not know what they don't know when coming into a new learning experience. To mitigate for this effect, we anticipate that a retrospective self-report at the end of term may provide data that more accurately captures PSTMs' expectancy and value gains over the term.

MODULE(S^2) materials are designed to provide opportunities for PSMTs to learn secondary mathematics and statistics from an advanced perspective while applying what they learn to secondary teaching situations. They have been shown to provide opportunities for PSMTs to build mathematical understandings that support the enactment of core teaching practices (Lischka et al., 2020), and in this investigation, we documented an increase in PSMTs' expectancy and value for enacting mathematically intensive core teaching practices designed to center student mathematical thinking in their future classrooms. As such, we contend that MODULE(S^2) materials can serve as a useful tool for teacher preparation programs across the country as they shift their programs to meet the growing demands placed on secondary mathematics teachers.

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