Improving Algebra Success with a Utility-Value Intervention

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ABSTRACT: Pass rates in community college entry-level math courses are a national crisis. The current study adapted a utility-value intervention from Hulleman and Harackiewicz (2009) to facilitate student success in community college math. In a double-blind experimental study (n = 180), we found a significant effect of the intervention on student pass rates. Further analysis revealed the intervention primarily improved men's passing rates by 13% (d = .54) but did not affect women's (d = -.15). The current study demonstrates that the utility-value intervention can boost community college math outcomes. Intervention fidelity, practice, theory, and study limitations are discussed.

Utility-value interventions tend to benefit students most at-risk for underperformance.

Students' performance in their courses can drastically impact academic success, especially when students fail classes early in their academic careers (Silva & White, 2013). This crisis is highlighted in developmental math classes, including intermediate algebra (the focus of the current study), a course students may take and fail numerous times (Bryk, Gomez, Grunow, & LeMahieu, 2015). At an individual and societal level, an inability to effectively train students in basic math has consequences for most jobs today (National Science Board, 2006). One solution proposed to address this problem is to move beyond traditional instruction and target major drivers of academic failure (Bryk et al., 2015).

A growing body of research suggests that student success can be facilitated through psychological interventions (Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016; Yeager & Walton, 2011). The current study focuses on one such intervention based on perceptions of value. When students believe what they are learning is useful, they are more likely to be interested in the topic and successful in class (Hulleman, Durik, Schweigert, & Harackiewicz, 2008). When students' perceptions of value are increased via self-reflection activities, their interest and performance increase (Harackiewicz, Canning, Tibbetts, Priniski, & Hyde, 2015; Hulleman & Harackiewicz, 2009), a finding that is strongest for low achieving students (Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman, Kosovich, Barron, & Daniel, 2017). Although value-related motivation interventions have not been studied in math courses, they hold great potential for helping struggling students.

Developmental Mathematics in Community College

Over the past few decades, studies about the impact of enrollment in developmental education on student success have attracted the attention of researchers and policymakers (Melguizo, Kosiewicz, Prather, & Bos, 2014). Thus far, the research shows that about 60% of community college students are designated as developmental, at-risk, low-achieving, disadvantaged, nontraditional, skill deficient, or underprepared for college-level coursework (Bailey, 2009).

Many community colleges have used their own institutional and national data to determine that developmental students' persistence to associate degree within 8 years is around 25% (Bailey, 2009) as compared to nondevelopmental students' persistence of about 40%. This statistic has inspired community college leaders, researchers, and policymakers to explore possible alternatives to improve students' outcomes through college-level developmental (math and other) courses (e.g., Hodara & Jaggars, 2014). Students who test into developmental math courses often lack both content knowledge and the appropriate learning and motivational strategies to succeed (Guy, Cornick, & Beckford, 2015). In order to address this challenge, educators from across the nation have been rethinking the first 2 years of college mathematics (Saxe & Braddy, 2015). Independent organizations and colleges have begun developing new mathematics pathways (Silva & White, 2013) to help students navigate personal and institutional barriers to success. Among the components built into these pathways are methods for facilitating student motivation to energize and direct students' academic behavior in useful directions. This study focuses on adapting one of these methods to intermediate algebra.

Utility-Value Interventions for Student Success

Focusing on the usefulness of a task to promote motivation is an interdisciplinary concept that spans academic domains in education. Usefulness is referred to by different labels in numerous psychological theories: utility value (Eccles et al., 1983), perceived instrumentality (Husman & Lens, 1999; Raynor, 1982), introjected regulation (Deci

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& Ryan, 1985), relevance (Assor, Kaplan, & Roth, 2002), and purpose (Yeager et al., 2014). Regardless of which label is adopted, leveraging the idea is demonstrably effective at improving individual's motivation. According to Eccles and colleagues (Eccles et al., 1983), *utility value* is specifically defined as the perceived usefulness of material to one's future goals. Importantly, utility-value interventions have shown benefits in college statistics (Acee & Weinstein, 2010), college biomedical science (Brown, Smith, Thoman, Allen, & Muragishi, 2015), college psychology (Hulleman, Godes et al., 2010), college biology (Harackiewicz et al., 2014), high school science (Hulleman & Harackiewicz, 2009), and high school math (Gaspard et al., 2015) by improving interest and achievement. The fact that utility-value interventions have demonstrated effectiveness across different academic domains and age levels suggests that the underlying process may be a general motivational mechanism. Because utility-value interventions tend to benefit students most at-risk for underperformance (Durik, Hulleman, & Harackiewicz, 2015), community college developmental math students are likely to benefit from making connections between what they are learning and their lives.

Utility-value interventions require students to engage with material they are learning and to connect it with their own lives. Different versions of these interventions have taken somewhat different approaches for prompting students to develop these connections. For example, Hulleman and Harackiewicz (2009) asked students to write brief essays in which they connected course material (from a high school science class) to their own lives or the lives of people they knew. Their study showed that students who wrote utility-value essays reported greater interest in additional science classes, and performed better in their current class than students who simply summarized material. Students who reported lower initial expectancy were also more likely to benefit from the interventions compared to those with relatively higher initial expectancy. The dependence of utility value on students' incoming motivational beliefs is significant as it has emerged in several studies (e.g., Hulleman & Harackiewicz, 2009).

Hulleman and colleagues' research was later adapted to ninth grade mathematics in Germany (Gaspard et al., 2015). The intervention revised the method of fostering utility value by asking students to evaluate quotes from other students who use math in daily life. Ultimately the revised intervention was able to boost student motivation and performance, with some notable additions. First, Gaspard and colleagues demonstrated sustained effects of the intervention on performance several months later. Second, they demonstrated that asking students to evaluate utility-value quotes actually resulted in larger improvements on self-reported motivation. Although Gaspard and colleagues' (2015) study focuses on ninth grade students, the mathematics content is similar to developmental math content that covers introductory and/or intermediate algebra. The results from Hulleman and colleagues (Hulleman & Harackiewicz, 2009; Hulleman, Schrager, Bodmann, & Harackiewicz, 2010) as well as Gaspard and colleagues (Gaspard et al., 2015) highlighted that students needed to reflect on the utility value of their course material.

Math instructors may try to convey the value of mathematics, but this approach of directly informing students about math's value may not be effective for all students (Carraher & Schliemann, 2002). In fact, one laboratory study (Canning & Harackiewicz, 2015) showed that biology students with high initial expectancy benefitted more from directly communicated utility value than from the original writing activity. At the same time, direct communication of utility value to low-expectancy students lowered motivation. In contrast, reflective writing activities were more effective in generating utility-value beliefs for individuals with low initial expectancy. Students with high initial expectancy sometimes reported lower motivation after such an intervention and instead benefitted from directly-communicated utility value. Other researchers (Canning & Harackiewicz, 2015) also highlight this complex pattern of results because it demonstrates a potential for well-intentioned practices to be harmful. Thus, for community college students who are thought to display lower motivation and weaker foundations in content knowledge than regularly admitted students, the reflection activities may be crucial for properly adapting the utility-value intervention.

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Many of the utility-value intervention studies have been derived from the expectancy-value framework for achievement motivation in education (Eccles, 1983). It is worth noting that, as the name might suggest, motivation is determined by a combination of expectancies for success and subjective task values. On the one hand, expectancies for success refer to individuals' beliefs that they can achieve a high level task or goal (e.g., pass a math course). This is to be contrasted with self-efficacy, which is a more granular construct that focuses on expectancy for a specific task (e.g., I can solve this word problem). Noteably, expectancies are often operationalized as confidence in one's ability to succeed. On the other hand, subjective task values refer to an individual's perception that a task is important, relevant, or interesting in some way. Utility value represents one dimension of value (the other two include importance value and intrinsic value). Thus, if individuals believe they can complete a task, and they want to complete the task, they are more likely to be motivated. Utility-value interventions represent a concrete translation of expectancy-value theory in that study results often demonstrate an interaction between assignment to a utility-value condition and students' preexisting levels of expectancy.

In the current research, we consolidate important advances from prior utility-value interventions to create a new version adapted for community college developmental math. Similar to the previous study, we included a writing prompt for students to reflect on the material (Hulleman & Harackiewicz, 2009). We also included a series of brief descriptions of the utility of math for various aspects of life (Canning & Harackiewicz, 2015). To support the direct communication and self-reflection, we included a selection of quotes from prior students to help scaffold student thinking and provide additional opportunities for them to reflect (Gaspard et al., 2015). Finally, to improve the potential for connections between math and students' lives to occur, we prompted students to write brief essays relating math to their lives (e.g., everyday, future career, and hobbies or interests; Hulleman et al., 2017). The goal of these adaptations was to maximize the number of potential students who could be influenced by the intervention.

The Current Study

In the current study, we assess the newly updated utility-value intervention in an intermediate math course at a two-year college. There are three major research questions that guided the current study. First, will students participating in the utility-value intervention preport higher utility value than a control group? Second, will students who participate in the intervention be more likely to pass, or less likely to withdraw, than students in the control group? Finally, will the effectiveness of the intervention be moderated by students' initial levels of competence?

Method

The current study was a longitudinal, double-blind experiment conducted in intermediate algebra classes at a large, urban community college in the southeastern U.S. Students received homework or quiz credit for completing intervention activities during a 16-week semester. We note that, although the intermediate algebra course is considered a

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3-credit college-level elective, it is considered a developmental math course at the institution.

Data/Materials

Sample. The total possible sample included 416 students nested within 22 classrooms. We collected data from students at three time points during the semester; Time 1, Time, 2, and Time 3. Time 1 included baseline data during the first 2 weeks of class, Time 2 included the intervention delivery during the 3rd and 4th weeks of the class, and Time 3 included the intervention follow-up during the 14th and 15th weeks of the semester. The participation rate was 44% for Time 1, 43% for Time 2, and 39% for Time 3. Approximately 77% of students participated in at least one of the activities. The experimental sample included the 177 students who were randomized to a treatment or control group (see the detailed description under Procedures) at the start of the intervention activity (57% women, 18% black, 37% white, 36% Hispanic, 59% receiving financial aid). Students were assigned the three study activities via email from their instructors using a standardized template that included a brief description of the activity.

Measures. The first and last activities were each a brief self-report questionnaire designed to capture various aspects of student motivation and attitudes (see Appendix). The questionnaire included measures of perceptions of expectancy in course performance (i.e., "How well do you expect to do in this class?"; 3-items, $\alpha = .88$), perceived value of learning math (i.e., "How useful is the course material to your everyday life?"; 3-items, $\alpha = .77$), perceived psychological costs of learning (i.e., "How often do you sacrifice too many things in order to do well in this class?"; 4-items, $\alpha = .82$), perceived utility value of math for one's future (i.e., "How important is the course material to your future?"; 2-items, $\alpha = .83$), perceived interest in the material (i.e., "How interested are you in taking more math classes?"; 3-items, $\alpha = .87$). Each measure used a 5-point Likert-type scale ranging from 1 (Not at All) to 5 (Extremely). In addition, students also provided some demographic information. Both questionnaires were expected to take less than 10 minutes on average. The second activity consisted of a shortened preintervention questionnaire measuring expectancy, value, and cost; the intervention activity (during which students were randomly assigned to the summary or utility-value condition); and a brief postintervention questionnaire measuring utility value, interest, and student demographics.

Coding. A student was coded as having passed (1) if they received a C or higher as their final grade, otherwise they were coded not passing (0). Thus, a student may not have passed because they failed or because they withdrew from the class. A student was coded as having withdrawn (0), and if they did not withdraw but failed, they were also coded (0).

Procedure

The first (Time 1, weeks 2 and 3) and third (Time 3, weeks 14 and 15) activities were surveys, and the second activity (Time 2, weeks 3 and 4) was the utility-value activity. At the time of participation, students were randomly assigned to either a summary group ($n = 80$) or a utility-value group ($n = 97$); three participants were removed because they did not proceed far enough to be randomized. The summary group was asked to write a short summary of some of the class material they were learning in a series of three short essays. The utility-value group read a set of quotes by former students who had learned about the utility value of math. The participants were then asked to write three short essays about the relevance of their course material to their everyday lives, potential future careers, and hobbies or interests. In total, students were asked to provide 9-12 sentences of writing. As in prior studies (e.g., Hulleman & Harackiewicz, 2009), those completing the summary activity were considered part of the control group whereas those completing the utility-value activity were considered part of the intervention group.

We created motivation covariates by averaging self-report measures of expectancy, value, and cost from Time 1 and 2.

Analyses

Analyses were conducted using a combination of descriptive statistics, multilevel multiple regression, and multilevel logistic regression. To improve statistical precision of outcome analyses, we created motivation covariates by averaging self-report measures of expectancy, value, and cost from Time 1 and 2 (both questionnaires measured prior to experimental assignment). We also included a battery of student demographics (i.e., sex, first time in college, financial aid status, and race/ethnicity) and academic characteristics (i.e., developmental mandate, exemption from developmental requirements) as covariates to improve the precision of our models. In order to reduce missing data–only 44% (Time 1) or 43% (Time 2) of students completed the Time 1 or Time 2 motivation measures–we created an average of the Time 1 and Time 2 motivation measures to create single baseline composites of motivation for 74% of the sample. These composite covariates were only used for the purposes of statistical precision in our regression analyses; any discussion of motivation prior to the intervention uses the individual scores from the appropriate time point. All covariates were group-mean centered.

Intervention Fidelity

An important aspect of understanding an intervention is to assess the degree to which it demonstrates *fidelity,* or alignment with expected processes and functioning (Nelson, Cordray, Hulleman, Darrow, & Sommer, 2012; O'Donnell, 2008). In this study we examined participant responsiveness, which is the degree to which individuals in the program engage with materials as expected (Nelson et al., 2012).We assessed the extent to which students wrote essays that were high quality, relevant to the intervention prompt, and of a desired length. Two trained raters coded student responses on several dimensions of intervention fidelity including quality of written utility value ($\alpha = .89$) and general writing quality ($\alpha = .85$).

Results

Pre-Intervention Descriptives

To test whether or not randomization was successful, we conducted a series of randomization checks based on student characteristics and preintervention motivation. The student characteristics included sex, χ^2 (1) = 0.84, $p = .36$; first time in college, χ^2 (1) = 5.49, $p = .02$; mandated developmental courses, χ^2 (3) = 5.25, $p = .15$; financial aid status, χ^2 (1) = 0.07, $p = .79$; exempt from developmental requirements, χ^2 (1) = 0.67, $p = .41$; black, χ^2 (1) = 0.09, $p = .77$; white, χ^2 (1) = 0.20, $p = .66$; Hispanic/latino(a), χ^2 (1) = 0.03, $p = .87$; and other, χ^2 (1) = 1.82, $p = .18$. Preintervention motivation included expectancy $F(1,197) = .015$, $p = .70$, value $F(1,197) = .24$, $p = .63$, and cost $F(1,197) = .93$, $p = .34$. Based on the relative similarity between conditions across student characteristics and baseline motivation, randomization was acceptable. However, student demographic characteristics were still included as covariates in the regression models.

Intermediate Outcomes

Using a hierarchical linear model, we regressed both postintervention motivation measures on our treatment indicator and covariates. The intervention had a positive and significant effect on postintervention self-reported utility value (Time 2), $b = .45$, $p = .014$, $d = .38$, controlling for demographic variables and prior motivation. The difference in postintervention interest was small, $b = .11$, $p = .57$, $d = .09$ and not statistically significant. No interaction effects were present between gender and experimental condition in predicting utility value or interest.

Final Outcomes

When examining intervention effects on course outcomes, two pairs of logistic regressions were conducted: two for withdrawal rates and two for pass rates. The first pair of models tested for an interaction between preintervention expectancy and experimental group. The second pair of models tested for an interaction between sex and experimental group. In terms of withdrawal rates, the students in the utility-value condition exhibited lower withdrawal rates (d = -.11), but the effect was not statistically significant in either interaction model. There was however a statistically significant main effect of the intervention on pass rates (b = 3.06, p = .04) and a marginally significant interaction between experimental group and sex (b = -4.68, p =.07; see Table 1 for the full model). There was not, however, an interaction between experimental group and preintervention expectancy (b = 1.39, p = .51). Figure 1 presents the intervention by sex interaction using the raw pass rates from each group, which illustrates the intervention effect was primarily driven by benefits for male students (d = .54), whereas there was only a small negative effect for female students (d = -.15). Both the main and interactive effects remained whether covariates were included in the model or not.

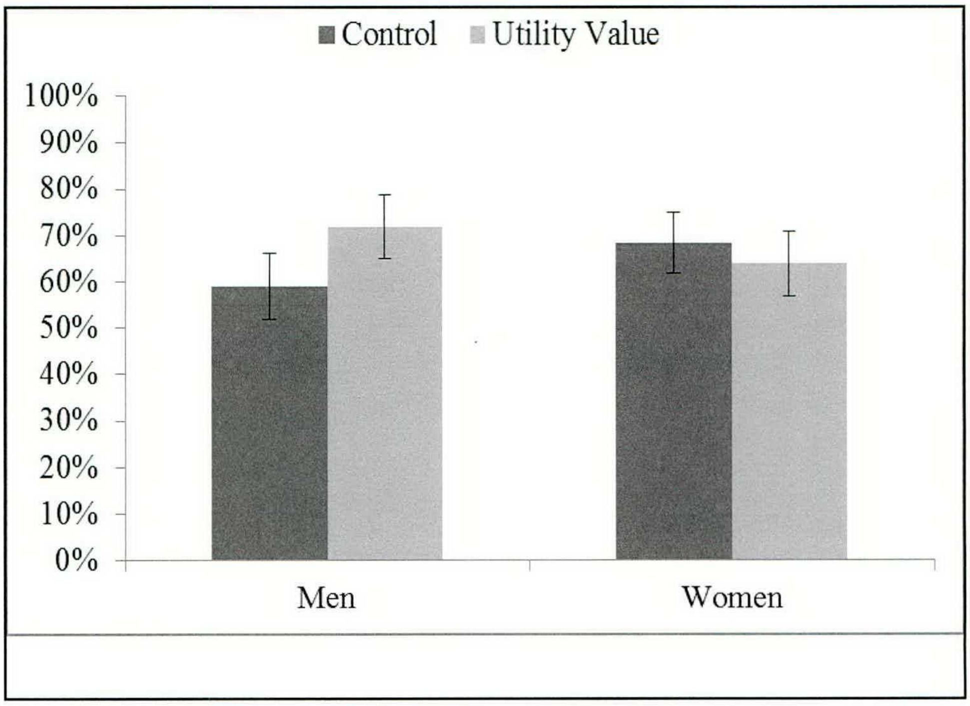

Figure 1. Multi-level logistic regression analyses demonstrated a marginally significant interaction effect between experimental group and gender. The effect was present with and without covariates. Raw pass rates by condition and gender demonstrate that the primary difference existed between the control and utility condition for men.

Intervention Fidelity

Overall, there was acceptable treatment differentiation (Nelson et al., 2012) based on coded utility-value quality of students' essays. Students in both groups demonstrated suboptimal compliance with the activity's instructions; each prompt asked students to write three or four sentences, but they only wrote 2.5 sentences on average. Students in the utility-value condition were more likely than the control to adhere to essay length, d = 0.45, and essay topic, d = .47. Students in both groups were approximately equivalent in their reactance (i.e., negative reaction to the activity), d = 0.00. Furthermore, students in the utility-value condition spent more time completing the activity, M = 12.0, SD = 7.5, minutes, (Note that winsorized means were used because of response time errors (i.e., likely participants failing to click submit), Median = 9.6 minutes, than the summary condition, M = 9.6, SD = 8.1, minutes, Median = 6.6 minutes. Individuals in the utilility-value condition demonstrated higher writing quality (d = .75). Students in the utility-value condition were also rated as producing substantially higher utility value in their essays, d = 1.64; the difference was even larger after controlling for activity time and writing quality, b = 1.71, p < .001, d = 2.52.

Table 1

Multi-Level Logistic Regression for Pass Rates (N = 177)

	b	SE	DF	*t*	*p*
Intercept	-15.00	8.39	10	-1.79	0.10
Treatment	3.06	1.48	156	2.07	0.04
Mandate	-1.57	0.89	10	-1.76	0.11
Female	1.70	2.59	10	0.65	0.53
Black	0.02	2.84	10	0.01	0.99
Hispanic	-0.34	2.67	10	-0.13	0.90
Other	-0.06	3.43	10	-0.02	0.99
First Time	0.99	3.81	10	0.26	0.80
Financial Aid	-1.51	2.77	10	-0.55	0.60
Bill1720	2.71	1.76	10	1.54	0.15
Confidence	3.21	1.78	10	1.80	0.10
Value	0.46	1.05	10	0.44	0.67
Cost	1.20	1.60	10	0.75	0.47
Tx by Female	-4.68	2.54	156	-1.84	0.07

Note: -2 Log Pseudo-Likelihood: 796.11, Between-Classroom Variance = 0.63 (SE = .71).

Discussion

The current research was aimed at improving student success (i.e., pass rates) in intermediate algebra courses. Students who received a utility-value intervention were asked to reflect on and briefly write about the usefulness of their math course to different aspects of their lives (i.e., everyday life, future career, hobbies/interests). The reflection essays led to higher self-reported utility-value immediately following the intervention compared to control group. Students who received the utility-value

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intervention, particularly men, were also more likely to pass their class than those in the control group. The results add to a growing body of literature showing that utility-value interventions can help students across a range of domains and ages. Importantly, the current research also demonstrates that utility value may work as a lever through which math instructors can improve student motivation and success. In the following sections, we first discuss limitations and then discuss theoretical and practical implications.

Limitations

There were two major limitations to this study, the most problematic of which was poor participation rates (an average of just over 40% at each time point). Unfortunately, this also constrains the generalizability of this study. Given that students who participated had substantially higher final course grades ($d = .54$, $p < .001$) than students who did not participate, it would appear that the intervention did not reach the students most in need. This may also explain why the interaction from prior research was not replicated. Further discussion with the instructors provided some illumination to this issue. Generally speaking, the instructors agreed that the students who did not participate in the activities were also least likely to attend or participate in class. Future versions of the utility value intervention would benefit from being more covertly integrated into the class (i.e., not as an obviously-external activity tied to a study). On a positive note, the study was only conducted with instructors who were interested in implementing the utility-value intervention, meaning the current study is likely to mimic real-life adoption of the intervention.

The second limitation relates to the causal mechanisms of the utility-value intervention. Our fidelity analysis examines several differentiating factors that show how the utility condition departs from the control condition (e.g., writing quality, time spent writing, topical focus). However, it is not clear if some or all of those aspects are the causal mechanism of the utility-value intervention. As a result, readers should not assume that forcing students to write for a longer time, or to write longer essays will necessarily benefit more from the intervention. Some students may have simply written more because they are more conscientious and more likely to follow rules. Future research needs to examine how to optimize the utility-value intervention. It is important to note that although this study does not identify which causal mechanisms within the intervention led to higher outcomes, there is a strong argument for the casual warrant of the utility-value condition as a whole. Because randomization occurred moments prior to participation in the intervention, it difficult to make a case for alternative explanations for the effects.

Implications for Theory and Research

Whereas prior iterations of the intervention were effective for low-expectancy students (Hulleman & Harackiewicz, 2009) or low-achieving students (Hulleman, Godes, et al., 2010), the current study was effective primarily for men. The current research shows that the intervention aids at least some struggling students by raising the pass rate among men by approximately 13% relative to a control group. Although these results do not directly replicate prior findings, they may be detecting a similar phenomenon using gender as a proxy variable. Men in the control group displayed the lowest pass rate relative to the women in the control group and utility-value groups. This finding suggests that men represented the majority of low-achieving students and that gender may have simply functioned as a proxy for prior math achievement (a variable we were unable to include in the study). However, a follow-up chi-square test showed that the groups were not statistically different in terms of raw pass rates, χ^2 (3) = 5, $p = 0.10$. Based on these results, further work is needed to understand the exact role that gender plays in these interventions. It is also possible that this effect can explain why the effect of the intervention did not depend on preintervention expectancy.

> *Women tend to report lower expectancy in their math ability than men despite displaying higher performance.*

Findings similar to the current research were observed in the Hulleman and colleagues (2017) study of psychology students where the utility-value intervention prevented a decline in classroom performance during the semester, particularly among men. In that study, men were the lower achieving group. Unfortunately, it is not possible to tease apart the role of gender, prior achievement, and perceived expectancy in either of these studies. One possible explanation is that women tend to report lower expectancy in their math ability than men despite displaying higher performance (Beilock, Gunderson, Ramirez, & Levine, 2010; Eccles & Wigfield, 2002). The result is a mismatch between expectancy and actual performance that could lead to differential effects during analysis. The nature of this mismatch is a topic for future research as it may illuminate the exact processes through which the intervention functions. For example, is it the case that the intervention works best for low-achieving individuals regardless of their expectancy? This may explain why some studies find an interaction between experimental condition and achievement, but not expectancy (Hulleman & Harackiewicz, 2009). Alternatively, is it the case that when expectancy and achievement are matched, the utility-value intervention is able to boost expectancy, which in turn boosts achievement? One recent study by Hulleman and colleagues (Hulleman et al., 2017) found that intervention effects depended on initial exam performance, and that the effects worked through later perceptions of expectancy (i.e., the intervention boosted expectancy which then boosted performance). Future research needs examine why gender effects emerge in some cases (Hulleman et al., 2017) but not others (Canning & Harackiewicz, 2015; Hulleman & Harackiewicz, 2009).

One possible route for future work is to examine the long-term effects of the intervention (i.e., future course-taking, graduation rates). Gaspard and colleagues (Gaspard et al., 2015) demonstrated sustained intervention effects over several weeks, but their intervention was three to five times longer than the one described in the current research, and it was delivered in person. Because the research base on motivation interventions in general–and utility-value interventions in particular–have tended to focus on short-term outcomes, we do not have prior research to consider when predicting the long-term effects of our intervention. This is an important factor to consider when determining the overall effectiveness of this type of intervention.

It is also worth investigating an intervention in which both utility value and expectancy are manipulated. If it is the case that motivation is a combination of expectancy and value, presumably a dual-target intervention could produce more powerful outcomes. At least one study explored such an intervention (Hulleman et al., 2017), but the expectancy manipulation was not effective. Hulleman and colleagues' study suggested that some utility-value interventions may increase achievement through impacts on expectancy, which is consistent with the reciprocal relationship between expectancies and values (Kosovich, Flake, & Hulleman, 2017).

Implications for Practice

The intervention tested in the current research is low-cost and brief; once developed it is free to use and takes students an average of 20 minutes to complete. That such a seemingly simple activity could improve pass rates may be met with skepticism or written off as common sense, but it is important to consider what we know about motivation generally and what we know about utility value specifically. The simple intervention is a product of years of careful theoretical work combined with rigorous testing based on prior research (Canning & Harackiewicz, 2015; Hulleman, Godes, et al., 2010; Hulleman & Harackiewicz, 2009; Hulleman et al., 2017). As discussed earlier, the current iteration of the intervention drew from several prior studies. Motivational interventions such as the utility-value intervention from the current research are thought to work through *recursive processes* (Yeager & Walton, 2011). The idea behind recursive processes is that concepts like motivation can be self-propogating under the right conditions. A student who does not find math useful may disengage from class and focus more time on other more personally-important endeavors. However, changing the importance of a math class in the students' mind can change its position on their priority list. Self-efficacy research further shows that success experiences breed greater motivation and success (Bandura & Schunk, 1981). Value may also foster positive academic emotions (Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010), which are another potential antecedent to feelings of efficacy (Bandura, 1982). Thus, a simple connection between a class and daily life made early in the semester has the potential to improve a student's success (Hulleman & Harackiewicz, 2009).

How Utility Value Is Commuicated Matters

The idea that students want to see the importance/relevance/usefulness in their courses is not novel. However, what students deem useful and what instructors deem useful is not always the same (Carraher & Schliemann, 2002). One problem that stems from this tension is that instructors may think they are communicating value for the material but students do not perceive the information as having the same kind of value. A greater concern is that telling students the material is important may actually harm their motivation. Indeed, one study conducted in a laboratory setting showed that students with low expectancy actually decreased in motivation and performance after they were directly told that a topic was useful (Canning & Harackiewicz, 2015). The study found that directly communicating utility value was only helpful for students with already-high expectancy. Thus, low-expectancy students need to find utility on their own. That is not to say that instructors cannot prompt and guide students to make these discoveries, but the reflection activity is hypothesized to be a central component of this process (Hulleman & Harackiewicz, 2009). Instructors interested in adopting this research should work to help students discover personally meaningful connections between the coursework and the students' own lives.

Which Connections Students Make Matters

All utility value is not created equal because students have different life experiences and goals. The extent to which a class is perceived as important to achieving one's goals depends on the individual (Vansteenkiste et al., 2004). The intervention in the current study departed from prior work by explicitly prompting students to consider utility value for three different possible areas: everyday life, future careers, and hobbies or interests. The purpose for this adaptation was to give the students more chances to make meaningful connections to their own personal goals and aspirations. How math is useful to a math major is going to be very different from how math is useful to an art major. A considerable amount of work was done by the current research team to develop intervention materials that fit in the intermediate algebra context. The quotes that students read as a part of the intervention were developed to be relatable on a personal level and related to the context. Practitioners wishing to adopt the materials from the current study will likely need to update the content to make it fit their particular context. For example, teaching a general education math class versus a math class major will require different examples and possibly different terminology.

Beyond Writing

Research on the most effective ways to foster utility value is ongoing, and writing activities are certainly not the only existing method (e.g., Gaspard et al.,

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2015). From our current understanding of the research, reflection is the way that students are best able to discover utility value. Presumably applied work, such as internships, projects related to student interests, and work studies, may provide richer opportunities to explore such connections. In these cases, we recommend pairing such activities with exercises such as a discussion or debrief that gives the individual an opportunity to genuinely reflect on their experience.

Conclusion

In recent years, educators have been exploring new ways to structure the early years of mathematics in college. This thinking has been spurred by the failure rates of students in early classes. The current study demonstrates one useful tool for educators in helping students navigate obstacles. Fostering perceptions of value for students is helpful because it relates to positive attitudes toward the course material in the short term and the long term. At the same time, interventions like the one tested in the current study also boost student performance, resulting in a higher proportion of students passing courses. Though not a cureall for challenges faced by math educators and students, the combination of a students' value for a course and expectancy in their abilities can be a powerful motivational force for educators to shape and direct.

From our current understanding of the research, reflection is the way that students are best able to discover utility value.

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Appendix

Expectancy-Value-Cost, Interest, and Utility Value Items

	Item
E1	How confident are you that you can learn the material in this class?
E2	How confident are you that you can be successful in this class?
E3	How well do you expect to do in this class?
V1	How relevant is the course material to your future career plans?
V2	How important is the course material to your future?
V3	How useful is the course material to your everyday life?
C1	How stressed out are you from taking this class?
C2	How often does this class require too much of your time or effort?
C3	How often do obstacles (class-related or other) limit the effort you can put into this class?
C4	How often do you sacrifice too many things in order to do well in this class?
UV1	How relevant is the course material to your future career plans?
UV2	How important is the course material to your future?
I1	How interested are you in taking more math classes?
I2	How interested are you in learning more about math?
I3	How interested are you in learning about careers involving math?

Note. E = Expectancy, V = Value, C = Cost, UV = Utility Value, I = Interest. All items were accompanied by a 5-point scale with labels for each anchor, for example: 1 - Not at all Confident, 2 – Slightly Confident, 3 – Somewhat Confident, 4 - Very Confident, 5 - Extremely Confident. Each response scale was adapted for the particular construct (e.g., slightly confident vs slightly useful).