STRONG START to FINISH

Motivate Lab

March 2022

Finding Relevance in College Math

EXECUTIVE SUMMARY

The impact of implementing classroom utility-value interventions on student learning outcomes

AUTHORS

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ACKNOWLEDGEMENTS

We received support for the writing of this report through funding from Strong Start to Finish. We are grateful to Maxine Roberts, Vilan Odekar and Christopher Mullin from Strong Start to Finish for their support of this project. We would like to thank Megan Moran, David Silverman, Erin Vines, Stephanie Wormington, Deb Howard, Julie Phelps, Maryke Lee, Hank Murrah and Jeff Kosovich for their efforts on intervention development and data collection. The authors would also like to thank the following individuals for their feedback and technical assistance on this report: Teresa Hulleman, Matt Best, Maryke Lee, Ashleigh Smith, Bruce Vandal, LaDonna Young, Emma Huelskoetter, Claudia Sutter, Travis Maddry and Catherine Foca. Most importantly, we would like to thank the math instructors and students who participated in our research.

Executive Summary

BRIEF DESCRIPTION OF RESEARCH

Our research program is focused on improving students' experience in community college math, particularly systemically underserved students (e.g., Black, Brown, Indigenous and first-generation students, adult learners and students with low incomes) who have experienced restricted access due to systems and structures in higher education. In previous studies,[1] we found that supporting students to make connections between course material and their daily lives was beneficial for students in four-year institutions. In this study, we tested the effectiveness of this motivational support in the context of community college math, with a particular focus on understanding the experiences of students who are the first in their family to attend college or receive a degree (i.e., first-generation students) and students enrolled in corequisite math courses. Supporting these students through these critical courses increases their likelihood of degree attainment which, in turn, can significantly impact their upward mobility.[2]

RESEARCH DESIGN

We embedded a series of reading, reflection and writing exercises (i.e., a utility-value intervention)[3] to help students connect what they learn in gateway and developmental math courses to their lives and future careers. Participants were students at a community college in Florida (N=2,699) and a community college in Tennessee (N=696). The intervention activities took students about 30 minutes to complete, and were developed as a partnership between researchers at Motivate Lab and community college math faculty. We randomly assigned students to an intervention or control condition; the students in the intervention condition received the reflection activities described above, while students in the control condition were asked to summarize a math concept they recently learned in class.

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1 Hulleman et al., 2010, 2017; Rosenzweig et al., 2019a; Harackiewicz et al., 2016.
2 Autor, 2014.
3 Hulleman & Harackiewicz, 2021.

STUDY DESIGN: RANDOMIZED CONTROL TRIAL (RCT)

The research design used in this study is called a randomized control trial (RCT). This type of study is often called a randomized field experiment. This means that:

1. Students had an equal chance of being randomly assigned to either the control or intervention condition.
2. Neither instructors nor students knew which condition students were in. This is referred to as "double-blinding" because both instructors and students were blind to the condition to which students were assigned.

This kind of research design allows us to make claims about the cause-and-effect relationship between the intervention and outcomes. In other words, it allows us to control for other "chance" factors — like students' prior math background or the quality of their instructor — that might have a bigger effect on their final math grade than the intervention activities they complete during this project. By randomly assigning a roughly equal number of students to intervention and to control groups, we can confidently draw conclusions about how our activities affected their success above and beyond all of these "chance" factors.

RESEARCH QUESTION AND PURPOSE

The purpose of this study was to investigate whether a course-embedded, utility-value intervention could support student motivation to learn while increasing success rates in community college math. We were particularly interested in learning if the intervention was especially beneficial for first-generation students as well as students enrolled in corequisite support courses. We focused on the following four research questions:

1. Does the utility-value intervention lead to better course outcomes for all students?
2. Does the utility-value intervention lead to better course outcomes for first-generation students?

3. Does the utility-value intervention lead to better course outcomes for students enrolled in corequisite support courses?
4. Does engaging with the utility-value intervention — by making high quality connections between math and students' lives — help them find relevance in their math courses and improve course outcomes?

WHY THE RESEARCH MATTERS AND WHO SHOULD CARE

Introductory math courses often act as gatekeeper courses[4] — structural barriers that impede students' progression toward a degree — whether they are gateway courses (i.e., designed to satisfy general education requirements) or developmental courses (i.e., designed to provide supplemental instruction for students who have not met a specific set of standards for academic preparation).

The developmental math pathway in particular has become an academic limbo land of sorts for students, with fewer than half of all students nationally who enter this pathway ever completing their college-level math course.[5] This structural barrier is particularly salient for Black, Brown, Indigenous, first-generation and adult students, and students with low incomes, who are more likely to be enrolled in developmental math courses and less likely to succeed in them.[6] [7]

The increased likelihood of being placed in the developmental pathway, along with lower levels of success in these pathways, produces an environment where students who are systemically underserved could be made to feel that they do not belong in college.[8] Because community colleges are more likely to enroll students from these systemically underserved groups,[9] [10] the developmental math barrier looms large on those campuses. In this report, we focus on students enrolled in community college mathematics for several reasons. First, with only 50% of two-year college students completing their introductory math courses, these courses are a significant barrier for degree completion and social mobility. This barrier is particularly salient for first-generation students and adult learners, who are more likely to enroll in community college than four-year schools, and are more likely to enroll in developmental math.[11]

4 Bailey et al., 2010
5 Bailey et al., 2010
6 Complete College America, 2021
7 Koch & Drake, 2018
8 Scott-Clayton & Rodriguez, 2015
9 Cataldi et al., 2018
10 Horn & Nevill, 2006
11 Bailey et al., 2010; Chen & Simone, 2016

Second, being assigned to a developmental math pathway sends a signal to students that they don't belong in college. Because supporting their families is often reported as a motivator for first-generation and adult students to pursue higher education, these signals can compound the guilt these students may feel by focusing on their education instead of their families.[12] Jointly, these forces can undermine the motivation to learn for first-generation and adult learners,[13] particularly for gateway courses, like introductory mathematics, which rarely feel connected to students' majors or career plans.[14] Third, the benefits of motivation interventions in general, and utility-value interventions in particular, have been understudied in the community college context and with first-generation and adult learners.

The corequisite support model was designed to avoid the purgatory of traditional developmental courses by allowing students to simultaneously enroll in college-level math and developmental support course sections. This model essentially places students into an additional math lab on top of their regular math course, providing a scheduled time for extra math support to cover foundational skills. Studies have found that students educated within a corequisite model were more likely to pass their gateway math and English courses when compared to similar students enrolled in traditional developmental models.[15] [16] [17] Beyond increased pass rates, a significant advantage of the corequisite model is that students do not need to enroll in and pass one or more developmental courses before taking the gateway course, thus resulting in a more cost-effective approach for both students and institutions.[18]

Although promising, a potential missing piece of the corequisite model is an explicit focus on designing the learning context to maximize students' motivation to learn. Our utility-value intervention aims to provide motivational support to first-generation students and students enrolled in corequisite courses by helping to compensate for a context that is not motivationally supportive for these groups.[19] [20] Integrating reflective activities focused on helping students make connections between math and their lives can signal to students that their identities are valued.[21] Furthermore, making space for students to connect their goals and interests to course material helps them see how what they are learning can be personally meaningful to them.[22] Through dozens of

12 Goldman et al., 2020; Petty, 2014
13 Canning et al., 2019; McKown, 2013
14 Kosovich, Hulleman et al., 2017
15 Logue et al., 2019
16 Ran & Lin, 2019
17 Ran, 2020
18 Belfield et al., 2016
19 Harackiewicz et al., 2016
20 Tibbetts et al., 2016
21 Canning et al., 2019
22 Hulleman et al., 2010

randomized field experiments, utility-value interventions have been found to increase interest in school topics, academic achievement and subsequent course taking.[23] Furthermore, these increases are most pronounced for students from systemically underserved backgrounds,[12] who are much more likely to be enrolled in developmental math courses.[24] [25]

In addition to helping create a more motivationally supportive climate, these activities are brief and easy to implement. Because the utility-value intervention is designed to be embedded within existing mathematics courses, our findings are relevant for anyone interested in creating more equitable learning environments and outcomes in community college mathematics. This includes community college mathematics instructors, administrators and policymakers.

KEY FINDINGS

Our results demonstrate that the utility-value intervention is effective in supporting student motivation and in boosting course grades and pass rates for first-generation students, and reducing withdrawal rates for all students. We found that students who were able to articulate in writing how specific math content was connected to their life benefitted most from the intervention. Writing about specific math content subsequently led students to perceive greater relevance of math to their daily lives and future career plans. Finally, we found that of the students who were enrolled in corequisite support courses, adult learners experienced the most benefits from the utility-value intervention. These effects apply to all first-generation students, regardless of their racial or family income background. This means that our intervention is as likely to benefit first-generation students who are also Black and Brown as it will benefit those who are white. However, because first-generation students are statistically more likely to also be from racially minoritized and low-income backgrounds,[26] the utility-value intervention will likely benefit more Black, Brown and low-income students than white and higher income students.

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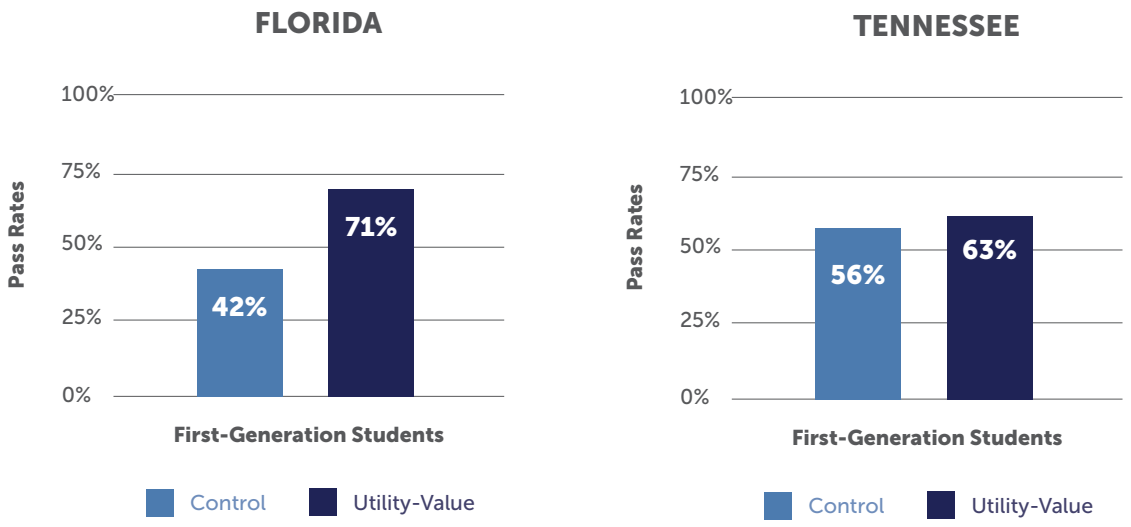
23 Hulleman et al., 2018
24 Hickey et al., 2020
25 Tibbetts et al., 2021
26 Terenzini et al., 1996

The utility-value intervention benefitted all students by decreasing withdrawal rates and increasing motivation to learn (both samples). Specifically, in Figure 1, the intervention reduced withdrawal rates — which are calculated after the first six weeks of the semester — by 33%. In terms of motivation to learn, in both samples the intervention increased students' perceptions of the relevance of math to their lives, which then led students to earn higher grades and pass rates in the course.

First-generation students exposed to the utility-value intervention had higher pass rates than the control group. This finding was consistent in both of our samples, which total more than 3,000 students, including 908 first-generation students.

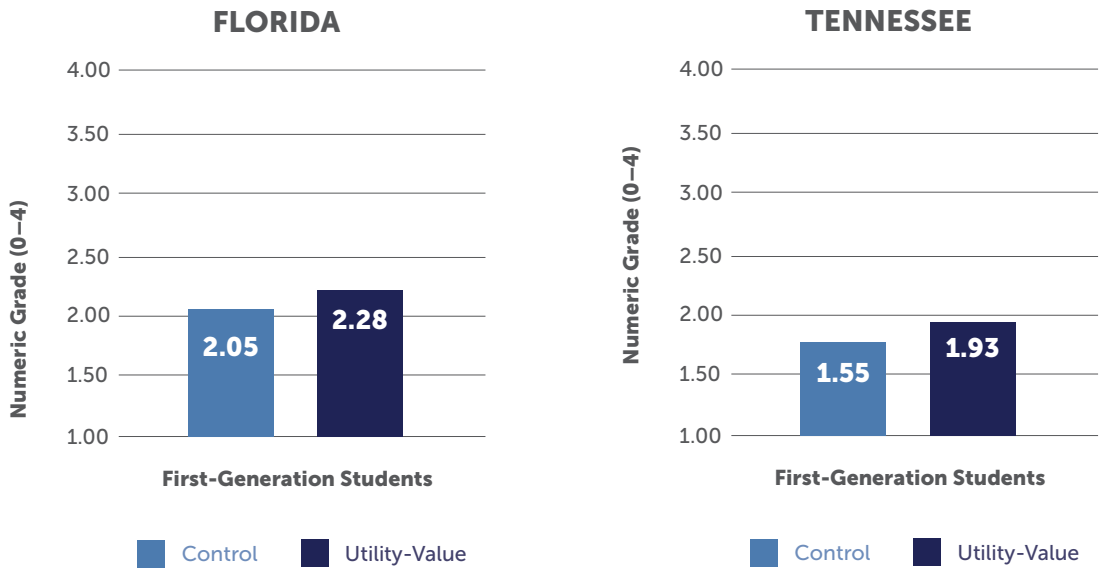
Figure 1. The effects of the utility-value intervention on pass rates by student generation status



Note: Error bars represent +/- 2 standard errors; both comparisons above are statistically significant at least $p < .05$.

First-generation students exposed to the utility-value intervention had higher grades than the control group. This finding was also consistent in both of our samples, which total more than 3,000 students, including 908 first-generation students.

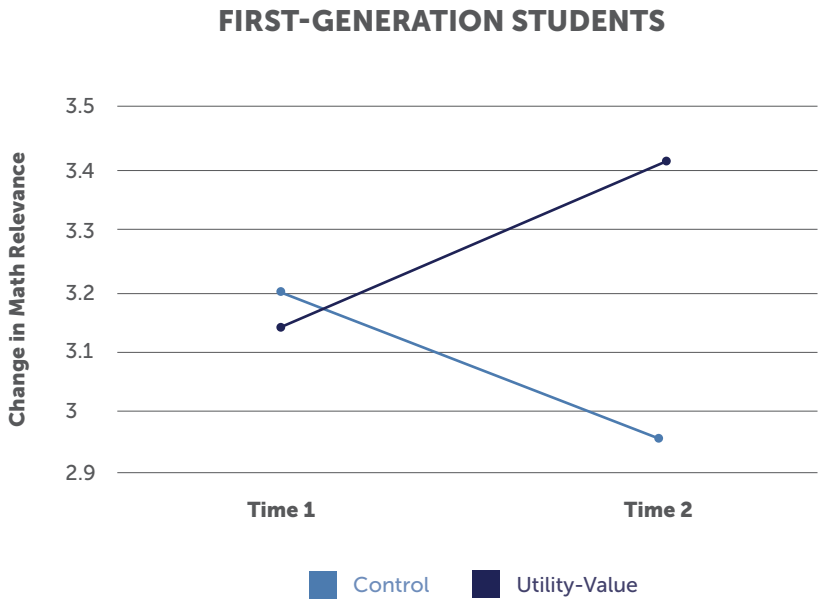
Figure 2. The effects of the utility-value intervention on grades by student generation status



Note: Error bars represent +/- 2 standard errors; both comparisons above are statistically significant at least $p < .05$.

Utility-value intervention effects were especially strong for first-generation students. First-generation students who did not receive the utility-value intervention reported a decrease in math relevance from the beginning to the middle of the semester. Those who did receive the intervention reported an increase in math relevance. Importantly, students who reported an increase in math relevance also had higher course grades and pass rates.

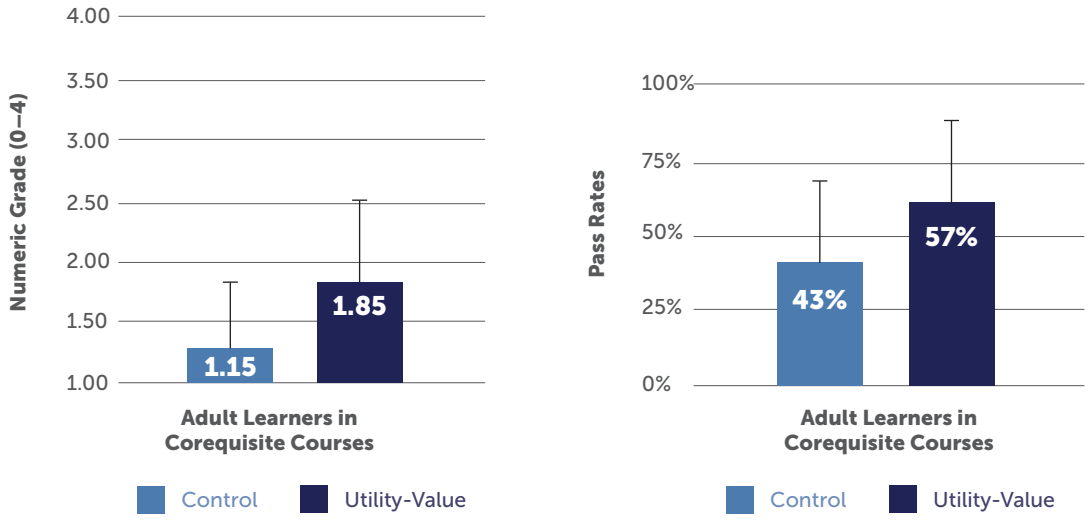
Figure 3. The change in students' perceived math relevance from the beginning of the semester to the end of the semester (Tennessee)



Note: Perceived math relevance was measured on a scale of 1-5 with 5 meaning students see more relevance in math for their lives. Time 1 (week 2). Time 2 (week 5). The change from Time 1 to Time 2 was statistically significant ($p < .05$) for both the control and utility-value conditions. The difference between the utility-value and control conditions was statistically significant at Time 2 but not Time 1 ($p < .05$).

Adult learners enrolled in corequisite courses who were exposed to the utility-value intervention earned higher course grades and pass rates than those in the control condition. We consider this finding to be suggestive and in need of further research for two reasons. First, although adult learners are increasingly becoming an important group of students, we did not specifically hypothesize that the utility-value intervention would be beneficial to them. Second, because of our data we were only able to look at this finding in Tennessee (and not Florida), which has a smaller sample size (a total of 71 adult students were enrolled in corequisite courses in our sample).

Figure 4. The effects of the utility-value intervention on grades and pass rate for adult learners enrolled in corequisite courses (Tennessee)



Note: Error bars represent +/- 2 standard errors; both comparisons above are statistically significant at least $p < .05$.

RECOMMENDATIONS

Based on these findings, we offer several recommendations regarding how policymakers, system leads and practitioners in the developmental education reform field can use this research to improve student outcomes.

Implement instructional practices that support purpose and relevance. Our results signal that those instructional practices that support student motivation in general, and the perceived relevance of math in particular, could increase student motivation and academic success in community college math. In addition to the utility-value intervention, instructors could ask students to reflect on the utility of each math topic in their lives using other evidence-based practices. For example, the Build Connections activity[27] supports instructors in scaffolding their students on how to make connections between the course content and their lives. Reflection prompts available on Motivate Lab's website could also be used to ask students to make their own connections.

Change contexts to support students. Instead of focusing on what students should individually improve, our results highlight changes in instructional practices that could benefit all students. Providing students with a guided opportunity to draw connections between course content and their lives improves learning outcomes, particularly for first-generation students. Because the activities were integrated into existing math courses, large-scale implementation does not require drastic changes to curriculum. This means that the utility-value intervention has the potential to be implemented at institutions across the nation as a complement to broader structural reforms, such as corequisite developmental education.

Foster interdisciplinary partnerships. Our design process involves working with students and math instructors to generate examples that are relevant to their local environment and experiences, as well as the specific math content being taught in the course. We then work with local instructors and administrators to implement the intervention in their math courses. This approach highlights how researchers and practitioners can work together to develop evidence-based solutions to increase equity in learning outcomes at their institutions. By equity, we mean the process of addressing issues of access and success for those who are marginalized and have been negatively impacted by institutional policies and practices, including but not limited to Black,

27 Hulleman et al., 2018

Brown, Asian-American and Indigenous students, adult learners and students with low incomes.[28]

Align with guided pathway programs. The guided pathways movement focuses on reforming the higher education experience to guide students inside and outside of the classroom throughout their entire journey through college. The utility-value intervention, and other strategies to help students find purpose and relevance in their schoolwork, could be integrated as a part of guided pathways reform[29] [30] to help students make more purposeful program and major choices. A student might become more committed to a program pathway if they can see how the math they are taking is related to their personal and academic goals.

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28 Strong Start to Finish website
29 Bailey et al., 2015
30 Center for Community College Student Engagement, 2020

REFERENCES

Autor, D. H. (2014). Skills, education, and the rise of earnings inequality among the "other 99 percent." *Science, 344*, 843–851.

Bailey, T., Jeong, D. W., & Cho, S.W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review, 29*(2), 255–270.

Bailey, T. R., Smith Jaggars, S., & Jenkins D. (2015). *Redesigning America's Community Colleges: A Clearer Path to Student Success*. Cambridge: Harvard University Press.

Belfield, C., Jenkins, D., & Lahr, H. (2016). Is corequisite remediation cost-effective? Early findings from Tennessee. *CCRC Research Brief, 62*, 1–13.

Canning, E. A., Priniski, S. J., & Harackiewicz, J. M. (2019). Unintended consequences of framing a utility-value intervention in two-year colleges. *Learning and Instruction, 62*, 37–48.

Cataldi, E. F., Bennett, C. T., Chen, X., and Simone, S. A. (2018). First-Generation Students: College Access, Persistence, and Postbachelor's Outcomes. National Center for Education Statistics, U.S. Department of Education.

Center for Community College Student Engagement. (2020). *Building momentum: Using guided pathways to redesign the student experience*. Austin, TX: The University of Texas at Austin, College of Education, Department of Educational Leadership and Policy, Program in Higher Education Leadership.

Chen, X., & Simone, S. (2016). *Remedial course taking at U.S. public 2- and 4-year institutions: Scope, experiences, and outcomes.* National Center for Education Statistics, U.S. Department of Education.

Complete College America. (2021). No room for doubt: Moving corequisite support from idea to imperative.

Cook, T. D., Campbell, D. T., & Shadish, W. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston, MA: Houghton Mifflin.

Goldman, J., Heddy, B. C., & Cavazos, J. (2020). First-generation college students' academic challenges understood through the lens of expectancy value theory in an introductory psychology course. *Teaching of Psychology*. Advance online publication.

Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Priniski, S. J., & Hyde, J. S. (2016). Closing achievement gaps with a utility-value intervention: Disentangling race and social class. *Journal of Personality and Social Psychology, 111*(5), 745–765.

Hickey, D. T., Robinson, J., Fiorini, S., & Feng, Y. (2020). Internet-based alternatives for equitable preparation, access, and success in gateway courses. *The Internet and Higher Education, 44*, 1–9.

Horn, L., and Nevill, S. (2006). Profile of Undergraduates in U.S. Postsecondary Education Institutions: 2003–04 with a Special Analysis of Community College Students. National Center for Education Statistics, 2006–184, U.S. Department of Education.

Hulleman, C. S., Godes, O., Hendricks, B., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology, 102*(4), 880–895.

Hulleman, C. S., & Harackiewicz, J. M. (2021). The utility-value intervention. In: Walton, G. W., & Crum, A. (Eds.), *Handbook of Wise Interventions: How Social Psychology Can Help People Change* (100–125). Guilford Press: New York.

Hulleman, C. S., Kosovich, J. J., Barron, K. E., & Daniel, D. B. (2017). Making connections: replicating and extending the utility value intervention in the classroom. *Journal of Educational Psychology, 109*(3), 387–404.

Hulleman, C. S., Murrah, W., Tibbetts, C. Y., & Francis, M. (2018, November). *Using utility-value interventions to remove barriers in math courses* [Conference presentation]. 2018 American Mathematical Association of Two-Year Colleges (AMATYC) Conference. Orlando, FL, United States.

Kosovich, J. J., Hulleman, C. S., & Barron, K. E. (2017). Measuring motivation in educational settings: A Case for pragmatic measurement. In: Renninger, K.A., & Hidi, S.E. (Eds.), *The Cambridge Handbook on Motivation and Learning* (39–60). New York, NY: Routledge.

Koch, A. K., & Drake, B. (2018). Digging into the disciplines: The impact of gateway courses in accounting, calculus, and chemistry on student success. *Chemistry, 34*, 29–4.

Logue, A. W., Douglas, D., & Watanabe-Rose, M. (2019). Corequisite mathematics remediation: Results over time and in different contexts. *Educational Evaluation and Policy Analysis, 41*(3), 294–315.

McKown, C. (2013). Social Equity Theory and Racial-Ethnic Achievement Gaps. *Child Dev, 84*: 1120–1136.

Petty, T. (2014). Motivating first-generation students to academic success and college completion. *College Student Journal, 48*(2), 257–264.

Ran, F. X. (2020, January 29). *Corequisite remediation is shown to improve gateway course outcomes. Now what?* Community College Research Center.

Ran, F. X., & Lin, Y. (2019). The effects of corequisite remediation: Evidence from a statewide reform in Tennessee (CCRC Working Paper No. 115). Columbia University, Teachers College, Community College Research Center.

Scott-Clayton, J., & Rodriguez, O. (2015). Development, discouragement, or diversion? New evidence on the effects of college remediation policy. *Education Finance and Policy, 10*(1), 4–45.

Strong Start to Finish. *Strong Start to Finish.* Education Commission of the States. Denver, CO.

Terenzini, P.T., Springer, L., Yaeger, P.M. et al. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education, 37*, 1–22.

Tibbetts, Y., Harackiewicz, J. M., Canning, E. A., Boston, J. S., Priniski, S. J., & Hyde, J. S. (2016). Affirming independence: Exploring mechanisms underlying a values affirmation intervention for first-generation students. *Journal of Personality and Social Psychology, 110*(5), 635–659.

Tibbetts, Y., DeCoster, J., Francis, M. K., Williams, C. L., Totonchi, D. A., Lee, G. A., & Hulleman, C. S. (2021, November). *Learning Mindsets Matter: Implications for Students Enrolled in Corequisite Courses*. Strong Start to Finish. Denver, CO.