

# Active Learning Mathematics (ALM)

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## Problem Addressed & General Approach

The Active Learning Mathematics Research Action Cluster (ALM RAC) was formed to address the ongoing problems of undergraduate student success in first-year mathematics courses (Precalculus through Calculus 2—P2C2). Over 90% of 2.5 million students in the United States who take collegiate mathematics courses each year are taking courses at or below Calculus 2. Student success in first year mathematics courses (or lack thereof) can prompt changes in decisions to pursue STEM majors; student retention from first to second year and the four- and six-year graduation rates are highly correlated with grades in first year mathematics courses (in large part because mathematics courses are a near-universal requirement for graduation). Active learning strategies can improve student engagement and learning outcomes, but instructors need professional development and ongoing support to positively change their teaching practices. Further, different in-class materials (activities) are needed to better engage students.

The ALM RAC activities are detailed in our driver diagram (see Figure 1). Related to curriculum and assessment, ALM RAC partners work to develop and share materials that can support active learning, and also promote local coordination of assessment, through common homework, exams, and grading. Instructor capacities are addressed through initial and ongoing professional development; graduate student instructors are a unique (rotating) population of P2C2 instructors who need targeted supports. Student dispositions are measured via common surveys and other outcome measures. Focusing on a common vision entails significant will-building and local leadership to navigate policies and barriers, and to activate change levers (such as hiring and empowering a course coordinator).

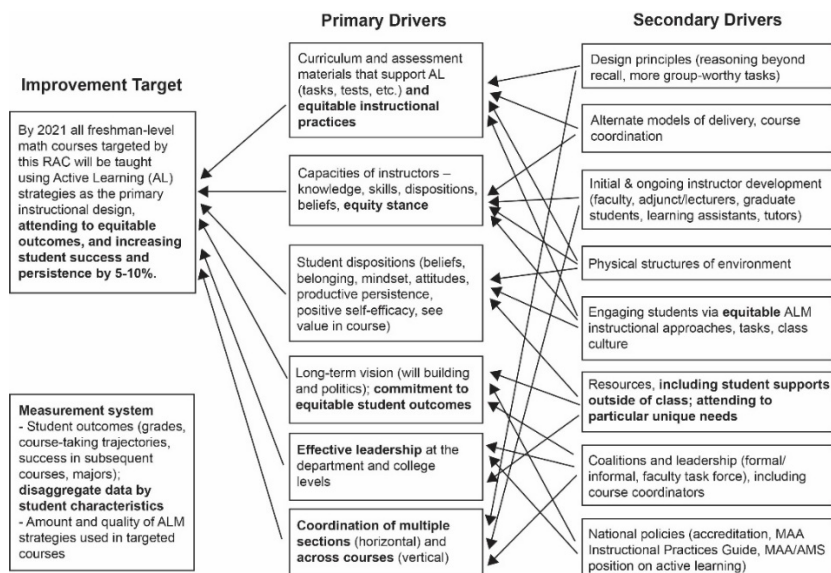


Figure 1. ALM RAC Driver diagram, as revised in 2019 to include leadership as a primary driver, and to update the secondary drivers.

Whereas ALM RAC members are focused on their own transformation efforts, a related coalition is studying how to effect departmental transformation to adopt and sustain active learning strategies. The Student Engagement in Mathematics through an Institutional Network for Active Learning (SEMINAL) project is a collaborative grant among the Association of Public and Land-grant Universities, the University of Colorado Boulder, the University of Nebraska–Lincoln, and San Diego State University (DUE-1624643, 1624610, 1624628, 1624639). Now in Year 4, SEMINAL’s research findings related to change levers for active learning, and sustaining departmental transformation efforts are aligned with ALM RAC efforts.

### **Current Progress**

The ALM RAC contributed a chapter to the 2020 Mathematics Teacher Education Partnership, summarizing our work to date and including multiple vignettes (Smith, Callahan, Mingus, & Hodge, 2020); one section of the book is focused on the mathematical content preparation of future teachers and also includes an overview chapter that is relevant to ALM RAC.

At our ALM RAC work time in June 2020, we spent time reviewing ALM RAC progress to date, to orient new members to our work and focus (see Appendix A). Given the global pandemic and ensuring impact on mathematics teaching and learning, strategies for actively engaging students in remote environments or in-person with physical distancing were where we focused most of our discussions. At the time, many faculty involved did not yet have a clear determination for fall format, so we talked about a range possibilities for actively engaging students in mathematics.

### **Resources and Opportunities for Engagement**

The ALM RAC welcomes additional partners who want to engage, from helping to develop a dynamic repository of materials, to engaging in lesson study for P2C2 lessons. During 2020–2021 we have monthly meetings set for the second Tuesday, July-May, at 3:30 p.m. Eastern time (contact Wendy Smith for the Zoom link). We are increasingly convinced how much contextual features and personal relationships impact the successful implementation and institutionalization of ALM efforts, so we appreciate having diverse partners whose collective experiences can better span the many variations.

We note that the 2018 publication by the MAA of an [\*Instructional Practices Guide\*](#), has many excellent principles for actively engaging students in learning mathematics. This publication is a great resource for helping to start local conversations about mathematics teaching and learning and has many practical tips for increasing student engagement. The SEMINAL project has a book forthcoming (Smith et al., Winter 2020–2021) that will focus on how departments changed their cultures to sustain active learning as the norm for first year mathematics teaching and learning. Local teams can implement or increase course coordination; coordination can help to sustain improvements and address inequitable student experiences and outcomes. Finally, those interested in improving P2C2 teaching and learning need to approach departmental transformation systemically, recruiting key leaders within and above the mathematics department in order to effectively initiate, implement, and sustain changes.

## **References**

Mathematical Association of America (2018). *Instructional practices guide*. Retrieved from:

<https://www.maa.org/programs-and-communities/curriculum%20resources/instructional-practices-guide>

Martin, W. G., Lawler, B. R., Lischka, A., & Smith, W. M., (Eds.) (2020). *The Mathematics Teacher Education Partnership: The power of a networked improvement community to transform secondary mathematics teacher preparation*. Volume 4 in B. Benken (Ed.), Association of Mathematics Teacher Educators Professional Book Series. Information Age Publishing.

Smith, W. M., Callahan, K., Mingus, T., & Hodge, A. (2020). *Active learning mathematics research action cluster*. In W. G. Martin, A. E. Lischka, W. M. Smith, & B. R. Lawler (Eds.), *The Mathematics Teacher Education Partnership: The power of a networked improvement community to transform secondary mathematics teacher preparation* (pp. 143–178). Volume 4 in B. Benken (Ed.), Association of Mathematics Teacher Educators Professional Book Series. Information Age Publishing.

Smith, W. M., Voigt, M., Strom, A., Webb, D. C., & Martin, W. G., (Eds.) (forthcoming). *Transformational change efforts: Student engagement in mathematics through an institutional network for active learning*. MAA/AMS Press.

## **Appendix A**

### *ALM RAC 2019–2020 Progress on Primary Drivers*

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#### **Curriculum and assessment materials that support AL (tasks, tests, etc.) and equitable instructional practices**

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Each campus is building its own set of materials; many pull from [University of Colorado materials](#). Textbook selection can be contentious and supports or inhibits ALM adoption. Building local materials can be a way to get people on board (ownership); sharing materials in useable form is an ongoing consideration (OneDrive, Google Drive, WikiSpace, Dropbox)

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#### **Capacities of instructors – knowledge, skills, dispositions, beliefs, equity stance**

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ALM RAC members each doing instructor professional development of some type (formal or informal) with instructors (including graduate student instructors, undergraduate learning assistants)

Student dispositions (beliefs, belonging, mindset, attitudes, productive persistence, positive self-efficacy, see value in course)

Some ALM RAC members are surveying students. Campuses engaged in comprehensive transformation efforts seem to be improving student outcomes.

Some ALM RAC members are preparing to use the [EQUIP](#) tool as a mechanism for collecting equity-related data for class participation.

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#### **Long-term vision (will building and politics); commitment to equitable student outcomes**

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Each ALM RAC member working on this; a key focus of ALM RAC meetings is sharing current lessons learned. Challenges to scaling up are often due to lack of buy-in. In some cases, collecting local data is (or is the foundation for) getting more people on board that there is a problem.

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#### **Effective leadership at the department and college levels**

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As a new driver, ALM RAC members are having ongoing conversations about how to effectively be leaders on their local campuses, how to work with formal leaders in and beyond the mathematics department, and how to frame ALM RAC work to align with leaders' priorities for campuses.

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#### **Coordination of multiple sections (“horizontal”) and across courses (“vertical”)**

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Each ALM RAC member is working on better coordination, along with hiring/designating coordinators. Getting buy-in for common assessments and common grading is a tough sell in some locations. Coordination can be argued as a structure for increasing equitable outcomes.