Active Learning in Mathematics Research Action Cluster (ALM RAC)

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Co-Leaders

Problem Addressed

Student success in undergraduate mathematics has significant implications for whether they choose to continue into STEM majors and related careers in the future. Even for those students who do not choose to major in mathematics, science, or engineering, success in entry-level undergraduate mathematics courses such as calculus can make or break their decision to persist in postsecondary education.

The Characteristics of Successful Programs in College Calculus (Bressoud, Carlson, Mesa, & Rasmussen, 2013) showed the percentage of students with grades of D, F or Withdraw (DFW) ranged from an average of 25 percent at Ph.D.-granting universities to an average of 37 percent at regional comprehensive universities. We are committed to improving students' achievement in and dispositions toward mathematics using models for Active Learning Mathematics (ALM).

With respect to the MTE-Partnership's Guiding Principles, the ALM RAC involves *Commitments by Institutions of Higher Education* through Institutional Focus, Disciplinary Partnerships, and Institutional Support for Faculty. The ALM RAC also addresses the guiding principle of *Candidates' Knowledge and Use of Mathematics* through future candidates' engagement in Mathematical Practices in introductory-level undergraduate mathematics courses, to deepen their Knowledge of the Discipline. Excellent introductory mathematics courses also have the potential to encourage more students to consider becoming secondary mathematics teachers (or at least reduce discouragement among potential future teachers).

General Approach

Our working theory of change is articulated in the following diagram:

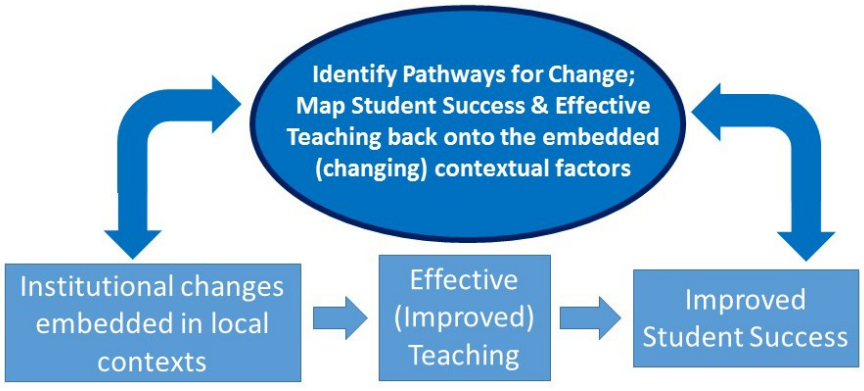

Figure 1. ALM RAC theory of change.

The overarching goal is to improve student success with undergraduate mathematics, starting with the Pre-calculus through Calculus 2 sequence (P2C2). This is accomplished through effective teaching practices, which are supported by learning environments that are more conducive to student interaction, reasoning, and problem solving and the use of instructional resources to support ALM. Faculty buy-in and institutional leadership supports training for Graduate Teaching Assistant and other P2C2 instructors. Also, for many campuses, undergraduate learning assistants are used to support student work with group activities and enhance student engagement in mathematical activity.

Table 1

Who We Are

Auburn University	**University of Colorado Boulder**
Gary Martin, Ulrich Albrecht	David Webb, Robert Tubbs, David Grant
California State University Fullerton	Faan Tone Liu, Eric Stade, Nancy Kress
David Pagni, Roberto Soto	**University of Hawaii Manoa**
California State University Chico	Monique Chyba, Mijana Jovovic
Christine Herrera	**University of Nebraska-Lincoln**
Florida International University	Wendy Smith, Allan Donsig,
Maria Campitelli	Nathan Wakefield
Fresno State University	**University of Nebraska Omaha**
Lance Burger	Janice Rech, Michael Matthews
Kennesaw State University	**University of South Carolina**
Kadian Callahan, Belinda Edwards	Sean Yee
San Diego State University	**West Virginia University**
Chris Rasmussen, Janet Bowers,	Vicki Seeley, Nicole Engelke,
Michael O'Sullivan, Matt Voigt, Naneh Apkarian	Matthew Campbell
Tuskegee University	**Western Michigan University**
Lauretta Garrett, Ana Tameru	Tabitha Mingus, Melinda Koelling

Current Progress

Over the past four years, we have worked collaboratively to improve instruction in introductory calculus courses. While the contexts across the 15 campuses are quite different, requiring somewhat different approaches to implementing ALM, we have been able to learn from one another's efforts. We have exchanged and co-developed instructional resources, used common measures to document shifts in student dispositions, and have regularly discussed the local models used to support learning environments that are more conducive to ALM. Several campuses adopted the "learning assistant" model used by Colorado. Other campuses have been expanding their efforts to include other P2C2 courses, pre-requisite courses for pre-calculus, and calculus 3. Discussions across campuses have helped to identify key features of approaches used and have confirmed the critical role of institutional support in promoting ALM. On some campuses, efforts are at a stable place, while in others, the efforts are expanding or just getting started. Ongoing work includes more coordinated data collection.

Opportunities for Engagement

A collaborative NSF-funded research grant – Student Engagement in Mathematics through an Institutional Network for Active Learning (SEMINAL) – now supports research to better understand how to enact and support institutional change in P2C2 courses. SEMINAL is actively soliciting additional partners ready for institutional transformation to join in this research project (see http://tinyurl.com/SEMINALIntro).

The Active Learning RAC is currently seeking additional partners who are interested in contributing to future research and products, including the use and revision of instructional resources, professional development materials, strategies to support instructional change, and the use and improvement of measures to study the impact of these changes (full partner). 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 also welcome partners who are interested in field-testing and implementing ALM resources and measures, without the full commitment of contributing to the Active Learning agenda or development of resources (participating partner).

Work of the 2017 Conference

During our RAC work time at the June 2017 MTE-Partnership conference, we first spent time learning what progress each campus has made. We also spent time revising our driver diagram (see below). We discussed data extensively, including:

- The importance of attending to the variances in the data
- Considering a broad range of data from DFW rates to student attitudes to classroom observations
- The need to examine subgroups of students, not just overall averages (e.g., how do we know our students' needs and develop appropriate supports for them? Are our efforts working equally well with all subgroups?)
- Ways to access university data (registration, grades), to track student trajectories, majors and grades
- Options for surveys; while the ALM RAC has been encouraging use of the Collegiate Active Learning in Calculus Survey (CALCS), SEMINAL has developed other options. CALCS primarily measures beliefs, along with intent to take more mathematics courses and some other student characteristics. SEMINAL has adapted the Postsecondary Instructional Practices Survey (PIPS) for instructors, and developed the SPIPS—a version of the PIPS for students that can be correlated with PIPS data. Further, SEMINAL has a Climate and Culture Survey for mathematics departments, to gauge the instructional climate and professional advice networks related to mathematics teaching. ALM RAC members can choose any/all of these surveys.
- Survey administration: how surveys are administered matters greatly for response rates. For faculty, ideally the department chair sends out surveys; at a minimum, the chair should send out a notice about the surveys and to stress their importance to the department. If the survey is administered via Qualtrics, then the system can send personalized reminders (only to those who have not completed the survey). For students, the CALCS survey is pre/post, so the survey requires a student identifier to link the two. SPIPS is just given once near the end of the semester. If one wants survey results tied to university data like grades, then student IDs need to be collected in the surveys. Students typically need an incentive to complete the survey(s), such as bonus points, or having the survey worth a

homework or quiz grade. Setting aside time during class to complete the survey typically results in much higher response rates than just emailing students a link to the survey. Given the ALM RAC members' experiences, having the student survey completed during class, and worth a quiz or homework grade yield the highest response rates.

- The WebWork homework system (open-source from the MAA) allows for customization of problems and the "hint" button. UNL problems for college algebra, precalculus, calculus 1 and calculus 2 are all available for sharing. The system can generate useful data for examining student learning.
- It can be very informative and useful to interview students. One can ask a class to nominate one person per group to attend a focus group interview. Students often have good insights into how various instructional approaches and classroom norms affect their interest, engagement and performance in the course.
- Observing courses helps to assess how successfully ALM strategies are being implemented. Also, having an observation protocol (MCOP^2) can help structure a reflective conversation of the observer and instructor after an observation. There is a need for more MCOP^2 training. At UNL, they have adapted the COPUS for a more math and ALM focus, and have been using that to structure observations.
- Sharing and publishing data requires an approved IRB protocol. UNL has an "umbrella" IRB to cover ALM RAC data collection and analyses. If your IRB will defer to UNL's, then you can be added to this protocol to cover your data collection and sharing de-identified data with the RAC.

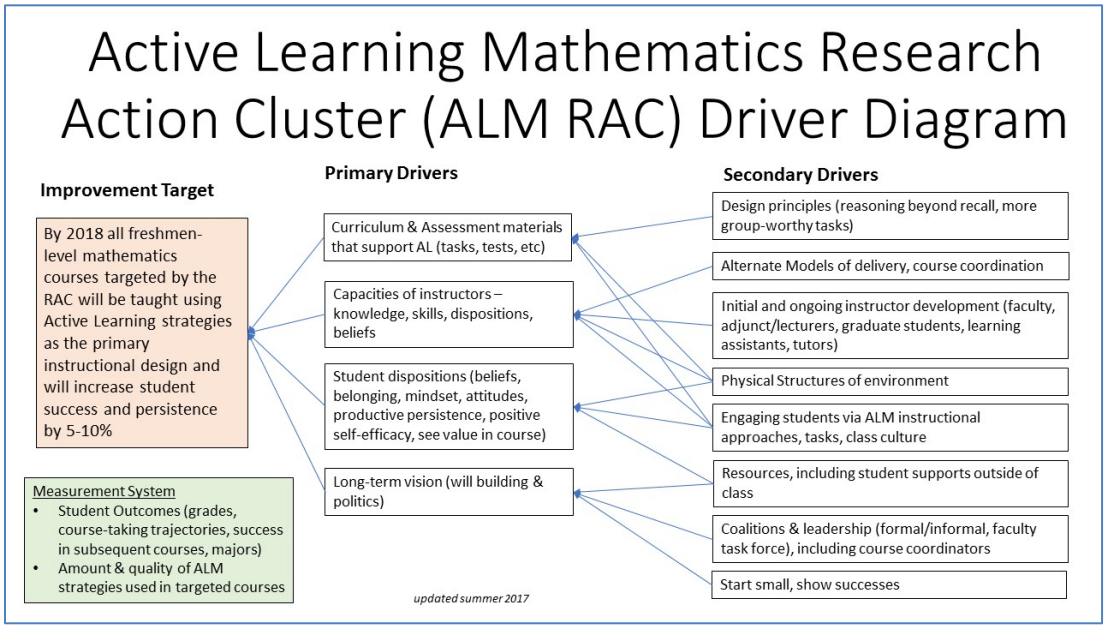

Figure 2. ALM RAC driver diagram, revised Summer 2017.

The ALM RAC work time was also used to discuss course coordination. Two key questions were: where is coordination used and what is common across partner campuses? Related to these two large questions, we discussed whether coordination is a starting point or level for change, or if coordination already exists and so it can be a tool for change. In the absence of course coordination, student success across

sections is typically highly variable; this data can then be a motivating factor for change. A key question in course coordination is: Who is responsible? Who decides a course will be coordinated, and who enforces instructor compliance with coordination? While some course coordination is very loose (e.g., just a common syllabus/homework), other coordinated aspects include: grading scale, grading scheme (weight of components to grades), common exams, common grading/rubrics for common exams, textbook, homework, quizzes, lessons/activities, calculator/technology use and policy. Further, "vertical coordination" can help students to experience coherence throughout the common sequence precalculus → calculus 1 → calculus 2 → calculus 3.

The ALM RAC planning discussion also touched on how to provide extra support for students who are not succeeding in courses. Three main strategies include the supplemental instruction model (CSU Fullerton), an extra recitation (Western Michigan), and individual interventions (UNL). Often, by the second or third week of class, we can identify students most at risk for failing. However, once students have been identified how do we then successfully (re)engage those students? Issues that lead to student failure often extend beyond "the math" to motivation and "life skills" (how to be a college student, time management, etc.)

For the 2017/18 school year, the ALM RAC work will include:

- Monthly meetings of the RAC members, to include some pre-determined topics as well as time for sharing challenges
- Create an annotated roster of RAC membership that includes particular features of each department (such as learning assistants, graduate student training, supplemental instruction, calculus 1 activities, etc.)
- Identifying ways to leverage intersections with SEMINAL project resources and emergent findings
- Recognizing that the SEMINAL Phase II award process may increase the number of RAC partners, articulate ways to manage coordination and communication among existing and new partners going forward
- Implementing common data collection and data analyses.

References

Bressoud, D., Carlson, M. P., Mesa, V., & Rasmussen, C. (2013). The calculus student: Insights from the Mathematical Association of America national study. *International Journal of Mathematical Education in Science & Technology, 44*(5), 685-698.