Transformational Practices to Incorporate Active Learning in Mathematics Courses

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Rebecca Machen (University of Colorado-Boulder)
Welcome to the Webinar! Let’s get to know each other while we wait for the official start.

Please answer the questions below in the “Chat,” located at the bottom of your screen.

Where are you from? and what attracted you to enroll in this webinar?
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❖ By participating, you are agreeing that your contributions become part of the recording
Housekeeping

- Please make sure that you are muted.
- Open the chat by clicking on chat at the bottom of your screen.
- We will have limited time to address questions. Type your question in the chat. We will save the chat and be able to address questions not answered during the webinar at a later date.
- We expect to have approximately 300 attendees in this webinar. Be open to new ideas and kind in their comments to others.
NOTE: The views expressed by the presenters are not necessarily the views of AMATYC. Commercial products mentioned by presenters are not endorsed by AMATYC.
Transformational Practices to Incorporate Active Learning in Mathematics Courses

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1. Visioning: Thinking about N years from now
2. Learning about Change Levers from SEMINAL Phase 1
3. Connecting and Discussing Change Levers to Systems
4. Cultural Change and Resources for Next Steps
• Imagine a situation N years in the future where your department has achieved equitable student outcomes in mathematics, and students are actively engaged in doing mathematics and become proficient at solving mathematical problems. What will this look like? What are the mathematical experiences students will have? How will you know you have equitable outcomes? What changes will need to be leveraged to achieve this vision?
Free Write: What is Your Goal?

In the Chat, click the link to a 1-question Poll and type in a short phrase to capture what your department will look like in the future, when you have equitable and active engagement in mathematics teaching and learning.

(you may submit the poll more than once if you want to submit multiple phrases)
Learning about Change Levers from SEMINAL Phase 1
What is the Problem?

- 95% of students in college math are taking courses at/below Calc 2 (3.2M)
- Average of 25% DFW at R1 institutions in Calculus (often closer to 50%)
- Failing math correlates highly with freshman dropouts
- After freshman year, students switch away from STEM majors (9-25%)
- Beliefs about & attitudes toward mathematics K-20 follow a decreasing trajectory
How Do People Learn?

- Teach others
- Do the math
- Discuss & critique
- Observe demonstration
- Listen
- Read

Amount of Learning

How does this align with how we teach?
What is “Active Learning”? 

Teaching methods and classroom norms that promote:

1. Students’ deep engagement in mathematical reasoning
2. Peer-to-peer interaction
3. Instructor interest in and use of student thinking
4. Instructors’ attention to equitable and inclusive practices

Laursen and Rasmussen (2019)
Undergrads in active learning environments can learn more effectively, resulting in increased achievement and improved dispositions (Freeman et al., 2014; Laursen et al., 2014; Rasmussen & Kwon, 2007), particularly for underrepresented groups (Laursen et al., 2011; Theobald et al., 2020).
How Can We Approach Change?

An n-dimensional problem (n>2) cannot be solved with a 1- or 2-dimensional solution

- Systemic approach needed to address the system that created/perpetuates current problems
- Cultural change is needed for a dept to shift away from lecture as the norm
- Cultural change encompasses **people, power, structures, & beliefs**
Effective Change Process

Assumptions

1. Start by developing a common vision of “success”
2. All relevant stakeholders are involved
3. Change is complex
4. Need “change agents”
5. Mathematical rigor is important
**Goal:** better understand how to enact and support institutional change aimed at implementing active learning in undergraduate mathematics learning environments

**Collaborative Research:**
**NSF I-USE Grant**
- $3 million, 2016-2022
- APLU
- University of Colorado Boulder
- University of Nebraska-Lincoln
- San Diego State University
- **Phase 1:** 6 cases of retrospective change
- **Phase 2:** 9 cases of incentivized change
- **Phase 3:** 12 cases of networked change
- AMS/MAA handbook coming in 2021
## Retrospective, Longitudinal & Ongoing Case Case Studies

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<th>Self-Study</th>
<th>Local Data</th>
<th>Observation</th>
<th>Interviews</th>
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<tr>
<td>Understanding local contexts, data, student supports &amp; histories</td>
<td>P2C2 student demographics</td>
<td>Observe P2C2 courses</td>
<td>Administrators, Department leaders</td>
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<td>Dept Climate &amp; Culture Survey</td>
<td>DFW rates</td>
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<td>P2C2 Coordinators</td>
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<td>Course-taking trajectories</td>
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<td>Faculty Instructors of P2C2</td>
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<td>Placement Retention</td>
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<td>P2C2 Instructor Survey</td>
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<td>Students in P2C2 courses</td>
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<tr>
<td></td>
<td>P2C2 Student Survey</td>
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- **Phase 1 retrospective cases**: 6 site visits - Spring 2017
  - Handbook coming April 2021
- **Phase 2 longitudinal incentivized cases**: 9 sites x 3 site visits 2018-2021
  - PRIMUS special issue online (2020)
- **Phase 3 ongoing case studies**: 12 sites (virtual visits)
<table>
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<th>All-In University</th>
<th>Crossroads University</th>
<th>Critical Response University</th>
<th>Long Term University</th>
<th>Phased Change University</th>
<th>Grassroots University</th>
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</thead>
<tbody>
<tr>
<td>~30,000 undergrads R2-Institution Hispanic Serving Dept Size: 80</td>
<td>~20,000 undergrads R1-Institution Dept Size: 130</td>
<td>~20,000 undergrads R1-Institution Dept Size: 220</td>
<td>~30,000 undergrads R1-Institution Dept Size: 300</td>
<td>~30,000 undergrads R1-Institution Dept Size: 120</td>
<td>~20,000 undergrads R3-Institution Dept Size: 70</td>
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- Department chair and Task Force created a detailed plan that went “all in” on implementing AL and tightening coordination
- Instead of continuing Emporium Model, department chair and Task Force created decided to move towards implementing AL
- In response to a crisis of bad grades and little coordination, a Task Force pushed a plan for implementing AL and coordination
- Having changes of AL and coordination in place for multiple decades; started from student complaints
- A couple of department leaders pushed using active learning projects in Calc 1, which lead to more coordination and expansion
- Using AL in this department is solely from individual faculty members choosing to, some were hired for this reason
Seeing the System

Institution

Department

Classroom

Instructors

Students
SEMINAL hypothesis
Critical features of transformed institutions:

✔ Institutional & community identities
✔ Campus culture with respect to teaching
✔ Effective leadership (opportunistic)
✔ Willingness to pay the costs of improved instruction
✔ Coordination of multi-section courses
✔ Sufficient support for enacting new pedagogies
✔ Flexibility
✔ Plan for succession/enculturation of people
SEMINAL Phase 2 - Local Change Strategies

- Initiate & expand course coordination (including assessments)
- Hiring (course coordinators, learning assistants; instructors)
- Instructor professional development
- Local data & course placement
- Active learning tasks & materials
- Culturally responsive teaching
- Planning for sustainability
Improve Student Outcomes

Levers for Change

- Use Data
- Leadership
- Active Learning
- Instructional Materials
- Coordination
- Professional Development
- Instructor Community of Practice
- Learning Assistants
- Learning Environment

Involvement of:
- Campus administrators for undergraduate education (provost & dean levels)
- Chair & Vice Chair
- Faculty Task Force
- Course Coordinators
- Math Ed Researchers
- Instructors (faculty, adjunct, grad)
- Learning Assistants
- Students
- Access to university data system (student demographics, major, retention, graduation)
- Attendance (class, Learning Center)
- DFW rates & enrollment
- Course-taking trajectories (subsequent grades)
- Student surveys (beliefs, perceptions)
- Focus group interviews (students, instructors)
- Instructor survey, interviews
- Observation (coordinators, peers)
- Assessments (homework, exams, item-level)
- Department culture, instructor networks
Use Data

- Access to university data system (student demographics, major, retention, graduation)

Use Data Takeaways

Analysis of local data can be a “structure” departments use to motivate, support, and sustain improvement efforts. For some departments, it became a way to protect the undoing of important improvement efforts.

- Instructor survey, interviews
- Observation (coordinators, peers)
- Assessments (homework, exams, item-level)
- Department culture, instructor networks
• Dept chair committed to efforts
• Faculty committee to drive and sustain reforms
• Align to university efforts
  • Freshman retention; graduation rates
  • Campus administrators’ priorities
• Coordinators
  • Semi-permanent
• Plan for sustainability
• Plan for turnover & bringing new people on board
Leadership

• Dept chair committed to efforts
• Faculty committee to drive and sustain

Leadership Takeaways
Department leaders can play a significant and continuing role in implementing any substantial changes. As a middle manager, the chair should expect to negotiate with administrators and work with faculty and graduate student instructors to enact changes. Committees had respected department members which led to trust and authority from the rest of the department.

• Plan for sustainability
• Plan for turnover & bringing new people on board
Active Learning

In most classes

• Group work for majority of time
• Class time focuses on application problems
• Mini-lectures for 5-10 min as needed
• Instructor (+ Learning Assistant)

In large lectures

• Clicker questions to prompt discussions
Active Learning

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- Clicker questions to prompt discussions

Active Learning Takeaways
These were the most common forms of active learning within and across the departments. Departments should anticipate setbacks when trying new active learning strategies. Recruiting and supporting “champions” of active learning were crucial for implementation. Giving instructors opportunities to discuss the teaching and learning behind these active learning strategies was essential to create a common vision.
“We run into problems that individually we would probably get stuck on, but instead of working it out of the books ourselves or trying to get lined up with the professor, we can group together and try and get it done. We’ve even gone as far as get together to get the homework done and branching out into other problems and not just the team quiz.”

- Precalculus Student

“I love my group”
“We’re teaching our groups, like to the people who don’t understand it.”
–Calculus students
Instructional Materials

- **Common course activities**
  - Worksheets
  - Course Packets
- **Assessment**
  - Homework
  - Quizzes
  - Exams/Midterms
- **Textbook/OER**
- **Messaging to students & instructors**
• **Common course activities**

  **Worksheets**

  **Instructional Materials Takeaways**

  A lot of well designed instructional materials are already available (e.g. online). Local adaptation of well-designed material resources can help increase student and instructor buy-in for active learning by allowing instructors to focus more of their energy on modifying and implementing active learning strategies in the classroom, rather than attempting to implement active learning with resources that were not designed for that purpose.
Coordination

- Syllabus
- Textbook (OER)
- Shared Lesson Plans/Resources
- Course Packets/Worksheets
- Homework (e.g., WeBWoRK)
- Exams (Midterms & Final)
  - Common Grading (e.g., Grade Scope, Crowdmark)
- Weekly instructor meetings
  - Begin prior to semester
  - Anticipating student misconceptions
Coordination

- Syllabus
- Textbook (OER)

Coordination Takeaways
Coordination systems have two main goals: building a supportive network and community among instructors and ensuring that students have a fair and high-quality learning experience. It is essential that a coordination system has and does all of these things (and not just some of them) to accomplish both of these goals.

- Begin prior to semester
- Anticipating student misconceptions
• Pre-Semester
• Weekly
  • Instructor meetings
• Dept Teaching Seminar
  • Faculty & grad students
• Travel to workshops (IBL)
• Pedagogy Course for GSI/LA
Professional Development Takeaways

Ongoing professional development is needed to help teachers implement new teaching techniques. This professional development needs to be adapted to specific needs and constraints of the department. Sustainability of this PD requires a shared responsibility among faculty members.
“While it may be tempting to simply authoritatively state the correct order in which to perform horizontal transformations, doing so effectively removes ownership of knowledge from students, and encourages them to view mathematics as a set of arbitrary rules to be applied blindly. By removing ownership from students, we ultimately discourage students from building their own base of knowledge surrounding the topic.”

--Precalculus Instructor
Instructor Community of Practice

- **Textbook**
- **Common Lesson Plans**
  contribute revisions, worked examples
- **Weekly instructor meetings**
- **Advice networks for teaching and learning**
Instructor Community of Practice

• **Textbook**

**Instructor Community of Practice Takeaways**

Providing shared opportunities (e.g., regular course meetings, classroom observations, professional development) for instructors to discuss the teaching and learning of mathematics was shown to be a critical factor in helping departments develop a shared vision and understanding of active learning.
Learning Assistants

- Support group work
- Training in supporting active learning
- Meet with instructors weekly
  - Reflect after class
- Recruited from math majors & ‘A’ students in courses with learning assistants
• Support group work

Learning Assistants Takeaways
Learning Assistants can be helpful in implementing and sustaining active learning, but they need to be supported in learning how to support this type of teaching and learning.
Learning Environment

- Dedicated, renovated classrooms
  - Tables & chairs
  - Whiteboards all around
- More time (50 - 75 min)
Learning Environment

• Dedicated, renovated classrooms
  • Tables & chairs
  • Whiteboards all around

Learning Environment Takeaways
Classrooms designed to facilitate group work were really helpful in implementing active learning by 1) setting up an environment for better student engagement and 2) shows commitment by the department and university.
Connecting and Discussing Change Levers to Systems
Poll: Which of these key takeaways/change levers would you want to work on first/next?

Poll: https://ssp.qualtrics.com/jfe/form/SV_9MkdjbUR3ITWHoG
Revisiting Different Systems

Effective Change Process (HOW change can happen)
- Decide goal
- Decide next steps
- Do plan & measure impact
- Plan strategies & measures
- Understand system

System of Stakeholders (WHO is involved)
- Institution
- Department
- Classroom
- Instructors
Leadership Takeaways
Department leaders can play a significant and continuing role in implementing any substantial changes. As a middle manager, the chair should expect to negotiate with administrators and work with faculty and graduate student instructors to enact changes. Committees had respected department members which led to trust and authority from the rest of the department.
Crossroads University

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**Coordination Takeaways**

Coordination systems have two main goals: building a supportive network and community among instructors and ensuring that students have a fair and high-quality learning experience. It is essential that a coordination system has and does all of these things (and not just some of them) to accomplish both of these goals.
Where are YOU in the change process?

Which Key Takeaway/change levers would you want to work on first/next?

WHO in the system is important? HOW would this change lever move through the change process? WHAT has to happen for this change to be successful in your context?

If your department is into the change process: What’s your change story? Which Key Takeaway/change lever was important and WHO and HOW did it move through the change process?
Cultural Change and Resources for Next Steps
Cultural Change

An organization’s strategy is determined by culture.

- Organizations have a historical context.
- Culture reflects biases and the theories of the founders, leaders, and current members.
Cultural Change

Schien’s suggestions to cultivate change:

1. Document departmental beliefs from the policies employed by the department, mission statement, pedagogical practices, etc.
2. Confirm the documented beliefs by conferring with the leadership team in the department, various colleagues, staff, and undergraduate/graduate students.
3. Create a committee or group with influence in the department that can speak with the stakeholders on the intended/future goals to transform (department chair, tenured faculty, instructor groups, graduate students etc.).
https://www.tandfonline.com/toc/upri20/31/3-5?nav=tocList
Accelerating Systemic Change Networks (ASCN) information on transforming institutions

ASCN Change Dashboard
https://ascnhighered.org/ASCN/change_dashboard/index.html

https://ascnhighered.org/ASCN/publications.html
Useful Resources

Practical plan for starting changes (checklists, inventories)

Useful Resources

Chapter 6 focuses on active learning, including curriculum resources and starting implementation

Teaching for Prowess
--Project focused on 2-year colleges and active learning
https://teachingforprowess.wordpress.com/

http://www.mtep.info/monograph
Opportunities for Continued Engagement

• Accelerating Systemic Change Network
  • https://ascnhighered.org/index.html

• Online communities
  • COMMIT Network https://www.comathinquiry.org/
  • MAA CONNECT https://connect.maa.org/home
  • AMATYC Communities https://my.amatyc.org/communities/allcommunities

• MSRI CIME 2021 (2022)
  • full in-person CIME March 16-18, 2022
    https://www.msri.org/workshops/1001
Questions?

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McGraw-Hill Higher Education is proud to support the 2021 AMATYC Webinar Series
Upcoming 4th National Mathematics Summit
June 14 & 15, 2021

Planning Leadership Team
Annette Cook, Paul Nolting, Julie Phelps and Nancy Sattler

Steering Committee
Christina Cobb and Denise Lujan (NOSS)
Rochelle Beatty, Kathryn Van Wagoner, and Laura Watkins (AMATYC)
Connie Richardson and Paula Talley (Charles A. Dana Center)
Ann Edwards (Carnegie Math Pathways/WestEd)
April Strom (MAA)
The 4th National Mathematics Summit begins at 1:00 p.m. on Monday, June 14th, and features keynote speaker, Jenna Carpenter, concurrent sessions, and more. The program will conclude Tuesday, June 15th at 5:00 p.m. This is a pre-conference to the NOSS 2021 conference and requires separate registration (https://thenoss.org/Math-Summit/)

The Math Summit is sponsored by AMATYC, NOSS, and Paul Nolting. Supporting partners include: Charles A. Dana Center, Carnegie Math Pathways/WestEd, and the MAA.
Questions??