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Teaching Mathematics Education Online: Instructional Theories, Strategies, and Technologies

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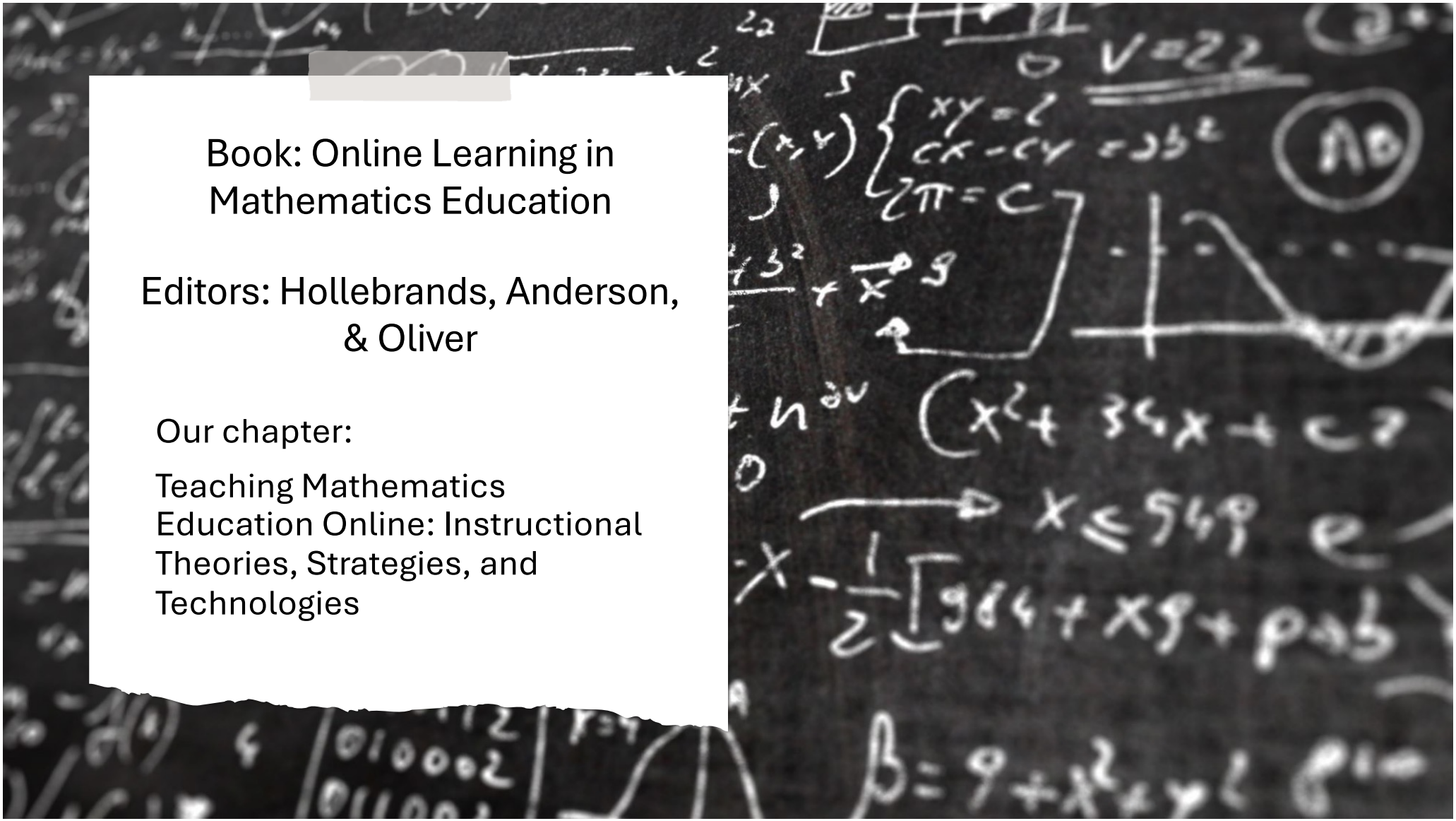


Book: Online Learning in Mathematics Education

Editors: Hollebrands, Anderson, & Oliver

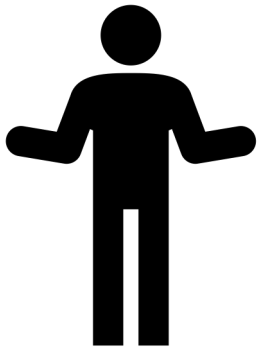
Our chapter:

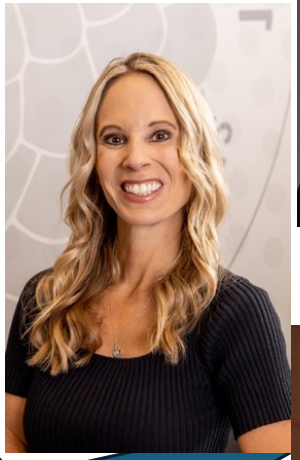
Teaching Mathematics Education Online: Instructional Theories, Strategies, and Technologies

Teaching Mathematics Education Online

- Broad orientation to:
  - Types of online learning environments
  - Learning theories to help steer course design
  - Strategies for engagement through popular online technologies
  - Applying theories through teaching strategies and online tools - examples

You can’t teach math online





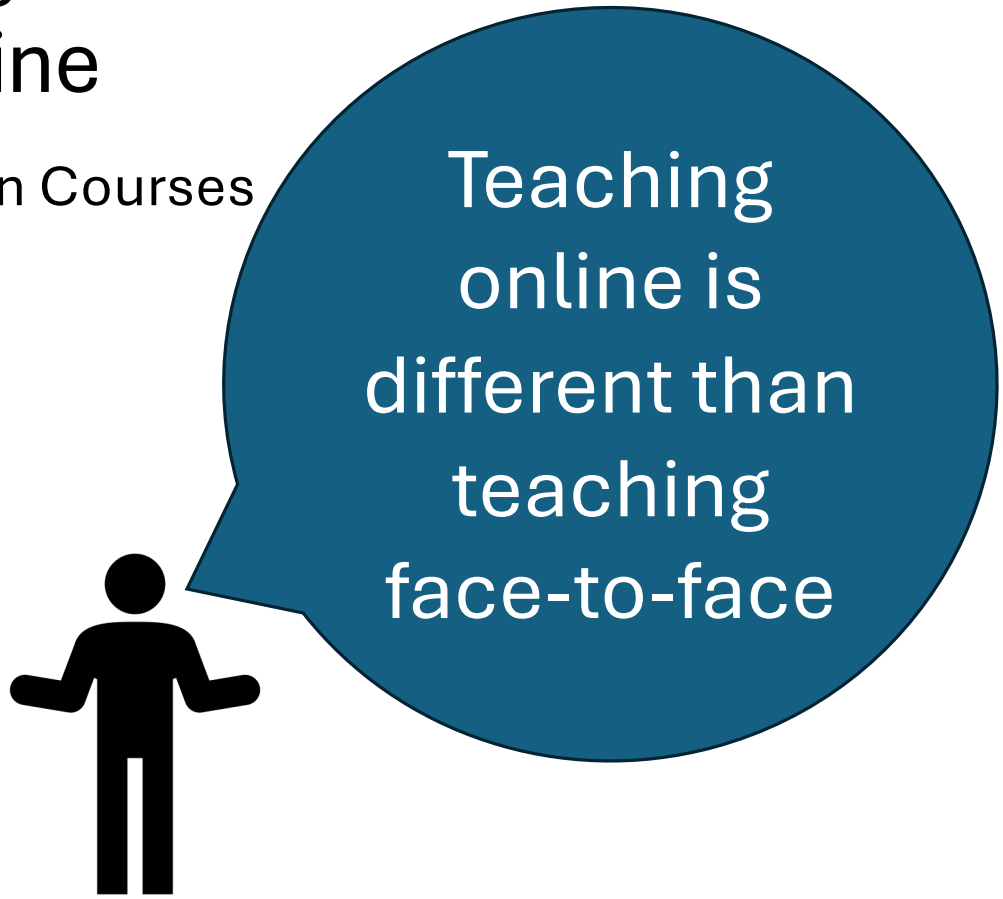
Yes, you can!

Challenges to teaching mathematics education courses online

- Types of Mathematics Education Courses
  - Mathematics Content Courses
  - Mathematics Methods Courses

Working within confines

- Lack of control over format
  - Environment
  - Class size
  - Meeting times/frequencies
  - Learning Platform (LMS)



Strategies for teaching mathematics education courses online

- Identify the online learning environment
  - Asynchronous
  - Synchronous
  - Bichronous
  - HyFlex

Table 1.1 Course classification of online and blended courses

Course classification	Description
Asynchronous online learning	A course where most of the content is delivered online and students can participate in the online course from anywhere and anytime. There are no real-time online or face-to-face meetings
Synchronous online learning	A course where most of the content is delivered online and students can participate in courses from anywhere. There are real-time online meetings, and students log in from anywhere but at the same time to participate in the course
Bichronous (Martin et al. 2020)	The blending of both asynchronous and synchronous online learning, where students can participate in any time, anywhere learning during the asynchronous parts of the course but then participate in real-time activities for the synchronous sessions
HyFlex	HyFlex is designed as a model where the student is given the option to either attend in campus or online. https://edtechbooks.org/hyflex

Adapted from Martin and Oyarzun (2017) and Martin et al. (2020)

Modeling Pedagogy

Ask Yourself:

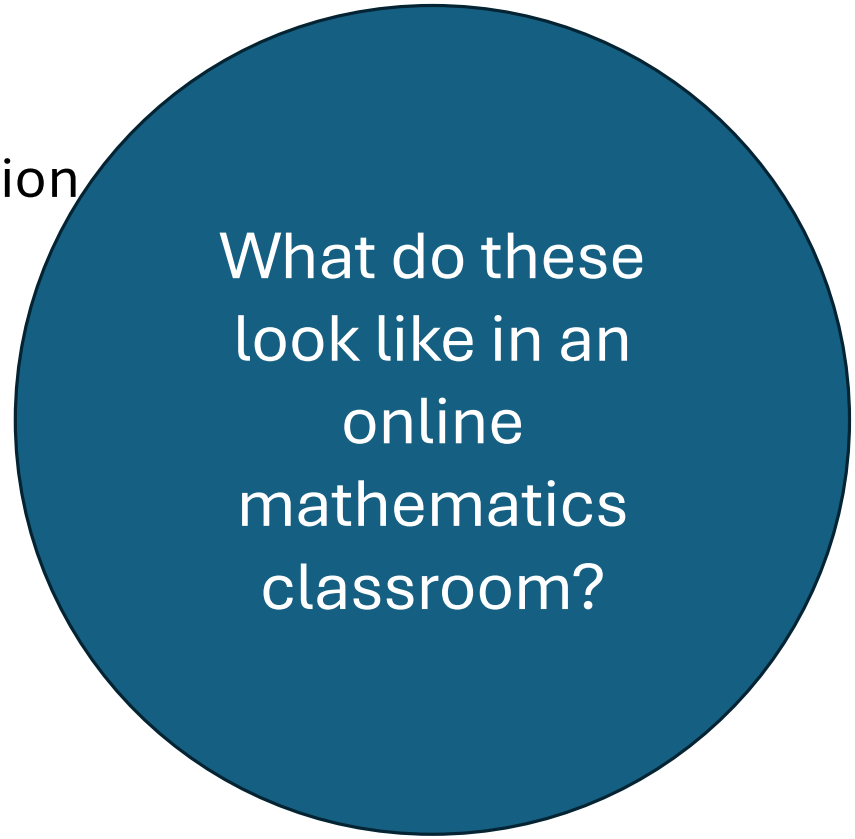
What learning behaviors and outcomes are intended for the course?

Is the goal to have students working together to solve problems?

Should students try a problem first individually and then as a team?

Let Instructional Theories, not Technology, Guide Instruction

- Cognitive Apprenticeship
- Individualized / Personalized Instruction
- Social Learning
  - Social Constructivism
  - Situated Cognition
  - Activity Theory
  - Situated Learning
  - Authentic Practice
  - Zone of Proximal Development



Cognitive Apprenticeship

Cognitive apprenticeship allows a learner to observe processes or methods used by an expert to learn an activity. Cognitive apprenticeship differs from traditional apprenticeship in that the activity being learned is less about a physical skill and more about a cognitive skill.

York, 2013

Cognitive Apprenticeship

- Traditionally an instructor typically might complete example problems while students take notes. Then, students would show they can complete similar problems by completing assessments (e.g., traditional homework, quizzes, or exams)

- In an online environment, the online mathematics instructor can work out problems on a virtual whiteboard or have pre-worked out problems on a PowerPoint or video, describing the process as the steps appear to the students. Students can then ask follow up questions before being assessed.

Individualized / Personalized Instruction

Social Learning

- Various learning theories argue that learning is a social process.
- This leads teachers to put learners in groups and in authentic situations to learn from both the situation and from others.
- These theories have led educators to place an increased emphasis on developing a learning community in the classroom.

Approaches to Group Responsibilities

Table 1.2 Approaches to group responsibilities

Collaborative approach	Each member of the group becomes involved with the decisions of the group and volunteers to assume responsibility for tasks or activities
Group task approach	Each member of the group is assigned a task within the group's structure. Tasks are assigned based on the member's skills or knowledge. An attempt is made to equalize the task responsibilities
Group role approach	Each member of the group is assigned a role (e.g., facilitator, recorder). The responsibilities of each role define the tasks or jobs to be done within the group. For each assignment or task, the individual's role will define the way in which that person will complete the job
Role assignment	The group determines what roles or responsibilities are necessary to complete the task or assignment. Once the roles have been defined, members can volunteer or be assigned to a role. Other ways to assign members to roles is by random drawing or voting

Smaldino, 2007

Grouping Students Online

- Cooperative Learning (Groupthink)
- Providing Choices
- Keep groups small (3-4 students)
- Breakout Rooms
- Groups feature (LMS specific)

Social Learning continued

- Zone of Proximal Development (Vygotsky, 1978)
- Combines both individual learning abilities with the social aspect by boosting the student to reach the outer edges of what they can learn on their own along with what a peer/instructor can help them learn through scaffolding
- Modeling successful behavior
- Grouping students – ill-structured problem, something they can't solve on their own

Inquiry-Based / Problem-Based Mathematics Education

Four pillars of inquiry-based mathematics education:

- Students engage deeply with coherent and meaningful mathematical tasks.
- Students collaboratively process mathematical ideas.
- Instructors inquire into student thinking.
- Instructors foster equity in their design and facilitation choices (Laursen and Rasmussen 2019, p. 138).

Leveraging Technology Interventions

Content-Specific

- Desmos
- Geogebra
- Mathematics Applets
- Pattern Block Applets
- PhET

Content-Neutral

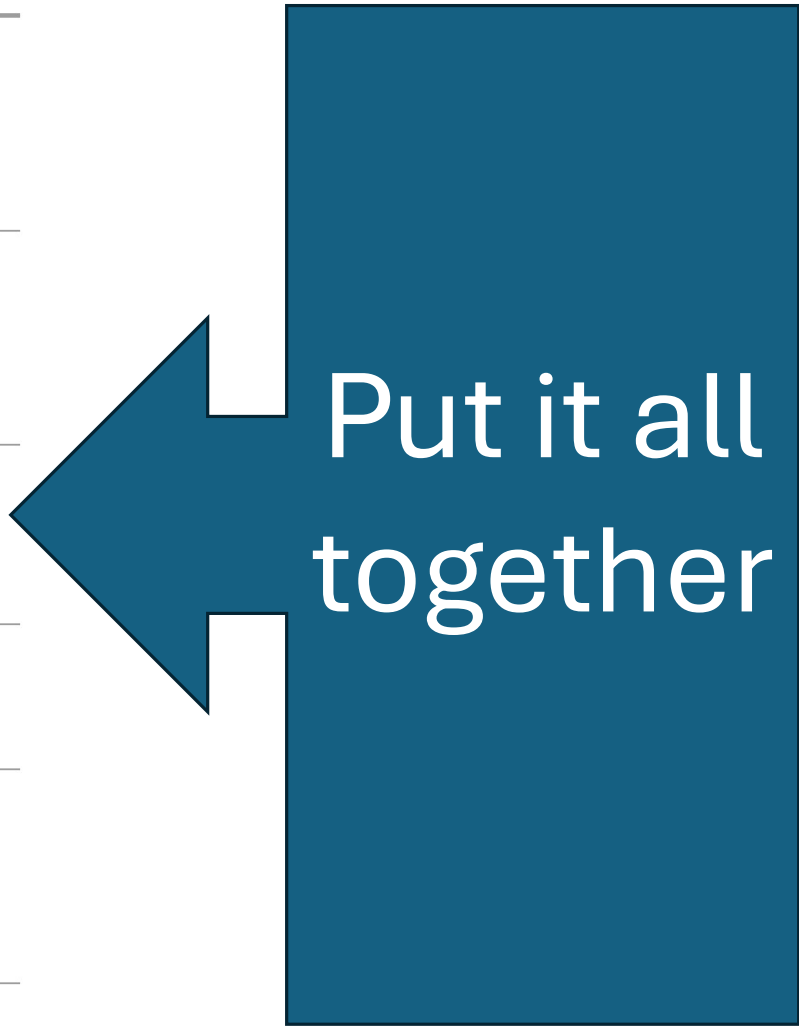
- Online Whiteboards
- Communication Tools
- Collaboration Tools
- Breakout Rooms
- Graphic Organizers

Instructional Strategies

- Case Study Discussions
- Think/Pair/Share
- Presentation Tools
- Traditional Activities that Translate Easily Online

Table 1.3 Theories, strategies, and technologies

Theory	Strategies (application of theory)	Technologies
Community of practice Social cognition Situated cognition	Collaborative learning Group work Interaction Think/pair/share Cooperative learning	Discussion board Chat room Audio/video conference Breakout rooms Share screen
Authentic activity/practice, situated learning	Learning by doing Authentic activity Practice teaching using active learning strategies Practice integrating technology into teaching	Share screen Co-host option
Individualized instruction	Individualized instruction Differentiated learning Jigsaw Individualized group projects	Videos Online worksheets Online quizzes Online/web-based homework
Cognitive apprenticeship	Direct instruction Advance organizer Presentations Lecture	Whiteboard Presentation software
Inquiry-oriented learning (active learning)	Inquiry-based learning Socratic questioning Scaffolding productive struggle, learning from failure, and perseverance Hands-on, minds-on	Audio/video conference Student presentations Group work-breakout rooms
Problem-based learning	Discovery learning Problem-based learning	Virtual/augmented reality



Don’t forget to consider:

- Equity
- Accessibility
- Diversity
- Inclusion

Any Questions?

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