Multimedia Educative Curriculum Materials:

Supporting (and assessing) teachers' PCK of scientific argumentation

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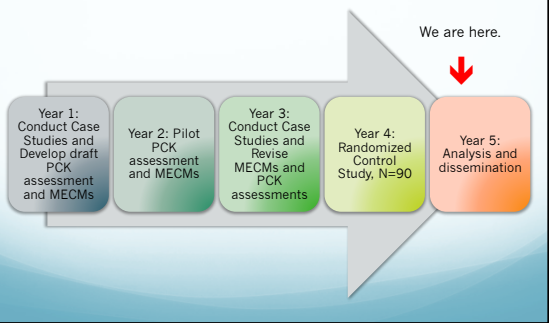
DRL-1119584

Agenda

- Why multimedia educative curriculum materials (MECMs)?
  - Theoretical background
  - Results · Year 1 – Case studies
  - Results · Year 3 – Case studies
- What do the MECMs look like?
  - MECM Design Principles
  - Example videos
  - Example interactive reflections
- Can the MECMs be separated from the curriculum?
  - Explore Argumentation Toolkit website
- How did the teachers use the curriculum?
  - Results – Year 4 – Teacher Use data
  - Results (in progress) – Year 4 – PCK assessment

Powerpoint – www.katherinelmcneill.com (click on Presentations)

MECM Project Timeline



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Why multimedia **educative** curriculum materials (MECMs)?

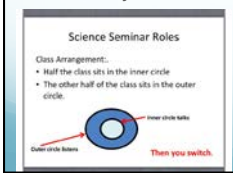
- Recent reform documents (NRC, 2012) and standards (NGSS Lead States, 2013) advocate for a new vision of proficiency in science in which students engage in science practices (Osborne, 2014).
- Teachers can lack depth of knowledge needed to integrate science practices into classroom instruction (Pruitt, 2014) and can have different views of what counts as argumentation (McNeill & Knight, 2013).
- Educative (i.e. support teacher learning) curriculum materials offer one potential avenue for supporting students in science practices (Davis & Krajcik, 2005; Davis, et. al, 2014).

Why **multimedia** educative curriculum materials (MECMs)?

- Alozie and her colleagues argue that "...the complexity of dialogic, inquiry discussions makes them difficult to capture and scaffold in print-based curriculum materials alone" (p. 417, 2010).
- Multimedia cases grounded in real life situations can support teacher learning by offering a rich and multi-layered image of classroom teaching (van den Berg, Wallace & Pedretti, 2008).
- Linking video cases specifically to a teacher's curriculum can help support the development of pedagogical content knowledge as the educative supports are situated in their own practice (Roth, et al., 2011).

Year 1 Cases (no MECMs): The Science Seminar

- Student-driven evidence-based discussion focused on a science question like, "How will the Indian Plate be different in 50 million years?"



Purpose of a Science Seminar

Goal: To work together to build shared understanding about a question, and consider what is the best argument to answer that question.

Students run the conversation:
- Use evidence.
- Listen to one another.
- Respond to one another.
- Agree/disagree, giving reasons why.

Regents of the University of California, 2012

Two different enactments: Ms. Richardson

- Ms. Richardson: ok. Marcus.
- Marcus: Um, I disagree with Ian and Jose. I see what they are saying. Um. Ian's theory it is still going to the Eurasian plate, because that entire area is still the Eurasian plate.
- Tony: But it's also colliding with the – what plate is that?
- *Several students go over to point to map Tony is holding.*
- Ms. Richardson: So you're talking about the countries of South Asia and Indonesia. You're saying that forms a different plate?
- Tony: Yeah. And it is also colliding with the Indian plate.
- Ian: Well, I (inaudible) cause – yes it is going to collide, but right here there's many – there's lots of spreading zone. It is going to get lots of crust – lots of new crust to make the plate bigger
- Eduardo: It is also a subduction zone.
- Ian: Yeah, but look – the subduction zone has like ¼ of the subduction zone and like 1, 2, 3, 4, 5, 6, 7, 8 – eight spreading zone
- Eduardo: But it is really small.
- Ian: Yeah but they have 8 that's ¼.
- Ms. Richardson: Is there anybody else who would like to join in the conversation with agreeing or disagreeing with um - the ideas that have been presented, or providing more evidence or new evidence? Bill?

McNeill, Gonzalez-Howard, Katsh-Singer, Price & Loper, 2013

Two different enactments: Ms. Brennan

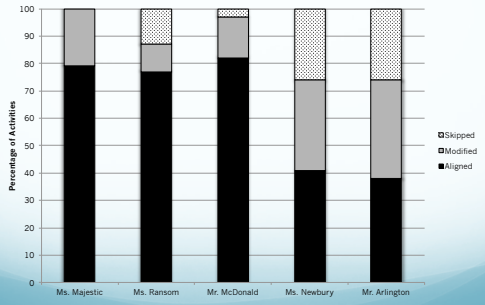
- Ms. Brennan: Elena why don't you come on up. Ok. And you guys be attentive. Guys this is a little bit different than a presentation where someone – this is, this is um a give and take where you are going to be um listening. The inner circle as well is going to be able to – um as they come up – when they come up they will give their evidence for their part, but we can't clap between speakers. Your engaged and listening. It is like as if you were a grown-up and you were going to a workshop. That is exactly what it is like. Ok. Elena.
- Elena: Well, I thought that the um Indian plate would get bigger over 50 million year period because of spreading zones which could easily spread the plates apart and make them wider.
- Ms. Brennan: Ok. Alright. (Elena sits down). Ok. I am going to need um – why don't you go ahead. Once this starts, why don't you come on up. Jordan why don't you come next. (Jordan stands up). And I am just going to move this right over here so you guys can go in and out (Teacher moves iPad). Ok.
- Jordan: I thought that um that the Himalayans would get taller, because when the plates like started crashing into each other – this one is going in this direction (Jordan points to the map) and it should make it bigger.
- Ms. Brennan: Ok. (Jordan sits down). Thank you very much. Another person. Come on up.

McNeill, Gonzalez-Howard, Katsh-Singer, Price & Loper, 2013

Factors Impacting Ms. Brennan's Instruction

- Curriculum User – Closely Follow
  - "the way that lesson is set up again, I so much appreciate getting that, you know you can practice it, but you can also walk through it and it stays with you, you know even to the point of "say this" in the textbox, you know that just was real helpful."
- Prior Teaching Experiences – Teacher Centered
  - I usually, usually, usually I have them, depending on the class and what we're doing, there's floor outlets for example, so if we're using anything with electricity, the configuration changes, but usually, they are more geared toward people all facing the front of the room, and you know, which is more like - not like a lecture hall necessarily, but they wouldn't necessarily be moved for group work.

Year 3 Cases (draft MECMs):
Fidelity to Procedure



McNeill, Marco-Bujosa, Gonzalez-Howard, & Loper, NARST 2016

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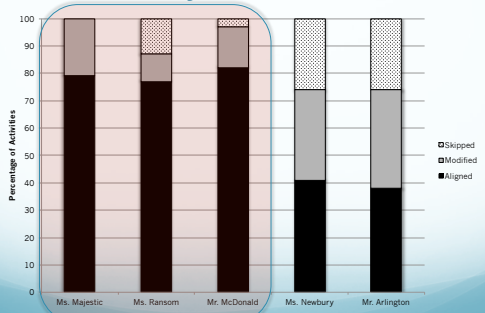
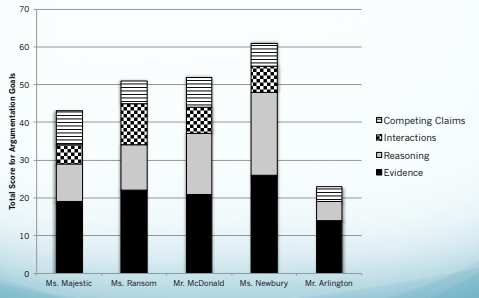


McNeill, Marco-Bujosa, Gonzalez-Howard, & Loper, NARST 2016

Year 3 Cases (draft MECMs): Fidelity to Goal



McNeill, Marco-Bujosa, Gonzalez-Howard, & Loper, NARST 2016

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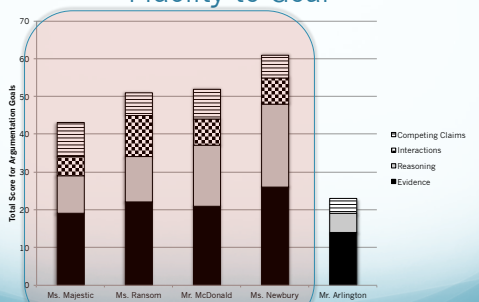

McNeill, Marco-Bujosa, Gonzalez-Howard, & Loper, NARST 2016

Why multimedia educative curriculum materials (MECMs)?

- Year 1 Cases.
  - Teacher Challenges
    - Some teachers oversimplified the structural elements of argumentation (i.e. evidence and reasoning)
    - Some teachers' classroom discourse followed more traditional teacher-led patterns.
- Year 3 Cases
  - Need to focus on the underlying goals of argumentation
  - Need information about teacher use of the curriculum
    - Highlighted the need to collect survey and backend data of teacher use of the curriculum.
    - Backend data is an affordance of multimedia curriculum, which you can not gather from text based.

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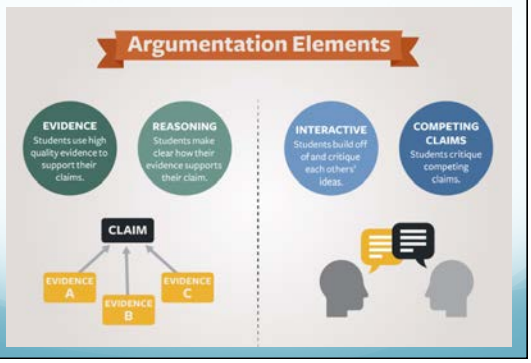
MECM Design Principles

1. Target **challenge areas** in enacting curriculum focused on scientific argumentation (Alozie, Moje & Krajcik, 2010; McNeill & Knight, 2013; McNeill et al., 2013; McNeill et al., 2016)
2. Use **multimedia representations of practice** that illustrate scientific argumentation in real classrooms (Lieberman & Mace, 2010; van den Berg, Wallace & Pedretti, 2008)
3. Support **active learning** by encouraging teacher reflection and connections (U.S. Department of Education, 2009; Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009)

Four Conceptions (McNeill et al., in press)

	Conception	Title
Structure	Conception 1A: Evidence	Teachers evaluate and support students' use of high-quality evidence to justify their claims.
	Conception 1B: Reasoning	Teachers evaluate and support students' use of scientific ideas or principles to explain the link between the evidence and their claim.
Dialogic Interactions	Conception 2A: Student Interactions	Teachers evaluate and support students in building off of and critiquing each others' ideas.
	Conception 2B: Competing Claims	Teachers evaluate and support students in critiquing competing claims.

Four Conceptions (McNeill et al., in press)



MECM Curricular Elements

Embedded within 3 middle school earth science units (62 lessons) educative supports targeting scientific argumentation:

- 28 Videos
- 24 Interactive Reflection
- 3 podcasts
- 4 Slideshows
- 21 Right hand notes (i.e. text boxes)
- 4 Graphics
- 7 Student Work Examples
- 1 Rubric
- 1 Argumentation article

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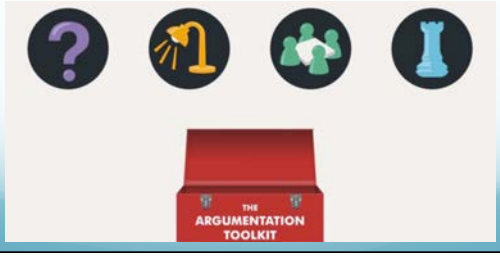
1. Target **challenge areas**
2. Use **multimedia representations of practice**
3. Support **active learning**

4 Video Categories Embedded in Lessons

3	6	5	10
Rationale	Approach	Activities	Strategies



Toolkit Video Category Overviews

Rationale **VIDEO**
Conveys a rationale for argumentation including to enhance deeper learning for all students, to provide connections to science, and to alignment with NGSS.

Approach **VIDEO**
Introduces 4 conceptions of argumentation and common student challenges associated with them.

Activity **VIDEO**
Explains the main argumentation activities step by step. Provides teachers with an authentic view of students doing the activity in the classroom.

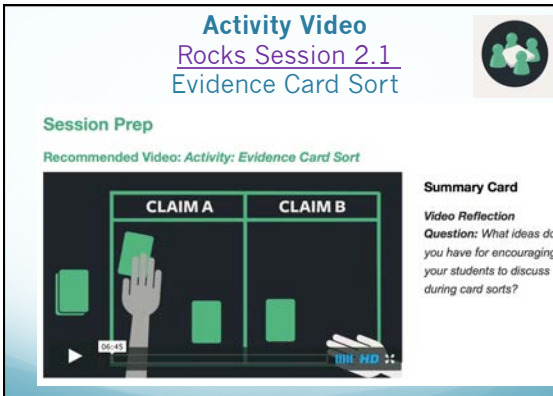
Strategy **VIDEO**
Provides deeper dives into student interactions and teacher moves around specific argumentation activities and addresses challenges.

Long **VIDEOs**
Include long unedited video recordings of student interactions that highlight different aspects of argumentation.

Approach Video
Rocks Introduction
Argumentation Toolkit Overview

Rationale Video
Rocks Session 1.3
Argumentation as Part of Science

Activity Video
Rocks Session 2.1
Evidence Card Sort



Strategy Video
Rocks Session 2.10
Stepping Back During Science Seminars

Recommended Video: *Strategy: Stepping Back During Science Seminars*

Summary Card

Video Reflection Question: *How difficult will it be for you to step back?*

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VIDEOs
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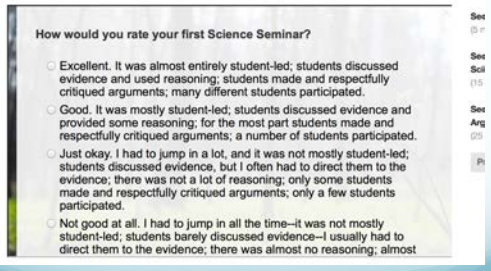
Interactive Reflection – Text
Rocks Session 2.11

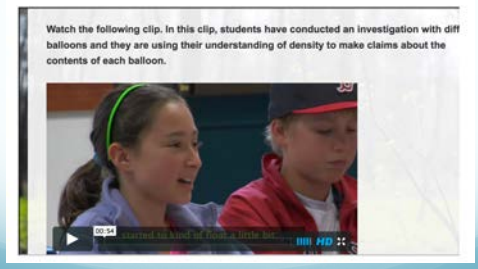


How would you rate your first Science Seminar?

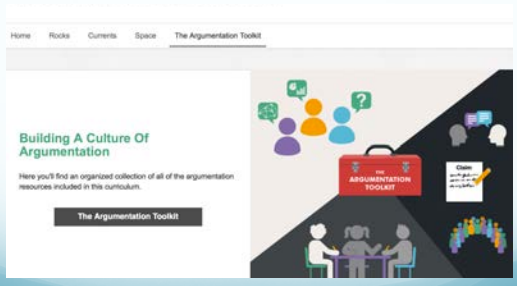
- Excellent. It was almost entirely student-led; students discussed evidence and used reasoning; students made and respectfully critiqued arguments; many different students participated.
- Good. It was mostly student-led; students discussed evidence and provided some reasoning; for the most part students made and respectfully critiqued arguments; a number of students participated.
- Just okay. I had to jump in a lot, and it was not mostly student-led; students discussed evidence, but I often had to direct them to the evidence; there was not a lot of reasoning; only some students made and respectfully critiqued arguments; only a few students participated.
- Not good at all. I had to jump in all the time--it was not mostly student-led; students barely discussed evidence--I usually had to direct them to the evidence; there was almost no reasoning; almost

Interactive Reflection – Analyze Video

Currents Session 1.6



Argumentation Toolkit



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Argumentation Toolkit

- Explore Argumentation Toolkit website - www.argumentationtoolkit.org
- This is a DRAFT website that is a library of the majority of the MECMs from the curriculum.
  - We removed some resources that were specific to the curriculum – 1 video, podcasts, interactive reflections, diagram of the activities within each unit
  - We are revising it for a "teacher educator" audience – for PD and maybe preservice classes
- Questions to Consider
  - Can the MECMs be separated from the curriculum and still be productive?
  - What resources are more productive? Less productive? Why?

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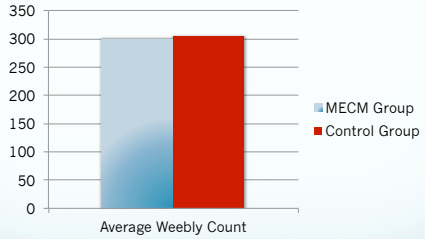
Research Design

Randomized Control Study 2014-15 (n=90)

- All teachers received a digital teacher's guide and all student materials
- Block randomization based on – school type, school location, teachers' years teaching & teachers' highest level of science education. Clustering by school district.
- Treatment teachers received additional MECMs (videos, interactive elements)
- Data Collection
  - Pre- and post-assessment of PCK for argumentation and beliefs about argumentation
  - Lesson surveys and post surveys about teacher use
  - Back-end data collection on teachers' use of digital curriculum and access of videos.

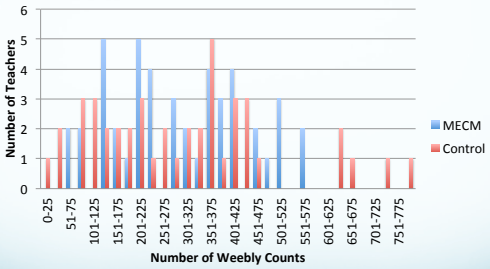
Page Views Across Groups



MECM (n = 46):
Average count ~ 299
Range: 62 to 576

Control (n = 44):
Average count ~ 304
Range: 14 to 799

Page Views Across Groups



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Average count ~ 304
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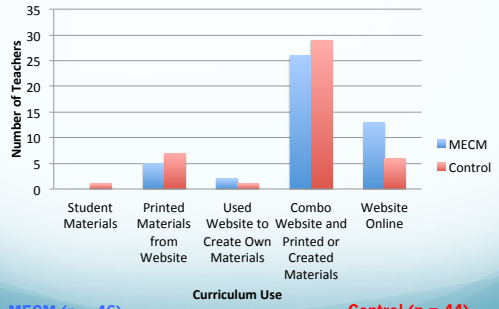
Post Survey Item

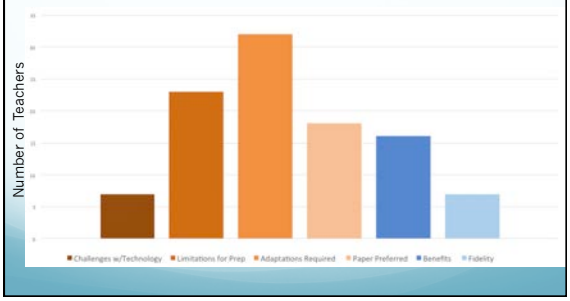
- Which was the most common way you used the Earth Science Curriculum?
  a. Predominantly used only the student materials
  b. Printed the materials from the weebly.com website
  c. Used the weebly.com website to create my own materials (e.g. PowerPoint or lesson plan)
  d. Combination of used the weebly.com website online AND materials I printed or created
  e. Predominately used the weebly.com website online
- Why did you use the curriculum in this way?

Which was the most common way you used the Curriculum?

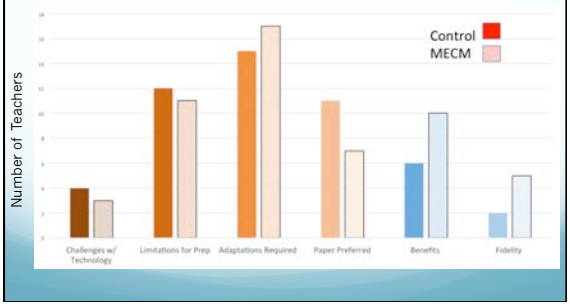


MECM (n = 46) Control (n = 44)

Why did you use the curriculum in this way? (n = 90)



Why? Control vs. MECM



Why did you use the curriculum in this way?

- Adaptations Required
  - "I wanted to have a variety of materials to help students of different learning style. I also like to find new and interesting materials to add to my resources," (119, Control)
- Limitations for Teacher Preparation
  - "It allowed me to make notes and prepare possible questions or situations that might occur before the lesson. It also gave me a structure of what to follow and notes for future use on what worked and what didn't work. I will keep these in a binder for reference next time I teach it," (118, MECM)
- Benefits of Online Curriculum
  - "I predominately used the web site online because i found it to be very user friendly. I liked that it was always there, / i could access it from home or where ever as long as I had internet service and my code," (132, MECM)

How many times did MECM teachers watch videos?

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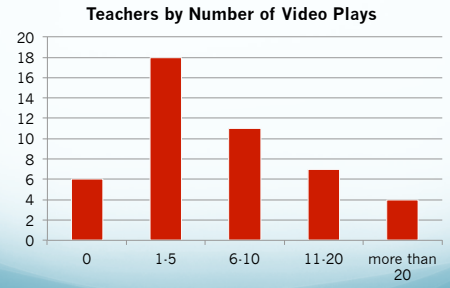
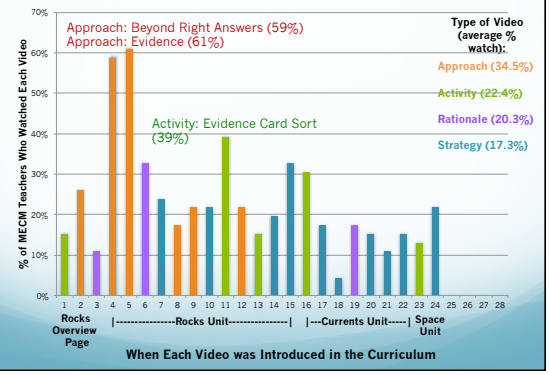


Which videos got watched the most?



PCK Assessment (McNeill et al, in press)

After writing arguments, Ms. Strong's students engage in the science seminar. During the discussion the following exchange takes place:

Alex: "I think we could live on Mars. It would be awesome!"
Melanie: "My claim is the opposite of Alex's. I don't think that humans could live on Mars."
Alex: "Why not? What's your evidence?"
Melanie: "Well there aren't any bodies of water on Mars' surface and humans need water to live."
Tina: "There might not be lakes and oceans on Mars like there are here on Earth, but I still agree with Alex because NASA scientists saw frozen water on Mars so humans could use that to live."
Melanie: "Yeah, but how much water did they find? Did they measure how much there is?"

What could have Ms. Strong said before beginning this science seminar to encourage Melanie, Alex and Tina to have this type of discussion?

a. **"The purpose behind a science seminar is for everyone to share their ideas."**
b. **"The objective of a scientific argument is to use all the evidence in the data table."**
c. **"The point of this seminar is to make sure we all understand your argument."**
d. **"The goal of argumentation is to convince each other of the strength of a claim."**

PCK Assessment (McNeill et al, in press)

- PCK needs to be treated not as information, but considered in terms of how it manifests itself in action in a particular context (Settlage, 2013).
- Conceptualization of PCK of argumentation
  - Moving beyond pseudoargumentation of surface level features to target quality of argumentation
  - Focus on dialogic argumentation needs to focus on students building off of and critiquing each others' claims.
- PCK assessments
  - Should use classroom contexts (e.g. vignettes, student writing and video)
  - The student argumentation examples need to highlight one specific strength or challenge

Lessons Learned from MECMs

- Case studies
  - Teacher Challenges - oversimplified the structural elements and teacher led classroom discourse patterns.
  - Need to focus on the underlying goals of argumentation and not just the procedures.
- MECM Design
  - 3 Design Principles: 1) Target challenge areas, 2) Use multimedia representations of practice, and 3) Support active learning
- Teachers used the digital curriculum in different ways
  - Use of videos – more likely to use them earlier in the curriculum, with the exception of some new activities later in the curriculum had increases
  - Affordances – videos to illustrate classroom practice and interactive prompts that can provide different support
  - Limitations – teachers want to be able to take notes and make changes to the lessons

More Information

- Contact information
  - kmcneill@bc.edu
- Powerpoint can be found at:
  - http://www.katherinelmcneill.com
- Thanks to:
  - Project supported in part by National Science Foundation (NSF DRL-1119584)
  - Maria Gonzalez-Howard, Lisa Marco-Bujosa and Rebecca Katsh-Singer, Boston College
  - Suzy Loper, Jacquey Barber, Phaela Peck, and Traci Wierman, Lawrence Hall of Science