EDE546: Teaching and Learning in STEM
LeChase Hall, Rm 285
Wednesdays 4:50-7:30
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WARNER SCHOOL OF EDUCATION
UNIVERSITY of ROCHESTER

Instructors:

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Overarching Driving Question: What do we know about teaching and learning that leads to high quality student learning in STEM? What counts as high quality?

1. How does one know when learning is happening? What are the instructional implications for learning math and science?

2. What do we mean by effective math and science teaching? What are the implications for instructional practices?

Overall 3-course Sequence Learning Goals:

- Fellows create STEM learning experiences that are highly interesting, meaningful and effective for ALL of their students.
- Fellows learn more about and incorporate best practices in STEM teaching in their classrooms, incorporating digital tools and resources.
- Fellows use new digital tools and resources to enrich students' STEM learning experiences.

First Course (EDE546) Description and Goals

- To develop a sharpened understanding of how people learn and how this informs classroom practices and pedagogy.
- To develop scholarly leadership in one's local context as an instructional leader, one who possesses deep knowledge of how people learn and translates/applies that knowledge in their ongoing classroom practices.

While not a major focus of this course, fellows will also gain exposure to u*nderstanding how digital tools enrich students learning experiences allowing for multiple modes of expression and build on experiences, abilities, and interests* (particularly in experiences as learners and reflecting on these experiences). We will accomplish these goals by working to understand the nature of STEM teaching and learning through engaging as learners and teachers in a learner-centered environment.

Course Modules

I. How People Learn
   A. Engaging as learners in math, science, STEM including how identity plays a role
   B. Reflecting on instructional practices to support learning
   C. Nature of math and science
   D. Access and equity

II. Theoretical Bases for Learning
   A. Identity and Learning

B. Motivation and Learning
C. Articulating your Theoretical Frameworks

III. Implications for Instruction: Teaching for Understanding
A. Inquiry
B. Pedagogical Content Knowledge (PCK) and TPACK
C. Discourse
D. Modeling

Philosophy Informing the Course

Learning to teach math or science is a process that takes many years to develop and honing the craft should be seen as a career-long process of identity development. Learning to be a *Reform-minded Socially Just STEM Teacher* whose practice is rooted in constructivist epistemology is even more challenging because it is not the experience that most of us had as learners (Lortie, 1975), and it is not the way that most teachers practice (Crawford, 2014). This course, which is part of the NSF-funded Fellowship, offers a means to turn our attention to that learning within the larger context of the fellowship. This course strives to engage learners in Big Ideas of STEM teaching and learning, including: *Social Constructivist Learning*; *Epistemic fluency* in Learning and Teaching Science and Math; and *teaching for equity* in high-poverty environments.

Classroom Community

The Warner Graduate School of Education and Human Development is dedicated to fostering a learning community that represents and builds on the rich diversity of human experiences, backgrounds, cultures, histories, ideas, and ways of living. Consistent with our dedication to education, leadership, counseling, and human development that can transform lives and make the world more just and humane, we recruit, support and learn with and from students, staff, and faculty from the broadest spectrum of human diversity. Likewise, we seek the same through our interactions with the broader local and global community. See the following link for the Warner School's statement: (http://www.rochester.edu/warner/warnerataglance/diversity.html). See http://www.rochester.edu/diversity/philosophy.html for the University of Rochester's statements about diversity. It is expected that our class meetings are supportive environments. A fundamental part of our class work is committing ourselves to fostering an inclusive, anti-oppressive environment where each person takes responsibility for her/his language, actions and interactions. In this course, an anti-oppressive environment means that we work against language, actions, interactions and ideologies that hurt people, whether intentionally or unintentionally. It is important that we listen to each other about how our words and actions are affecting one another and that we talk about a class moment in which something may feel hurtful. The instructors view these skills as essential to good teaching and not simply professional courtesies. This course is an opportunity to practice these social justice skills in our social interactions and academic work. Actions deemed by the instructors to be detrimental to the development of a supportive environment will first be addressed by a meeting between an instructor and student(s) at the earliest possible convenience of all parties, but no later than the next class session. If these actions continue after the meeting and are deemed disruptive to the social or academic progress of the class, the instructor may seek additional meetings with the individual, which may involve other parties as needed to resolve the situation. Continued detrimental actions may result in consequences for a student's academic standing in the class.

Course Requirements

The format of the course will be that of a seminar and a working group and therefore depends on students fully participating. Thus, the success and value of the class will be largely dependent upon your preparation for and participation in class discussions and collaborative work. It is essential that you attend every class, are prepared for discussions, and have thoughtfully completed your weekly assignment. Weekly assignments often serve as a scaffolded component of larger projects eliminating a crunch at the end of the semester.

Attendance

When you are absent from class, the class is not the same. Your presence makes a difference for you and others in the class. You impact the conversations! Absences from class will negatively impact your course grade and no more than two absences are permitted. It is also VERY important that you be on time to class.

If you are unable to attend class, you need to call one of us on our mobile phone. Leave a message if there is no answer, explaining why you are unable to make the class. You will also need to meet with a peer to find out what experiences you missed and ***approach an instructor regarding your own plan for a make-up experience that will allow you to similarly explore the concepts addressed***. You will need to have the work completed based upon a mutually agreed upon time.

Participation
All of the above mentioned items will impact your overall participation in class. Be an active learner by engaging in discussions, asking questions and appropriately questioning and challenging thoughts and ideas that are being discussed.

Blackboard
We will use one Blackboard site - Warner Noyce Digitally Rich Seminar - for **all** course communications for this course and for Leadership Seminar throughout the life of this project. This site will be active for the full five years of the fellowship and thus will serve as a record and repository for participants to utilize for the life of the program.

Special Needs
Students are encouraged to share with one of the instructors, in confidence, information about needed specific course accommodations. See us after class or during a scheduled time as early as possible.

Membership
You are encouraged to become a participating member of STANYS, CWS-STANYS and NSTA or NCTM, NCSM and AMTNYS for this year (and hopefully into the future).

Assessments/Major Projects/Readings:

I. Class Weekly Reading(s)

Each week you will be required to read several assigned readings. As a reflection on what you read, you may be required to:

- Write a critical synthesis of the assigned readings; or
- Complete a literature circle graphic organizer;
- Complete a QUAD

Your written reflections will be collected each week and feedback will be given formatively. See the appendix of this syllabus to learn about the format of these reflection tools. All written assignments are to be submitted in word-processed form with the file name following the format ***date – assignment – name.***

II. Problem of Practice 1.0
Bridging theory and practice and engaging with research are ways we become more sure-footed as practitioners. As a means to authentically engage with what it means to be a reform-minded STEM teacher, you will have the opportunity to engage in an experience investigating a "problem of practice" in your classroom. That is, you will engage in a systematic analysis of a deliberate classroom practice that you would like to initiate. This will be an original work that draws directly on *your* practice, and will serve as a summative assessment in the course. With support and scaffolding, you will:

- work to understand the problem of practice in your context;
- utilize current research in the field to illuminate the problem of practice;
- apply theory to flesh out deeper understanding;
- instigate and refine an approach to address the problem of practice in context; and,
- share your project and findings during our final class in a 10-minute presentation.

Problems of practice can be any component of your STEM teaching that is problematized either by you or in the literature. For example, some problems of practice from the research are: fostering student-to-student discourse; using models as a means to deepen conceptual understanding; formatively assessing student explanations of concepts or phenomenon.

The **format** of your written work should be similar to what is found in practitioner journals such as NCTM (*Teaching Children Mathematics; Mathematics in the Middle School;* or *Mathematics Teacher*), or NSTA (*Science Teacher* or *Science Scope*). Some examples will be posted on Blackboard from past students. The samples will not be meant to indicate content, rather genre, style, and audience (other math and science teachers).

PoP Milemarkers to be brought to class **and** submitted to Blackboard on each due date as a collective document:

1. What are you interested in investigating? Why is this a problem worth investigating? What do you know already? What do you need to find out in order to begin your investigation? (Feb. 6 draft; Feb. 27 resubmitted)
2. What is your "intervention" or your planned approach? How will you investigate this problem? What information/data will you collect? (Feb. 27)
3. What is some current research in the field that speaks to this problem of practice? (March 20)
4. Provide status update through *a one page synthesis* that tells your story so far (bring 2 extra copies to class). You will discuss your progress so far with a peer group. What have you done? Why? How does your PoP connect to the field? What data are you collecting? What are you discovering/learning from the data so far (if appropriate)? You will receive written feedback from instructors on your submitted work (April 10 draft for peer review; April 24 to Blackboard for feedback from instructors).
5. Final paper submitted to Blackboard; 10-min presentation in class (May 29)

Your final paper should follow A.P.A. formatting. Cite references (an additional page) APA style (if you need to, look this up at Purdue Owl Writing Lab for example). We expect you to refer to and include references beyond those provided in class. All written assignments are to be submitted in word-processed form with the file name following the format ***date – assignment – name.***

III. Theoretical Framework

Purpose: Articulate your developing theory of math/science learning grounded in research. This document is not about teaching, it is about learning. This document is not about your opinion, it is about what research has shown that informs your current beliefs and thinking about learning.

This assignment should be a careful synthesis of the work that has been done in the course and its relevance in your emerging understanding and beliefs of math/science learning.

The Theoretical Framework should be organized in paragraphs having to do with different aspects of what it means to learn math or science, including your definition of math/science. Refer to the topics outlined in the syllabus for some of the aspects that could be included related to learning. As you discuss your beliefs and the supporting research, be sure to include your rationale for why it's important, meaningful, and relevant to students.

This should not be more than 3 pages, double spaced or 1.5 spaced, 10-12 point font.

First draft due April 3; Final copy due May 22.

Your final paper should follow A.P.A. formatting. Cite references (an additional page) APA style (if you need to, look this up at Purdue Owl Writing Lab for example). We expect you to refer to and include references beyond those provided in class. All written assignments are to be submitted in word-processed form with the file name following the format

date – assignment – name.

IV. Video-recording analysis and reflection of your practice

You will video record your teaching practice supporting a meaning making experience in your classroom with a reflection for peer review and discussion (due May 1 - May 15).

Required Textbooks (Click to download or go to site to purchase):

National Research Council. 2000. How People Learn: Brain, Mind, Experience, and School: Expanded Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/9853.

National Academies of Sciences, Engineering, and Medicine. 2018. How People Learn II: Learners, Contexts, and Cultures. Washington, DC: The National Academies Press. https://doi.org/10.17226/24783.

For the following, fellows are required to obtain either the math or science sections of this book, which can be downloaded separately. The full book can be downloaded if you choose at:

National Research Council. 2005. How Students Learn: History, Mathematics, and Science in the Classroom. Washington, DC: The National Academies Press. https://doi.org/10.17226/10126.

Recommended Resources:

Common Core State Standards for Mathematics

National Research Council. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165. Download here: A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas

National Research Council. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press, 2013 download here: http://www.nap.edu/NGSS/

Learning Plan

Class	Objectives/Activities
LS 1 Jan 16	**Leadership Seminar: Project Launch**
1 Jan 23	**How People Learn + in Science** **DUE for this session:** Readings for this session: ● A Framework for K-12 Science Education (2011) ● Bybee (2012) - Scientific and Engineering Practices in K-12 Classrooms **Overarching Essential Question:** *What do we know about teaching and learning that leads to high quality student learning in STEM? What counts as high quality?*

	Sub-questions: 1. How does one know when learning is happening? What are the instructional implications for learning math and science? 2. What do we mean by effective math and science teaching? What are the implications for instructional practices? Project Norms ● Be community active (as part of a Noyce Community) ● Own the details (of which there are many as a grad student) ● Embrace it or change it (Work with the consensus or Voice your choice).
2 Jan 30	**How People Learn + in Mathematics** **DUE for this session:** Readings for this session: ● Standards for Mathematical Practice w/ NYS Next Gen intro Do a QUAD for each of these readings: ● *How People Learn*: Chapter 1 (Introduction) - Learning: From Speculation to Science ● *How People Learn II:* Summary **Introduce PoP 1.0** *Inquiry is inquiry… Inquiry into practice as a way to study your own learning and teaching practice.*
3 Feb 6	**How People Learn** **DUE for this session:** Readings for this session: Do a Literature Circle reflection for these readings: ● *How People Learn* Chapter 2 (Learners and Learning): How Experts Differ from Novices ● *How People Learn II*: Chapter 3 - Types of Learning and the Developing Brain ● Lederman (2014) pp. 600-612 ONLY - Research on teaching and learning of nature of science PoP 1.0 Milemarker #1 (question draft and rationale)
4 Feb 13	**How People Learn +STEM** **Learning - Disciplinary Content Knowledge:** How do Scientists, Engineers and Mathematicians think and do? What are their understandings? **DUE for this session:** Do a QUAD reflection for each of these readings: ● Becker & Park (2011) - Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis ● Schoenfeld (1992) Learning to Think Mathematically Part I (old but relevant overview of how one views what it means to do mathematics) Review NYS Next Generation Mathematics Standards Intro + Framework for K-12 Science Chapter 2 Prepare a question for a panel member. **STEM Panel**
2 Feb 20	**Leadership Seminar**

Zoom 5-7 pm	
5 Feb 27	**How People Learn +STEM** **DUE for this session:** Do a QUAD reflection for this reading: • Boaler (2002): Mathematics knowing and doing (summary of articles for *Educational Studies in Mathematics* journal) • ~~Ginsburg (2008) - The mathematical disposition of structural engineers~~ Read overview of two assigned learning theories in *Learning Theories in Plain English* (2016; found in Blackboard or for a minimal cost at http://www.learning-theories.com), and be ready to discuss. PoP Milemarker #2 (including PoP Milemarker #1 revised): Revised question and plan submitted to Blackboard AND bring a hard copy to class Introduction to Theoretical Framework
6 March 6	**How People Learn/Theoretical Bases for Learning** **Learning Theories:** What are the importance of theories? How do theories of learning inform what we understand about understanding math and science? **DUE this session:** ***Readings TBD*** Talk by Wenger on his social theory of learning (2013; 1 hour): https://www.youtube.com/watch?v=qn3joQSQm4o Contribute to discussion board for Learning Theories, and comment on someone else's post. HPL II Chapt. 2-Context and Culture
LS 3 March 13 Zoom 5-7 pm	**Leadership Seminar**
7 March 20	**How People Learn/Theoretical Bases for Learning** **Equity & Identity** Guest Facilitator: Eden Badertscher (EDC) What do we need to understand about having Equity in the forefront of our minds in terms of how it impacts learning. **DUE for this session:** Critical Synthesis reflection of the readings: • Gay (2010) - Pedagogical Potential of Cultural Responsiveness • Miller & Kracjick (2015) - Reflecting on Instruction to Promote Equity and Alignment to the NGSS • Delpit (2012) *Multiplication is for White People*: Chapter 1 (pgs. 3-25) PoP Milemarker #3
8 March 27	**Theoretical Bases for Learning** **Identity and Learning** **DUE this session:** **Readings** Complete a Literature Circle reflection: • Boaler (2002) - Knowledge, Practice & Identity • Nasir & Hand (2008) - From Court to the Classroom:... and Identity…

9 April 3	**Theoretical Bases for Learning** **Motivation and Learning** **DUE for this session:** **Readings** Complete a critical synthesis reflection: • Boaler (2013) - Ability and Mathematics: The Mindset Revolution • Reeve, Deci, Ryan et. al. (2004) - Self-determination Theory: A Dialectical Framework • Niemiec and Ryan (2009) - Autonomy, Competence, and Relatedness Theoretical Framework draft
10 April 10	**Implications for Instruction: Teaching for Understanding** **EQ: What do we mean by "Inquiry-based Math and Science Teaching" as a framework that guides instructional decisions?** **DUE for this session:** **Readings -** Complete a QUAD for each of your readings Math Fellows read: ● Horn (2012) - Strength in Numbers Chps 1 + 2 Science Fellows read: ● Bybee (2011) - Scientific and Engineering Practices in K-12 Classrooms ● Windschitl, Thompson & Braaten - Ambitious Science Teaching, Chapter 1 & 9 PoP Milemarker #4 due for peer feedback (bring 2 extra copies to class) **In preparation for the next 3 class sessions:** Select a 5-min video segment of your interaction with students (small group or whole group) as you support them in developing understanding of a math/science concept. Be prepared to: - Provide rationale for why you selected this clip - Lesson goal and context - What you would like to get out of this video analysis Sign up on Google Doc for either May 1, 8 or 15
April 17 No class/No LS	**Break**
4 April 24 Zoom 5-7 pm	**Leadership Seminar** **NOTE:** For EDE546 submit PoP Milemarker #4 to Blackboard for instructor feedback
11 May 1	**Implications for Instruction: Teaching for Understanding** **Pedagogical Content Knowledge (PCK) and TPACK** **DUE for this session:** **Readings -** Complete a Critical Synthesis for your readings: ● Picha (2018) https://www.edutopia.org/article/effective-technology-use-math-class?fbclid=IwAR0SNTsqJDdspxcOfURvQvB8Fa_YctuKfG6cN_UhP2GHNKr0HYLWph1FasM ● HPL II Ch 8: Digital Technology Math Fellows read: ● Ball (2003) - Mathematics in the 21st Century: What Mathematical Knowledge is Needed for Teaching Mathematics?

	Science Fellows read: ● Magnusson, Kracjick, and Borko (1999) (Ch 4 through pg. 115) **Video review analysis protocol (1/3)** Select a 5-min video segment of your interaction with students (small group or whole group) as you support them in developing understanding of a math/science concept. Be prepared to: - Provide rationale for why you selected this clip - Lesson goal and context - What you would like to get out of this video analysis
12 May 8	**Implications for Instruction: Teaching for Understanding** **Classroom Talk and Discourse** **DUE for this session:** Complete a Literature Circle reflection for each of your readings Readings for this session: ● Gay (2010) - Ch. 4 Culture and Communication in the Classroom Math Fellows read: ● Aguirre, Mayfield-Ingram & Martin (2013) Impact of Identity in K-8 Mathematics: Rethinking Equity-based Practices Chps 4 + 5 Science Fellows read: ● Windschitl, Thompson, and Braaten (2018) Ambitious Science Teaching, Chapters 3 & 4 **Video review analysis protocol (2/3)** Select a 5-min video segment of your interaction with students (small group or whole group) as you support them in developing understanding of a math/science concept. Be prepared to: - Provide rationale for why you selected this clip - Lesson goal and context - What you would like to get out of this video analysis
13 May 15	**Implications for Instruction: Teaching for Understanding** **Modeling in Math & Science** **DUE for this session:** Complete a QUAD reflection for each reading Readings for this session: ● Cirillo, Pelesko, Felton-Koestler & Rubel (2016) in "Mathematical Modeling and Modeling Mathematics, Perspectives on Modeling in School Mathematics ● Campbell & Long (2014) - Using Scientific Models to Elucidate Student Thinking **Video review analysis protocol (3/3)** Select a 5-min video segment of your interaction with students (small group or whole group) as you support them in developing understanding of a math/science concept. Be prepared to: - Provide rationale for why you selected this clip - Lesson goal and context - What you would like to get out of this video analysis

5 May 22 Zoom 5-7 pm	**Leadership Seminar** **NOTE:** For EDE546 submit Theoretical Framework to Blackboard
14 May 29	**Implications for Instruction: Teaching for Understanding** **DUE for this session:** Assignments: Problem of Practice Final Draft due - Final Draft uploaded to Blackboard **Problems of Practice Presentations**
6 June 5 Zoom 5-7 pm	**Leadership Seminar**
7 June 12 Zoom 5-7 pm	**Leadership Seminar**