**IL 3471**

**Instructional Issues in Mathematics and Science Education**

**Fall Term 2020**

**Course Instructor**

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| 50th.jpeg | ***Mary Kay Stein***  828 LRDC  (412) 327-3587  [mkstein@pitt.edu](mailto:mkstein@pitt.edu)  I am aProfessor of Learning Sciences and Policy at the University of Pittsburgh and a Senior Scientist at the Learning Research and Development Center. My research focuses on the study of mathematics teacher learning and classroom instruction, including how organizational and policy contexts shape instruction. I have been the lead or co-lead on ten federally funded research grants (IES or NSF) and have also been funded by a variety of private foundations including the McDonnell, Spencer and the MacArthur foundations. I have published widely in both research and practitioner venues. My book (with Margaret Smith) on *Five Practices for Orchestrating Classroom Discussion* is in its second printing and is currently the National Council of Teachers of Mathematics bestselling book.  The best way to contact me is via e-mail ([mkstein@pitt.edu](mailto:ellice@pitt.edu)). I will usually be able to respond to your e-mail questions in 24 hours. If you need to “see” me, I can arrange a meeting via Zoom. Please e-mail me so that we can set up a date and time. | |
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**Course Overview**

Recent reform efforts in mathematics (CCSSM) and science (NGSS) education set ambitious goals for *every* student. The success of these reform movements and the achievement of the desired outcomes for student learning rely on the implementation of “ambitious instruction” in mathematics and science classrooms. The aim of this course is to unpack the meaning of ambitious instruction and the issues related to its implementation, while exploring different solutions to these important problems of research and practice. In this course, more specifically, we will address following questions:

1. What is ambitious teaching and learning in mathematics and science classrooms, and what are its historical antecedents?
2. How does current instructional practice match up to calls for ambitious instruction?
3. What is the relationship between equity and rigor in the classroom, and how can equity be supported in mathematics and science classrooms?
4. What are the primary ways in which research has approached the study of mathematics and science education?
5. What are the features of teaching that have been identified by research on ambitious instruction?
6. How can the current (situation of) teaching be improved to promote ambitious instruction?

The format of this course is online, and it will be delivered fully online. Synchronous class meetings will be held as Zoom sessions on four Saturdays (September 12, October 3, November 7, and December 5) sometime between 1pm and 5pm, while most of the rest of the class will take place asynchronously. Each week will start on Monday (morning) and will end on Sunday (night). It is important to follow the course schedule and complete the requirements in a timely manner so as to make the most of this course.

**Course Policies**

**Attendance/Participation**

Your active participation is necessary both for your own learning and that of others. Therefore, students are expected to attend all Saturday class sessions, join Zoom meetings on time, and be prepared to participate in meaningful and respectful ways. This course meets as a whole class only four times throughout the term and missing one of those sessions constitutes a significant portion of the online interaction with the instructor and peers, and thus counts against points that you will receive for participation.

Although students are expected to attend all Saturday class sessions, working professionals sometimes find themselves in circumstances that cause them to miss these class meetings. Exceptions to the attendance policy may be made for a required work-related commitment, illness, or an emergency only. All other absences are not considered excused.

**Academic Integrity**

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity ([www.cfo.pitt.edu/policies/policy/02/02-03-02.html](http://www.cfo.pitt.edu/policies/policy/02/02-03-02.html)).

Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, from the February 1974 Senate Committee on Tenure and Academic Freedom reported to the Senate Council, will be required to participate in the outlined procedural process as initiated by the instructor.

**Classroom Recording**

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion, and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student’s own private use.

**Disability/Special Needs**

If you require special circumstances to enable your participation in the course, please let me know as soon as possible. According to Pitt policy, if you have a disability that requires special testing accommodations or other classroom modifications, you need to notify both the instructor and the Disability Resources and Services no later than the 2nd week of the term. You may be asked to provide documentation of your disability to determine the appropriateness of accommodations. To notify Disability Resources and Services, call 648-7890 (Voice or TTD) to schedule an appointment. The Office is located in 216 William Pitt Union.

**G-grades**

Should any student anticipate being in a situation where he/she will be unable to complete the work required of this course, the student should make an appointment with his/her academic advisor and the course instructor as soon as possible. Under certain circumstances (and only with approval from both the course instructor and academic advisor), the student may be granted a G-grade for the term. The student would then have an agreed-upon amount of time (not exceeding one academic year) to satisfactorily complete the work for the course. Upon receiving all work, the course instructor would evaluate the work and enter a permanent grade into the student’s record.

**Grievance Procedures**

The purpose of grievance procedures is to ensure the rights and responsibilities of faculty and students in their relationships with each other. When a student taking a course in the Doctor of Education Program (EdD) believes that a faculty member has not met his or her obligations (as an instructor or in another capacity) as described in the Academic Integrity Guidelines, the student should follow the procedure described in the Guidelines by (1) first trying to resolve the matter with the faculty member directly; (2) then, if needed, attempting to resolve the matter through conversations with the EdD Program Director, Dr. Thomas Akiva [tomakiva@pitt.edu](mailto:tomakiva@pitt.edu); (3) if needed, next talking with the academic integrity officer of the school, Asst. Dean Shederick McClendon, [samcclendon@pitt.edu](mailto:samcclendon@pitt.edu); and (4) if needed, filing a written statement of charges with Asst. Dean McClendon.

**Late Submission of Assignments**

All assignments will be submitted to Canvas. The submission system will close past due dates.

Late submissions should be cleared with the instructor before the due date. If negotiated, they will be accepted via email. It is the student’s responsibility to initiate requests for late submissions. Note that late assignments will have lowest priority for grading and feedback.

**Re-submission of Assignments**

You can re-submit an assignment until its due date. Once the due date passes, an assignment cannot be revised and/or submitted.

**Required Materials**

All materials are available in Canvas or will be provided during on-line class sessions or by instructor through email.

**Sexual Harassment**

The University of Pittsburgh is committed to the maintenance of a community free from all forms of sexual misconduct. Sexual misconduct violates University policy as well as state, federal, and local laws. It is neither permitted nor condoned. It is also a violation of the University of Pittsburgh’s policy against sexual misconduct for any employee or student at the University of Pittsburgh to attempt in any way to retaliate against a person who makes a claim of sexual misconduct. Any individual who, after thorough investigation and an informal or formal hearing, is found to have violated the University’s policy against sexual misconduct, will be subject to disciplinary action, including, but not limited to, reprimand, suspension, termination, or expulsion. Any disciplinary action taken will depend upon the severity of the offense. For more information, see University of Pittsburgh's Sexual Misconduct Policy: <https://www.cfo.pitt.edu/policies/policy/07/07-06-04.html>

**Course Requirements and Grading**

**Readings**: This is a doctoral level course, so reading is a critical component of the course content. Reading materials can be found in course modules on Canvas. Please complete assigned readings weekly; for some weeks, you will need to read them no later than Wednesdayin order to complete related assignments.

The flow of the course has been designed to provide you with the opportunity to engage deeply with research and practice related to mathematics and science instruction. The course is divided into 4 sections: Roots of Ambitious Instruction; Overview of Contemporary Research on Instruction; Features of Ambitious Instruction; and Improving Teaching. Each week begins with one or more readings followed by reflection questions and—in some cases—virtual group activities.

**Reflection Questions** require a written, text-based response (approximately 150-200 words per question). These questions are designed to be answered independently in order to provide you with the time and space to formulate and collect your ideas with respect to the readings before participating in discussions or activities about them. My goal with this “private think time” is to prepare you tomake better sense of the ideas introduced in readings and to help you to connect your understanding of the course readings to your individual perspectives.

**Activity/Group Discussion:**Learning also happens in interaction with your peers. Therefore, some of the weeks will also involve small group work along with the readings.In these weeks, I will provide an activity that you complete individudally (e.g., make a Venn Diagram; rate the rigor of a set of mathematical instructional tasks) followed by a request that you (a) share your responses to the activity in self-organized Zoom meetings; and (b) work with your small group to produce a shared artifact. Questions for group discussions are provided to guide this work.

**Whole-Class Discussions:**There are 4synchronous Zoom sessions during which we will engage

(for at least part of the time) in whole-class discussions.

**Grading**

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| Grade | Percentage |
| A+ | 97-100 |
| A | 94-96 |
| A- | 90-93 |
| B+ | 87-89 |
| B | 84-86 |
| B- | 80-83 |
| C+ | 77-79 |
| C | 74-76 |
| C- | 70-73 |
| D+ | 67-69 |
| D | 64-66 |
| D- | 60-63 |
| F | < 60 |

Assignments and deadlines forthcoming.

**Course Schedule**

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| **Date** | **Readings and Activities** |
| August 22  11am  (optional) | **Welcome event**  Course instructor will host an informal “meeting.” In this Zoom session, we will get to know each other and go through the syllabus. Participation is encouraged, but voluntary. |
| August 24  (Week 1) | **Roots of “Ambitious Teaching”**  National Research Council. (1987). *Education and learning to think*. The National Academies Press. <https://doi.org/10.17226/1032>  **Reflection Question 1:**  Resnick’s 1987 monograph provided the rationale and guidance for what today is often referred to as ***ambitious teaching and learning***. The monograph also laid the groundwork for the approach to teaching higher-order thinking that is currently recommended: ***embedding them in the******regular******curriculum***(as opposed to teaching them in separate courses and/or to special groups of students). Despite the age of this monograph, these remain as two pillars of today’s standards movement.  Assume the role of department head (in either science of mathematics). Use Resnick’s arguments to convince a reluctant superintendent or school board member that your district needs to provide more opportunities for students to engage in higher-order thinking skills and that the best way to do so is through the regular course of instruction (via carefully selected and enacted curricula).  Please provide a written, text-based response of approximately 150-200 words and upload into Canvas. Due Date: **Sunday, August 30 midnight** |
| August 31  (Week 2) | **Roots of “Ambitious Teaching” Cont’d**  (read either the math or the science reading)  **MATH:** National Research Council. 1989. *Everybody counts: A report to the nation on the future of mathematics education*. The National Academies Press. <https://doi.org/10.17226/1199>.  Opportunity—Tapping the Power of Mathematics (pages 1-11)  Curriculum—Developing Mathematical Po (pages 43-51)  Teaching—Learning through Involvement (pages 57-67)  **SCIENCE:** National Research Council*.* (2007). *Taking science to school: Learning and teaching science in Grades K-8.* The National Academies Press. <https://doi.org/10.17226/11625>  Executive Summary (pages 1-7)  Introduction (pages 9-49)  **Activity/Group Discussion 2:**  *Everybody Counts* was a call-to-action for the nation in general and for mathematics education in particular. Issued in 1989, it **provided a new vision of what mathematics for the new century might look like**. Using the table in the Canvas module as a template, identify 5 features of this new vision. For each of those features, indicate—based on your experiences— where things stand in 2020 in terms of progress and obstacles to achieving that vision.  Upload into Canvas by midweek.  *Taking Science to School* (2007) was a research synthesis that made a compelling argument that students were able to engage with scientific ideas and practices at younger ages and in more sophisticated ways than previously thought. Building on this research, the authors made a set of recommendations for how things should change in science education. Using the table provided in the Canvas module as a template, identify 5 features of their recommendations. For each of those features, indicate—based on your experiences--where things stand in 2020 in terms of progress and obstacles to achieving those recommendations.  Upload into Canvas by midweek.  During self-arranged Zoom sessions, share your tables with one another and talk about the areas in which you agree and those in which you disagree. Create a “consensus table” using the template in Canvas and upload into Canvas by Sunday, September 6, midnight |
| September 7  (Week 3) | **Overview of Practice**  (read either the math or the science reading)  **MATH:** Hiebert, J., Stigler, J. W., & Manaster, A. B. (1999). Mathematical features of lessons in the TIMMS video study. *ZDM*, *31*(6), 196-201.  **SCIENCE:** Weiss, I., Pasley, J., Smith, S., Banilower, E., & Heck, D. (2003). *Looking inside the classroom: A study of K-12 mathematics and science education in the United States*. Horizon Research, Inc.  **Reflection Question 3:**  3a-(everybody responds):  How did your identification of progress and challenges (from Week 2) compare to the empirical data presented in this week’s readings?  3b-Mathematics:  The Stigler and Hiebert article reflects the state of mathematics instruction in the 1990s, a period of much “reform activity.” Nevertheless, classrooms appeared to remain very traditional and skills-oriented. Why do you think that is so? If the TIMMS study were to be repeated today do you think the results would be different?  3b-Science:  The study by Weiss and colleagues also paints a picture of traditional, text-book driven instruction. Perhaps, though it was unreasonable to expect to see “reform-oriented” practices in science classrooms in the early 2000s, as reform activity did not gain steam until later in the decade. (*Taking Science to School* was not published until 2007.) If the study were repeated today, would classrooms look different? Have any of the “five implications” at the end of the Weiss article been carried out? |
| Sept. 12 | **First Synchronous Session**  Read a case study of a middle-school mathematics teacher who is trying to teach in more ambitious ways  Agenda  15 min : Check-in  90 minutes: Case Study  15 minutes: Consolidation and Closing |
| September 14  (Week 4) | **Overview of Contemporary Research: Mathematics**  Hiebert, J. S., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students’ learning. In F. K. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371-404). Information Age.  **Reflection Question 4:**  Practitioners often have an intuitive sense of whether and how their teaching is influencing student learning. Research, however, must establish the connection between teaching and learning in systematic and methodical ways. In our next two readings, researchers discuss why research-based knowledge of the relationship between teaching and learning remains uncertain and problematic. Why is it so difficult for researchers to establish how teaching influences student learning?  According to Hiebert and Grouws, current research has identified teaching practices that are effective in supporting students’ skill efficiency and teaching practices that are effective in supporting students’ conceptual understanding. In what ways are these practices the same or different? |
| September 21  (Week 5) | **Overview of Contemporary Research: Science**  Windschitl, M., & Calabrese Barton, A. (2016). Rigor and equity by design: Locating a set of core teaching practices for the science education community. In D. H. Gitomer, & Bell, C. A. (Eds.), *AERA handbook of research on teaching*, (5th ed., pp. 1099-1158). AERA Press.  **Reflection Question 5:**  Windschitl and Barton paint a picture of instructional practices in science that is less ‘settled’ than in mathematics (although mathematics educators still have much to learn about effective teaching practices). This piece identifies promising instructional practices by translating scholarship to teaching practices in four main areas: lesson planning; eliciting student ideas; supporting ongoing changes in students’ thinking; and supporting students evidence-based explanations (starting on page 1121). Pick one of these areas and contrast its recommendations for practice with traditional teaching.  **Activity/Group Discussion 5:**  Based on the readings thus far, make a Venn diagram with ambitious teaching practices for mathematics in one circle and ambitious teaching practices for science in the second circle (use template provided in this week’s module).  During self-organized Zoom sessions, share your Venn diagrams with one another and talk about which ambitious instructional practices are shared by both mathematics and science and which are unique.  Create a shared Venn diagram that identifies (a) ways in which ambitious instruction is similar across the two subjects; and (b) which practices are unique to either mathematics or science and why that might be. |
| September 28  (Week 6) | **Overview of Research: Equity Issues**  Delpit, L. (2001). Other people’s children. *Harvard Educational Review*, *56*(4), 379-385.  Goffney, I., Gutiérrez, R., & Boston, M. (Eds.). (2018). *Rehumanizing mathematics for Black, Indigenous, and Latinx students*. National Council of Teachers of Mathematics.  **Reflection Questions 6:**  Delpit identifies what she sees as a “schism” between progressive educational movements (like the mathematics and science reforms we’ve been talking about) and the needs of minoritized students. Describe that schism, including its source.  How does a “rehumanized” version of mathematics differ from the mainstream view of mathematics discussed in Weeks 1 – 5? Why is it important? |
| October 3 | **Second Synchronous Session**  Learning to “See” Inside Classrooms  Agenda  15 min Check-in  90 minutes: Video Case Study  15 minutes: Consolidation and Closing |
| October 5  (Week 7) | **Features of Teaching: Noticing**  (read math OR science)  **MATH:** Sherin, M. G., & Han, S. Y. (2004). Teacher learning in the context of a video club. *Teaching and Teacher education*, *20*(2), 163-183.  **SCIENCE:** Barnhart, T., & van Es, E. (2015). Studying teacher noticing: Examining the relationship among pre-service science teachers' ability to attend, analyze, and respond to student thinking. *Teaching and Teacher Education, 45*, 83-93.  General question  **Reflection Question 7:** |
| October 12  (Week 8) | **Features of Teaching: Cognitive Demand (Mathematics)**  Stein, M. K., Grover, B. W., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, *33*(2), 455-488.  **Reflection Question 8:**   * What do Stein et.al. mean when they refer to the “cognitive demand” of an instructional task? * Is it the same thing as the degree of difficulty of the task? * Is it the same thing as Bloom’s Taxonomy? If not, how is it different? * Why do students often not engage in the level and kind of cognitive thinking that instructional tasks ask them to do? |
| Oct. 19  (Week 9) | **Features of Teaching: Cognitive Demand (Science)**  Tekkumru Kisa, M., Stein, M. K., & Schunn, C. (2015). A framework for analyzing cognitive demand and content-practices integration: Task analysis guide in science. *Journal of Research on Science Teaching, 52*(5), 659-685.  **Reflection Question 9:**  Both the Stein et al and Tekkumru-Kisa et al articles are organized around the concept of an “instructional task.” Why and how are instructional tasks important?  In what ways are the mathematics levels of cognitive demand and the science levels of cognitive demand similar and different? |
| October 26  (Week 10) | **NO READINGS**  **Activity/Group Discussion 8:**  Students will receive a “packet” of math and science tasks and will sort them independently into categories of high- or low-cognitive demand and upload into Canvas.  During self-organized Zoom groups, students will surface agreements and disagreements and discuss the importance and rationales for high-and low-demand tasks. A shared artifact will be created and uploaded into Canvas. |
| November 2  (Week 11) | **Features of Teaching: Orchestrating Productive Classroom Discussions**  Stein, M.K., Engle, R.A., Smith, M.S., & Hughes, E.K. (2008). Orchestrating productive mathematical discussions: Helping teachers learn to better incorporate student thinking. *Mathematical Thinking and Learning, 10*(4), 313-340.  **Reflection Question 11 TBD**  **OPTIONAL ADDITIONAL READINGS:**  **MATH:** Smith, M., & Stein, M.K. (2018). *Five practices for orchestrating productive mathematics discussions,* (pp. 61-74). Corwin Press.    **SCIENCE:** Cartier, J., Smith, M.S., Stein, M.K., & Ross, D.\* (2013). *Five practices for orchestrating task-based discussions in science,* (pp. 85-98)*.* Corwin Press. |
| November 7 | **Third Synchronous Session** |
| November 9  (Week 12) | **Features of Teaching: Culturally Relevant Pedagogy**  Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: aka the remix. *Harvard Educational Review*, *84*(1), 74-84.  Kokka, K. (2020). *Social justice pedagogy for whom? Developing privileged students’ critical mathematics consciousness.* Urban Review.  **Reflection Question 12: TBD** |
| November 16  (Week 13) | **Improving Teaching: Teacher Knowledge**  Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14.  **Reflection Question 13:**  What does Shulman mean by the missing paradigm of research on teaching? Why is it so consequential?  Identify the categories of knowledge that Shulman discusses and give examples of each from your teaching. Which of these categories are best developed in your particular subject area (e.g., biology) and which are least well developed? |
| November 23  (Week 14) | **Improving Teaching: Building a Knowledge Base for Teaching**  Hiebert, J., Gallimore, R., & Stigler, J. W. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher*, *31*(5), 3-15.  **Reflection Question 14:**  What are some of the problems involved with trying to translate research knowledge into knowledge for teaching?  What are some of the problems involved with trying to transform teachers’ craft knowledge into a reliable research base for teaching? |
| November 30  Week 15 | **Work on Final Paper** |
| Dec. 5 | **Fourth Synchronous Session** |