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Rutgers, The State University of New Jersey

15:254:649:01 Topics in Mathematics Education: Seminar in Mathematical Ideas

Fall 2015

Wednesdays 7:40-10:30

ED-211

Instructor: Gerald A. Goldin	Email: geraldgoldin@dimacs.rutgers.edu
Phone Number : 908-720-2434	Location: 10 Seminary Place, 2nd floor
Office Hours: Wednesdays 3:00-4:00 p.m. or by appointment	Prerequisites or other limitations: *Open to teachers of middle school or high school mathematics, and students enrolled in the M.Ed., Ed.D., or Ph.D. programs in Education with an interest in mathematics education teaching and research.*
Mode of Instruction: ___ Lecture _x_ Seminar ___ Hybrid ___ Online ___ Other	Permission required: _x_ No ___Yes Directions about where to get permission numbers: from the instructor

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentations: hhttps://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Course Description

Learning goals:

The seminar is designed as an experience in mathematical thinking -- a supportive, activity-based exploration of what it means to think mathematically. By the end of the course, you will acquire a deeper understanding of the processes of mathematical discovery, pattern detection and description, invention, and the creation of mathematical representations. We will be sharing ways of thinking with each other, as well as thinking about how students think about

mathematical ideas. We will be especially attentive to the affective domain – the experience of doing mathematics, the enjoyment of mathematics, the aesthetics of mathematics, and the role of negative emotions such as anxiety and frustration. The mathematical topics will be selected according to the backgrounds of the students in the seminar.

New Jersey Professional Standards for Teachers (2014)[1]:

The content of this course is relevant to the following standards:

Standard One: Learner Development. The teacher understands how learners grow and develop, recognizing that patterns of learning and development vary individually within and across the cognitive, linguistic, social, emotional, and physical areas, and designs and implements developmentally appropriate and challenging learning experiences.

ii. Essential Knowledge:
(1) The teacher understands how learning occurs--how learners construct knowledge, acquire skills, and develop disciplined thinking processes--and knows how to use instructional strategies that promote student learning;
(2) The teacher understands that each learner's cognitive, linguistic, social, emotional, and physical development influences learning and knows how to make instructional decisions that build on learners' strengths and needs;

iii. Critical Dispositions:
(1) The teacher respects learners' differing strengths and needs and is committed to using this information to further each learner's development;
(2) The teacher is committed to using learners' strengths as a basis for growth, and their misconceptions as opportunities for learning;
(3) The teacher takes responsibility for promoting learners' growth and development;

Standard Two: Learning Differences. The teacher uses understanding of individual differences and diverse cultures and communities to ensure inclusive learning environments that enable each learner to meet high standards.

ii. Essential Knowledge:
(1) The teacher utilizes resources related to educational strategies for instruction and methods of teaching to accommodate individual differences and to employ positive behavioral intervention techniques for students with autism and other developmental disabilities;
(2) The teacher understands and identifies differences in approaches to learning and performance and knows how to design instruction that uses each learner's strengths to promote growth;
(5) The teacher understands that learners bring assets for learning based on their individual experiences, abilities, talents, prior learning, and peer and social group interactions, as well as language, culture, family, and community values;

iii. Critical Dispositions:
(1) The teacher believes that all learners can achieve at high levels and persists in helping each learner reach his or her full potential;
(3) The teacher makes learners feel valued and helps them learn to value each other;

Standard Four: Content Knowledge. The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches, particularly as they relate to the Common Core Standards and the New Jersey Core Curriculum Content Standards and creates learning experiences that make these aspects of the discipline accessible and meaningful for learners to assure mastery of the content.

[1] http://www.state.nj.us/education/code/current/title6a/chap9.pdf

ii. Essential Knowledge:

(1) The teacher understands major concepts, assumptions, debates, processes of inquiry, and ways of knowing that are central to the discipline(s) he or she teaches;
(2) The teacher understands common misconceptions in learning the discipline and how to guide learners to accurate conceptual understanding;
(5) The teacher has a deep knowledge of student content standards and learning progressions in the discipline(s) he or she teaches;
(7) The teacher understands the concepts inherent in numeracy to enable students to represent physical events, work with data, reason, communicate mathematically, and make connections within their respective content areas in order to solve problems.

iii. Critical Dispositions:
(4) The teacher is committed to work toward each learner's mastery of disciplinary content and skills; and
(5) The teacher shows enthusiasm for the discipline(s) they teach and is committed to making connections to everyday life

Standard Five: Application of Content. The teacher understands how to connect concepts and use differing perspectives to engage learners in critical thinking, creativity, and collaborative problem solving related to authentic local and global issues.

ii. Essential Knowledge:
(1) The teacher understands the ways of knowing in his or her discipline, how it relates to other disciplinary approaches to inquiry, and the strengths and limitations of each approach in addressing problems, issues, and concerns.
(5) The teacher understands critical thinking processes and knows how to help learners develop high level questioning skills to promote their independent learning;
(6) The teacher understands communication modes and skills as vehicles for learning (for example, information gathering and processing) across disciplines as well as vehicles for expressing learning;
(7) The teacher understands creative thinking processes and how to engage learners in producing original work

iii. Critical Dispositions:
(3) The teacher values flexible learning environments that encourage learner exploration, discovery, and expression across content areas.

Council for the Accreditation of Education Professionals (2013)[2]:

Standard 1: Candidate Knowledge, Skills, and Dispositions
- 1.1 Content Knowledge and Pedagogical Knowledge
- 1.2 Instructional Practice
  - Learning Experiences
- 1.6 Learner and Learning
  - Learning Experiences
- 1.8 Learner and Learning
  - Relationships and Communication

[2] http://caepnet.files.wordpress.com/2013/09/final_board_approved1.pdf

Course catalog description:

Treats problematical yet fundamental ideas in the mathematics curriculum by exploring their historical development, and the logical and cognitive issues involved in understanding and applying them.

Other description of course purposes, context, methods, etc.:

This is a seminar course requiring substantial participation by students in discussions and mathematical activities, both during class and outside of class. Students will keep mathematical journals and research mathematical topics in depth, from historical and logical points of view – how mathematical discoveries are made, and how students develop deep mathematical understanding.

The level of mathematics explored will be based on the individual backgrounds of the participants and their teaching experience, and may range from middle school to graduate school. We will also give substantial attention to the affective dimension of mathematical learning and discovery. The mathematical topics in the week-by-week syllabus below are suggestive, but may be modified according to the backgrounds of the participants in the seminar.

Over the course of the semester, one or two classes may be conducted remotely.

The course content will lead participants to deep and thoughtful perspectives on many of the following important ideas in mathematics education – a kind of dictionary to help organize the insights acquired during mathematical exploration and investigation: (mathematical) *ability*, *abstraction*, (mathematical) *accuracy and correctness*, *algorithms*, *alternative conceptions*, (mathematical) *affect*, *applications* (of mathematics), *behaviorism*. (mathematical) *beliefs*, (mathematical) *communication*, *computation*, *concept(s)*, *conceptual understanding*, mathematics in *context*, *constructivism*, (mathematical) *conventions*, *correct answers*, mathematical *creativity*, *declarative knowledge*, *discovery learning*, (mathematical) *engagement*, *epistemological obstacles*, *examples*, *expository teaching*, *generic examples*, *generalization*, *heuristics*, *heuristic thinking*, (mathematical) *invention*, *mathematics* (what it is), (mathematical) *meaning*, *misconceptions*, (mathematical) *models*, *motivation*, (mathematical) *notation*, *patterns*, *performance*, *problem solving*, *procedural knowledge*, (mathematical) *processes*, *proof*, (mathematical) *reasoning*, *representations* and *systems of representation*, *rules* and *rule learning*, (mathematical) *skills*, *space*, *spatial thinking*, *spatial representation*, *(mathematical) speed*, *strategies* for problem solving, (mathematical) *structure(s)*, *technology*, *theorems*, *truth* (in mathematics), *understanding*, *visualization.* We may augment this "dictionary" as the seminar develops.

Required texts:

There is no required textbook for this course. Selected articles, research papers, and other materials, assigned throughout the course, will be available on the Sakai course site under *Resources*.

Grading policy:

Grades for the course will be based on:

40% Class participation in discussions and activities

30% Written mathematical assignments, journal entries, and Sakai postings

30% Final project and presentation

Academic Integrity Policy:

Any violation of academic honesty is a serious offense and is therefore subject to an appropriate penalty. Refer to http://academicintegrity.rutgers.edu/integrity.shtml for a full explanation of policies.

In assignments and class activities, quizzes, tests, papers, field projects, PowerPoint presentations, and other class-related work, text taken from other sources *must be placed within quotations and the author/source is appropriately cited.*

Use of the internet and available curricula to research ideas for activities, lesson plans, assessments, etc., and working together with other students, is of course strongly encouraged,. But ideas that are taken from such resources must be cited properly, to prevent plagiarism. Use of resources word for word, or problem for problem, even when the resources are cited properly, does not satisfy the requirements of the class – all work handed in should be original, expressed in your own words.

Web site:

https://sakai.rutgers.edu/portal (specific course Sakai access will be available to those who have officially registered for this course).

Course Requirements

Attendance Policy

Since this is a seminar course, attendance is an essential requirement. Except in emergencies, necessary absences should be prearranged and sharply limited. In such cases, you are responsible for contacting me, obtaining course materials, and making up the class through out-of-class activity or notes from others in the class.

Summary of Requirements

You need to be prepared to discuss and ask questions about assigned readings, and to engage in group work and individual activities designed to explore mathematical ideas and of the nature of students' mathematical learning at their deepest levels.

Quizzes each week or two are designed to cover assigned readings, and to assess your conceptual understanding of topics we cover in class.

Each participant should keep a mathematical journal. Individual journal entries are to be posted bi-weekly on the appropriate Sakai forum, addressing the mathematical ideas discussed in class and that you have further researched. Other Sakai postings include responding to the posts of other students, and comments on topics highlighted for discussion. Occasional written assignments will be given during class.

Each student will create and submit a final project exploring a mathematical concept in depth. This includes a written development of no more than fifteen pages, addressing the history and/or the logic behind the topic, and including references to web-based resources about the topic. Depending on the size of the group, each student will deliver a short class presentation about her or his project.

Tentative Course Schedule by Week (subject to change)

Week	**Topics to be covered (tentative)**	**Assignments & readings due (to be specified week by week)**
1. Wed Sep 2nd	Introduction. Construction and interpretation of rational numbers.	
2. Wed Sep 9th	More on rational numbers.	Mathematics: A Very Short Introduction (by Timothy Gowers), Oxford University Press (2002), Chapter 2 (pp. 17-34)
3. Wed Sep 16th	Extensions of the concept of number. Mathematical creativity and giftedness.	Skemp, R. (1976). Relational Understanding and Instrumental Understanding. Mathematics Teaching, 77, 20-26. *Activity to be specified*
4. Wed Sep 23rd	The idea of dimension in mathematics. Representation.	Kline, M. (1972). Mathematical Thought from Ancient to Modern Times, Vol. 1 (pp. 15-23). Oxford, UK: Oxford University Press *Journal entries: first set*

5. Wed Sep 30th	Symmetry and its meanings. The concept of a mathematical structure.	*Activity to be specified*
6. Wed Oct 7th	The real numbers. The concept of infinity.	*Activity to be specified*
7. Wed Oct 14th	Structural properties of number systems.	*Reading to be specified* *Journal entries: second set*
8. Wed Oct 21st	Foundations of probability Foundational issues in mathematics	*Activity to be specified*
9. Wed Oct 28th	Algebraic thinking and representation.	*Project outlines due* *Reading to be specified*
10. Wed Nov 4th	Fractal geometry, projective geometry. Mathematical art.	*Activity to be specified*
11. Wed Nov 11th	Explorations in topology. Reasoning and proof.	Journal entries: third set
12. Wed Nov 18th	Work on mathematical projects.	*Project resources and bibliog. due*
13. Wed Dec 2nd	Student presentations and discussions.	Journal entries: final set
14. Wed Dec 9th	Student presentations and discussions.	Final projects due