Department of Mathematics & Statistics
Concordia University

MATH 649
Problem Solving and Heuristics
Fall 2014

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Office hours: Tuesdays, 14:00-16:00, or by appointment.

Textbook: There is no single textbook for this course. A variety of sources (books, articles) will be used. *Moodle* platform will be used to provide course materials. The access to this space will be allowed only to the students enrolled in the course.

Purpose: It is widely accepted that any mathematical activity consists in solving some problems. Accordingly, problem solving is a heart of mathematics teaching and learning as it appeals to a variety of mathematical concepts, relations and procedures while requiring sufficiently developed reasoning and communication abilities, as well as the capacity to make connections between branches of mathematics, mathematics and other subjects, and mathematics and real life. By looking at the student as a potentially 'good' problem solver, this course will examine different types of problems, cognitive processes, tools and strategies involved in solving them successfully, as well as a variety of contexts in which problems can be posed and investigated in depth. Based on an extensive literature review and concrete examples of problems and students' solutions from the classroom and beyond, we will discuss the characteristics of a 'good' problem, the place of problems in the modern curricula at different levels ranging from elementary to advanced ones. Furthermore, we will look at the diversity of problems and problem situations, as well as strategies and heuristics that help to deal with challenges that students may face when attempting to solve problem from different areas of mathematics and across. Besides 'traditional' word problems, we will explore other types of problems, such as open-ended, ill-defined, and contextualized, which creates a multitude of teaching and learning opportunities for asking 'good' questions, conducting investigations, looking at different strategies and different solutions, and eventually posing new problems. Problems from mathematical competitions, recreations, such as puzzles, enigmas will be also analyzed.

From the point of view of teaching and learning, many questions arise in terms of how to better integrate problems in teaching scenarios, how to assess students' solutions and how to guide students through the problem-solving process. Benefits and shortages of 'new' ways of teaching which include collaboration and discussion between students, use of technology, distance learning, will be also

discussed. In this course, you will have an opportunity to study in more depth several topics related to problem solving and/or problem posing, one of which will be chosen for in-depth study according to your own interests. You will inform the instructor about your interests and the instructor will help you select relevant literature and conduct a small-scale experiment.

Assessment: The evaluation will be based on the following assessments:

- Attendance and participation in class discussions **–** 10%
- Weekly assignments – 15%
- Reading reports presentation – 15%
- Review of literature on teaching and learning problem solving and heuristics according to the chosen area/level/context (3000 words) – 20%
- Report from a research project conducted by the student (6000 words) – 40%

TOTAL: 100%

Attendance and Participation: In-class attendance is compulsory. If, for some important reason, a student cannot attend the class, he or she must inform the instructor in advance.

Students are expected to actively participate in classroom discussions. Interventions should be based, first of all, on knowledge of mathematics and mathematics education literature and, secondly, on personal experience and opinion.

Personal cell phones, iPods, iPads, tablets, laptops and other such electronic devices are not to be consulted during the class unless it is directly related to the task given by the instructor.

Weekly Assignments: Five (5) short reading assignments will be given at different moments of the semester. They may also include different tasks related to the search for problems, solving problems, as well as brief analyses (assessment) of solutions. Each assignment will be placed on the Moodle website of the course two weeks prior to the deadline that will be agreed between the students and the instructor.

Reading Presentations: By Tuesday, September 16, students will inform the instructor (by email) about the area/level/mathematics teaching and learning they wish to study more in depth from the point of view of problem solving/posing and heuristics. The instructor will advise each student on relevant readings, but students are also welcome to propose their own lists of readings. Presentations of readings will be scheduled based on the internal logic of chosen topics. Presentations will be scheduled **from Tuesday, October 14 to Tuesday, November 4**.

Literature Review: The student will read and review at least four articles or book sections on students' strategies of problem solving in their chosen area/concept/process of mathematics.

In an essay of about 3000 words, the student will identify the context and the research problems discussed by the authors, the frameworks and the methods they used to study the problem-solving strategies, as well as a summary of the findings and the teaching implications. This assignment will be due by **November 7**.

Research Report: You will be asked to design and conduct a small-scale experiment with some students (or a group of students) which implies solving and/or posting problems. You will describe the experiment and its analysis in a report of about 6000 words.

The Report should contain the following parts:

1. Introduction
   Brief presentation of the aim of the experiment, the participants' backgrounds, and a preview of the results obtained.

2. Theoretical perspective and methods
   Based on literature review, you will describe and justify your theoretical approach and methods of data collection (interviews, questionnaire, (classroom) observations, samples of students' work, etc.).

3. Results
   The participants' responses are described and analyzed.

4. Discussion
   The results of the experiment are discussed in the light of recent scientific findings about students' problem-solving (and/or problem-posing) strategies taken from the literature. Do the results corroborate those found by other researchers? Do they refine them? Contradict them?

5. Conclusions and recommendations
   5.1. Summary of the revealed successes and challenges
   5.2. Could the experiment be improved? How?

6. References
   References must be listed in alphabetical order, using the APA Fifth Edition style. References within the main body of the text should have the format "(AUTHOR-LAST-NAME, YEAR)", e.g., (Ainley, 1994).

You will have an opportunity to present your initial ideas for the experiment in the November class sessions, and obtain feedback and advice from your peers and the instructor. The deadline for submission of completed Reports is **December 15, 2014**.