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Course Description: Heuristics in mathematical problem solving and mathematical modeling for
teachers. Professional development, readings, interactive experiences, and discus-sions will provide the theoretical framework and background to the identified topics. The course will focus on problem solving, inquiry, and assessment of children’s mathematical thought. Students will engage in mathematical activities as a basis for reflecting on teaching and learning mathematics.

Objectives:
1. To develop mathematical problem solving skills.
2. To enhance each teacher’s confidence in and positive attitude toward mathematical problems.
3. To develop an understanding of 7th–12th grade students’ problem solving behaviors in order that teachers will be able to help students learn to solve mathematical problems.
4. To become familiar with models for assessing the mathematical problem solving abilities of students.


Evaluation: Components of the final grade are as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Attendance and Participation</td>
<td>15%</td>
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<tr>
<td>Weekly Problems</td>
<td>30%</td>
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<tr>
<td>Abstracts</td>
<td>15%</td>
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<tr>
<td>Reflective Journal</td>
<td>10%</td>
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<tr>
<td>Problem Solving Project</td>
<td>30%</td>
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</table>

Missed Classes: If you miss a class, you are required to search the literature and read at least three recent research articles, not on the syllabus, that focus on a particular aspect of problem solving or the teaching of problem solving. A synthesis of the three articles in the form of a paper is required. Include a complete bibliographic reference, APA style (Publication Manual of the American Psychological Association, Fourth Edition). Each a paper should be contain at least two thematic sections. The first section should be a description of the research, i.e. what was studied, how was it studied, and what are the results. The second section should be your reaction to what was presented in the context of the material presented in the course. Please note, everyone has a one professional/personal day exemption from this policy with “no questions asked.” Exceptions to this policy are at the discretion of the instructor.
Missed Exams, Quizzes, and Assignments: Missed exams and quizzes will not be made up. Exceptions will be made only in accordance with University and Departmental policy and at the discretion of the instructor provided arrangements are made in advance. I realize in the case of extreme emergencies this may not be possible. In that case, I should be contacted as soon as possible. Verification of the emergency should be provided (A note stating only that you visited the Health Center is not sufficient.). If a make-up is given, the exam or quiz given in place of the missing exam or quiz will NOT be the same as the original exam, but will cover the same material, as well as reflecting the fact that you had more time to study. That is, there is no guarantee of having the same level of difficulty.

Late or missing homework will be accepted in my office until 5:50 P.M. on the class day following the due date excluding weekends and holidays. Late homework will receive a 25% reduction in grade. Assignments incorporating the use of technology should be started sufficiently early so that there will be sufficient time to overcome any difficulties involved in using technology. In other words, I could not complete the assignment on time due to technological difficulties will not constitute a valid excuse for late assignments. Exceptions to this policy are governed by the same policy stated in the previous paragraph.

Incompletes: A grade of incomplete is possible, but only in the case of prolonged absence or other excused emergency in accordance with University and Departmental policy and at the discretion of the instructor. The student must be receiving a passing grade at the time the incomplete is granted, and the missing work must be completed in the time frame agreed upon by both the student and the instructor. Failure to complete the missing work in the agreed upon time frame will result in a zero for the missing work. A grade of incomplete will not be given to a student to avoid a failing grade in the course.

Academic Support: Students with disabilities who believe they may need an accommodation in this class are encouraged to contact Julie Snow, Director of Disabilities Services at (507) 389-2825, ML 116, as soon as possible to ensure that accommodations are implemented in a timely fashion.

Assignments: Details for the major course assignments are as follows:

Daily Assignments: Problems for this course will be assigned and distributed on a weekly basis. These will be due as assigned. Additionally, you will need to work five problems from the Polyà book of interest to you.

Grading Rubric: Each problem solution will be graded in approximately the following manner:

4 Solution is complete and accurate. All mathematics is done correctly and supporting work is shown and explained when needed. All work is clear and concise—external interpretation of work is not needed and writing is void of extraneous information. Drawings and figures are included when needed and are easy to understand.

3.5 Some elements of a score of 4 and some elements of a score of 3 are present.

3 Solution is almost complete and correct, but some minor error is made in computation, notation, or communication. Explanations are provided, although there may be some minor errors or unclear writing. Work is relatively clear and concise. Drawings and figures are included when needed and relatively easy to understand.

2.5 Some elements of a score of 2 and some elements of a score of 3 are present.
2 Solution has partially correct answer but contains some significant errors (beyond miscalculations or miscopying). Explanations are provided but are missing some critical elements. Work may be confusing to understand, be too brief, or too long. Drawings and figures are included when needed but lack some critical element that makes them easy to understand.

1.5 Some elements of a score of 2 and some elements of a score of 1 are present.

1 Some work is correct, but the student reaches an impasse early. The work shows some evidence of a chain of reasoning. This implies that the student makes some reasonable entry into the problem with at least one useful step correct and valid; however, the response fails to use this step to make further progress on a solution. Drawings and figures are not included when they are needed.

0 Work is all wrong or meaningless. No correct mathematics is used for a solution. No answer is given.

For your work to be considered complete and correct:

Solutions should show any necessary work. You need to explain your reasoning and make your computations clear. Use complete English sentences if the meaning of the mathematical sentences is not otherwise clear. Solutions not showing the necessary work will receive a grade of zero.

Use standard notation and language. Do not invent your own notation and abbreviations, and then expect me to figure out what you meant. For instance, do not use "#" in your sentence if you mean "pounds" or "numbers".

Do not use the "equals" sign ("=") to mean "indicates", "is", "leads to", "is related to", or anything else in a sentence; use actual words. The equals sign should be used only in equations, and only to mean "is equal to".

Do not do magic. Plus/minus signs, "= 0", radicals, and denominators should not disappear in the middle of your calculations, only to mysteriously reappear at the end. Each step should be complete.

For graphs, use a ruler to draw the axes and straight lines, clearly labeling the axes, the scale, and the points of interest. Use a consistent scale on the axes.

If the problem is of the "Explain" or "Write in your own words" type, then copying the answer from the back of the book, or the definition from the chapter, is unacceptable. Write the answer in your words, not the text’s.

Remember to put your final answer at the end of your work. Label your answer appropriately. If the answer is to a word problem, make sure to put appropriate units on the answer. For instance, if the problem involves money, then the answer should involve dollars or cents.

In short, you should prepare your assignments in such a way that you could hand them to anyone else in the class and they would be able to follow what you have done.

In summary, schools today have made the development of essential skills, the provision of significant and meaningful learning experiences, and the development of the workforce some of its primary goals for student success. As such, they want their instructors to guide the students toward a higher level of confidence and competence. In math, that translates into a greater need for clarity in mathematical writing. The intention on these "Homework Guidelines" is that you and your instructor communicate better, and that you succeed both in your present mathematics courses and in future mathematical communication with co-workers and clients.
Guidelines For All Assignments:

The following guidelines apply to **ALL** assignments. Assignments not meeting these requirements in general will be returned with a **25% reduction in grade**.

1. Homework is due at the beginning of class on the assigned due date.
2. The student’s name and class period should be written clearly on the assignment.
3. Assignments should be turned in on standard-sized paper (8.5” x 11”), with no “fringe” or ragged edges running down the side as a result of the paper’s having been torn out of a spiral notebook.
4. The pages of an assignment should be stapled (note that a paper clip is **NOT** a staple). Do not fold, tear, spit on, or otherwise “dog-ear” the pages. If your assignment is not stapled, I would prefer that the pages be handed in loose or paperclipped together (with your name on each sheet) rather than with the corners be folded or shredded.
5. Homework must be written clearly and legibly or it will not be graded and it will be counted wrong. Pencil should be used; mistakes cleanly erased not scratched through or crossed out. If you work in ink, “white-out” should be used to correct your mistakes.
6. Problems should appear in problem number order with the exceptions of problems requiring graphs as part of the solution. If you accidentally do a problem out of order, or separate part of the problem from the rest, then include a note referring me to the missed problem or work. Graphs must appear on graph paper and may be attached at the end of the problem set. Any other work necessary to the solution of the problem must accompany the graph.
7. Problems should start near the left-hand margin, with each succeeding problem below the preceding one, not off to the right. Do not work in multiple columns down the page. Keep work within the margins. If you run out of room at the end of a problem, please continue onto the next page; do not try to squeeze lines together at the bottom of the sheet. Do not lap over the margins on the left or right; do not wrap writing around the notebook holes. Do not squeeze the problems together, with one problem running into the next or one step running into the next. Use sufficient space for each problem, with at least one blank line between one problem and the next. In short, do not hand in work that is the quality of scratch work. Do scratch work, but do it on another paper. For grading, hand-in only your final draft.

These assignments should be done in such a way that if a potential employer were to call me for an example of your work while you were here at Minnesota State University, Mankato; you would be pleased to have me show them one of your assignments.

Journal Article Review:

The purpose of this assignment is to give you an opportunity to locate and read some of the professional literature related to mathematics content and problem solving. You are responsible for one journal abstract. It should be 2–3 pages in length, double-spaced and typed. A copy of the article should be attached to your review (**due October 27th**).

A review of a research article should include an overview of the article (a few paragraphs) that discusses the research question, methods, and conclusion. The remainder of the review should address the potential impact of the article on your teaching and/or on the teachers you work with. Possible resources are *Journal for Research in Mathematics Education, School Science and*
Grading Rubric:

The assignment will be graded in the following manner:

Format (5 points possible):

5 Uses correct font size, spacing, documentation, and maintains appropriate length.
4 One mistake in format.
3 Two mistakes in format.
2 Three mistakes in format.
0 Does not follow the prescribed format.

Article (5 points possible):

5 Selected article is appropriate for course; journal is acceptable; article is attached to review.
0 Article or journal is inappropriate. Article is not attached to review.

Summary (20 points possible):

20 Clear, well-organized summary of article including research questions, methodology, and conclusions of author.
15 Reasonable, but not completely clear or is missing one of the following: research questions, methodology, and conclusions of author.
10 Vague and/or is missing two of the following: research questions, methodology, and conclusions of author.
5 Inaccuracies in summary; conflict with authors intent.
0 Summary largely unrelated to article.

Reaction (20 points possible):

20 Clear, thoughtful discussion of how the ideas in the article would translate to the classroom.
15 Clear discussion of how the ideas in the article would translate to the classroom.
10 Discussion of how the ideas in the article would translate into a classroom lacks clarity and thought.
5 Superficial discussion of how the ideas in the article would translate into a classroom lacks clarity and thought.
0 Missing or evidence of understanding missing.

Expression (15 points possible):

15 Ideas clearly presented in professional tone; well-organized and easy to follow.
12 Ideas clearly presented in professional tone; well-organized; may lack clarity or continuity in a few places.
8 Ideas presented in professional tone; may lack clarity or continuity.
4 Lacks professional tone or lack of organization and clarity may interfere with meaning.
0 Incomprehensible with many errors in organization and continuity.

*Mechanics (12 points possible):*

12 Clear, accurate grammar and no spelling errors.
9 Few grammar errors and no consistent misspellings.
6 Grammar or spelling errors that do not significantly detract from understanding.
3 Occasional grammar or consistent spelling errors.
0 Errors that significantly interfere with understanding.

*Reflective Journal:*
Write a reflection about the relationship between teaching and learning as it evolves in your classroom over the period of this semester (due December 8th).

*Grading Rubric:*
The assignment will be graded as follows:

16 Reflection is clearly written and addresses all the requested components. There is evidence of thoughtful reflection that just goes beyond just summarizing a reading or stating unlinked thoughts.
12 The reflection addresses all the requested components, but the reflection is not thoughtful and engaging, or the reflection is thoughtful but does not address all the requested components.
8 Reflection address some but not all of the required components and is missing evidence of thoughtful reflection.
4 Reflection does not address any of the required components and was not thoughtfully done.
0 No attempt at reflection.

*Research Project:*
Select a grade level and a strand of mathematics such as geometry, algebra, trigonometry, calculus, etc. and compile from 15 to 20 problems from the Eisenhower National Clearing House, the internet, school resources, or of your own creation. Prepare solutions based on the solution strategies your students might use to solve these problems, and be prepared to discuss these with the class (due October 13th). Be sure to list the content covered by these problems. Field test these problems in your class(es) and collect copies of student work demonstrating a variety of solution strategies. Develop an assessment strategy for grading these problems. Be prepared to discuss the results with the class (due November 17th). Design a way to present your findings from this project. Be prepared to present a twenty-minute overview of your project, bring handouts for the class and one copy of the complete project to submit in class (due December 11th).

*Grading Rubric:*
The course project will be will be divided as follows with the indicated point values representing the total possible points.

*Written Paper:*

10 Describe your project. What problems did you use, what was the grading rubric you developed.
15 You should include samples of students work, graded, and a rationale for applying your rubric.
15 Write a summary of what you learned from the investigation. What did you learn about problem solving and teaching problem solving from this project?

**Presentation:**

15 Provide a clear “glimpse” of your investigation (20 minutes).

**Schedule of Meetings:**

The class meetings are tentatively scheduled as follows:

1. September 1
   - Introduction and get acquainted.
   - Review of syllabus and course requirements.
   - Theme: What is a Problem?

2. September 8
   - Theme: Problem Solving Heuristics

3. September 15
   - Theme: Historical Perspectives on Problem Solving Mathematics

4. September 22
   - Theme: Problem Solving as a Means to Learning

5. September 29
   - Theme: Problem Posing as a Way to Teach Problem Solving

6. October 6
   - Theme: Rubrics

7. October 13
   - Theme: Discussion of Preliminary Drafts of Problems for Problems Solving Project

8. October 20
   - Theme: Discussion of Preliminary Drafts of Problems for Problem Solving Project

9. October 27
   - Theme: Piaget
   - Readings: Duckworth
   - Assignment: Research Reaction Due

10. November 3
    - Theme: Piaget (continued)
    - Readings: Duckworth

11. November 10
    - Theme: Piaget (continued)
12. November 17  
Theme: Discussion of Scoring Rubrics Used for Problem Solving Projects

13. November 24 (No Class)

14. December 1  
Theme: Computers and Problem Solving  

15. December 8  
Theme: Open Ended Problems Assignment: Reflective Journal

16. December 15  
Project Presentations

Readings:  
The following constitute the primary readings for the course and will be placed on reserve in the library.


DeYoung, M. (2001). Challenge problems: Love them or hate them, but learn from them. *Mathematics teaching in the middle school, 6*(8), 484–488.

Duckworth, E. *Piaget Rediscovered*. Educational Services Incorporated.


### Additional Resources:

The following is a list of additional resources in problem solving that you might find useful.

**Journals:**

The journals which focus on mathematics and contain relevant articles on problem solving include *The Arithmetic Teacher, The Mathematics Teacher, School Science and Mathematics, Vector,* and *Journal for Research in Mathematics Education.*

**Books:**


Charles, R. I., Lester, F., & O’Daffer, P. *How to evaluate progress in problem solving.* Reston, VA: NCTM.


**Affect and Problem Solving:**


**Thinking and Metacognition in Problem Solving:**


**Teaching and Teacher Education and Problem Solving:**


Writing and Mathematical Problem Solving:


Social Dimensions of Problem Solving:


