Assessing the Influence of a Mathematics Elementary Teachers' Circle

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Significance

"Teaching mathematics through problem solving is a challenge for teachers who learned mathematics by doing exercises. How do teachers develop their own problem solving abilities as well as their abilities to teach mathematics through problem solving?"

"Due to improvements in the pre-K-12 mathematics curriculum, teachers are asked to teach content they did not learn in elementary school and to use processes they did not experience as learners."

---Sakshaug, L. E., & Wohlhunter, K. A. (2010). Journey toward teaching mathematics through problem solving. *School Science and Mathematics 110*(8), 397-409.

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Background

Teacher Quality Partnership (2010) – $8.9 million TQG
Five partner elementary schools, all "urban schools" – high percentage of economically disadvantaged, minority, special education, English-language learners

	Econ. Disadv	Black AA	Hispa-nic	Multi-Racial	White	SPED	ESOL
1	73%	45%	36%	4%	11%	11%	24%
2	93%	17%	73%	3%	7%	11%	51%
3	68%	51%	33%	6%	9%	11%	27%
4	86%	17%	71%	2%	7%	17%	52%
5	83%	38%	46%	4%	7%	10%	36%

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Background

- Began with 31 teachers – stipend $1000 plus $500 supply
- Immersion workshop – 3 days during winter break, 8 hours a day
- Four follow-up sessions, two hours long, after school at one of the elementary schools during Spring

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Research Questions & Design

- Does participation in Math Teachers' Circles increase participants' use of and appreciation for problem solving in their teaching?

  Journaling – each day of workshop, each follow-up session, & weekly.

- Does participation in Math Teachers' Circles improve participants' ability to engage in problem solving?

  Pre- and post-test.

- Does participation in Math Teachers' Circles change teachers' attitudes towards mathematics and problem solving?

  Pre- and post-survey.

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What is Problem Solving?

- NO prescribed solution method – problems not exercises.
- Not necessarily “advanced content” or a “word problem” or a real-life application of mathematics.
- Use of a variety of strategies to explore the problem and look for entry points to its solution.
- Persistence and patience in seeking a solution.
- Appreciation of the need to fully understand the problem and constraints.
- Development of conjectures and questions inspired by the problem.
- A willingness to collaborate with others to discuss and compare strategies and solutions including appreciation of the possibility of different approaches and identifying correspondences between different approaches.
- Awareness of the need for a convincing argument for the correctness and adequacy of the solution.

Q3: Attitude Survey

Pre- and Post-survey:

- Attitudes Toward Mathematics and Its Teaching (ATMAT) Scale: Ludlow, L.H. & Bell, K. N. (1996) Educational and Psychological Measurement Vol 56 no 5 October 1996 864-880

- Originally 29-item, 6-point Likert scale – modified to include questions about the use of problem solving in teaching. (e.g. "Problem solving is an important part of every mathematics class I teach.")

- No change in attitudes from the beginning of the immersion Workshop (Feb 21) to the final meeting (April 14)

Q2: Problem Solving

Pre-test and Post-test:

- Pre-test: What is the largest 5-digit multiple of 11 that has exactly 3 different digits?
- Post-test: Find the smallest integer multiple of 84 whose decimal representation uses just two digits 6 and 7.

- 5-point rubric based on definition of problem solving. Two scorers – correlation .84 for the pre-test and .92 for the post-test.

- A paired sample t-test indicated scores were significantly higher for the post-test (M=3.74, SD=1.37) than the pre-test (M=3.05, SD=1.19), $t(20)=-2.62$, $p=.008$.

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Q1: Teaching & Problem Solving

Evidence for influence on their teaching – **true problem solving:**

- ***"…I was able to give some problems that really make the kids have to stop and think. It was interesting to see how the kids tried to work it out when the easy rule did not work. Just when I thought they had reached the frustration level, they surprised me and told me they where [sic] not ready for the answer yet… This was a real good day in my classroom… a little shocking as well…"***

- ***"I tried to give the students as much independence as possible rather than trying to guide them in solving it 'my way'. The students came up with many different strategies and really listened to each other when they were presenting."***

- ***"I want to try to get my class to be able to have a lengthy conversation about a problem solving activity and use different strategies as a group to figure it out."***

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Q3: Teaching & Problem Solving

Evidence for influence on their teaching **– use of collaborative groups**:

- ***"I brought back from the workshop a deeper understanding of the thought processes I use to problem solve and most of all a greater admiration for other peoples' processes and approaches. I've never been a big fan of group work and tend to use it sparingly in the classroom. I realize now that my students could benefit greatly by learning from each other?"***

- ***"What interested me were the dynamics of how groups worked through problems, moving from whole group conjecture, to individual work, to pairs working together, and then back to whole group (or some similar combination). I discussed some of these experiences with my students early this past week before we worked on the problems discussed above. If anything, it seemed to validate their own experiences, and may well have encouraged them to be better partners and classmates, putting more into their work and expecting more from their partners and classmates."***

Q3:Teaching & Problem Solving

Evidence for influence on their teaching – **justification and stamina**:

- ***"Students should not just get an answer correct. They should be able to justify and explain their results. My kids have really benefited from this activity."***
- ***"I've changed my approach by giving the students more time to solve the problems collaboratively instead of me solving the problems with them. I get them to explain more and discuss the different approaches and strategies to students used to solve different problems."***
- ***" the students were showing great endurance and wanted to continue working on more problems like it."***

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Q3: Teaching & Problem Solving

Frustration:

- ***"I'm giving more thought to them solving problems than just giving them information. This is something new to them, so they don't particularly like it. It's easier for them to be told, but I'm hoping they will be intrigued by finding the answers themselves. I'm going to do more exploratory learning and try to apply problem solving."***

- ***"Honestly I found it difficult to incorporate the problem solving activities as I would like with my students… CRCT…but it's not nearly as high a level as I would like for my kids to be at."***

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Q3: Teaching & Problem Solving

As we read the journaling the participants roughly divided into three types:

- those who exemplified our definition of problem solving from the beginning (11 out of 25),
- those whose mind was changed by participation in math circles (10 out of 25) and
- those who never exhibited an understanding of problem solving as in our definition (4 out of 25).

Q3: Teaching & Problem Solving

Corinne was one whose mind was changed by participation in math circles (10 out of 25):

Initially: "***We have shown the students how to look for important information in the problem and eliminate anything that isn't relevant to the answer… We try to make the students follow the same steps every time they solve a problem.***"

March 4: "***I have focused more on the amount of discussion about the problems than the actual math that we did during the workshop. I want to try to get my class to be able to have a lengthy conversation about a problem solving activity and use different strategies as a group to figure it out.***"

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Q3: Teaching & Problem Solving

Cynthia was one whose mind was changed by participation in math circles (10 out of 25):

Initially: "***I teach students a mnemonic for problem solving RULES …***

March 11: "***I've changed my approach by giving the students more time to solve the problems collaboratively instead of me solving the problems with them. I get them to explain more and discuss the different approaches and strategies to [sic] students used to solve different problems.***"

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Conclusions

- No change in attitudes (time, definition of problem solving).
- Significant change in problem solving skills.
- Clear influence on teaching and understanding of problem solving.

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