

Pre-service Teacher Capacity in Mathematics: Research Outcomes and Program Changes

**Ann Kajander, Associate Professor
Faculty of Education, Lakehead University**

Carlos Zerpa, Lakehead University, PhD Student

Jennifer Holm, Lakehead University, MEd

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The Study

- This study of pre-service teachers forms part of a broader study which also includes studying in-service teachers (eg. Kajander & Mason, 2007)

Rationale

Teacher

- Teacher preparation programs are one year long in Ontario.

Methods Course

- Standard 36 hour methods course allows little time

Mathematical Understanding

- Many junior-intermediate (grades 4 – 10) candidates arrive anxious and weak in their understanding

Question

- What can be done *in the time we have?*

Framework

Specialized Understanding

- This work is conceptually grounded in the literature related to 'mathematics for teaching' (eg. Ball, Hill & Bass, 2005),

Beliefs and Practice

- Teachers' beliefs also affect their practice (Wilkins, 2008)

Procedural Oriented Beliefs

- Elementary teacher-candidates tend to have a procedurally-oriented set of beliefs about mathematics, as well as having weak mathematical self-concepts (Wilkins, 2008)

Context and Purpose

Overall goal was to study, and ultimately improve, teacher-candidates' understanding of, and comfort with, mathematics as appropriate for teaching

Cohort of 110 to 150 teacher-candidates each year were studied at the beginning and end of their (one year) methods course

Mathematics Methods Course

Reform Based Approach

Included

- Numeracy, Geometry and Patterning

NCTM 2000

- Principles and Standards – Teaching strategies

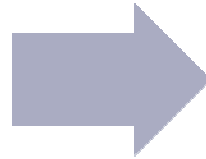
Instruction
Focused on

- Construction of ideas
- Building knowledge
- Manipulatives and introductory use of technology
- Sharing knowledge and ideas
- Open-ended problems
- Coach or facilitator
- Class assessment

Methodology

Instrument and Measurements

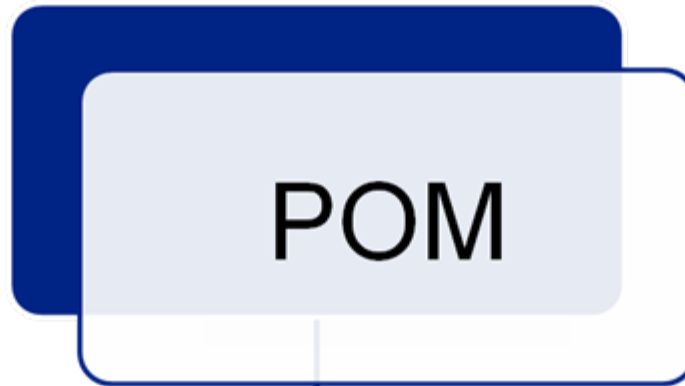
- Perceptions of Mathematics Questionnaire (POM)
- Demographics Variables
- Conceptual and Procedural Knowledge and Values



Procedure and Analysis

- Descriptive Statistics
Pretest and Post-test
- T-test
Repeated Measures

Methodology



POM

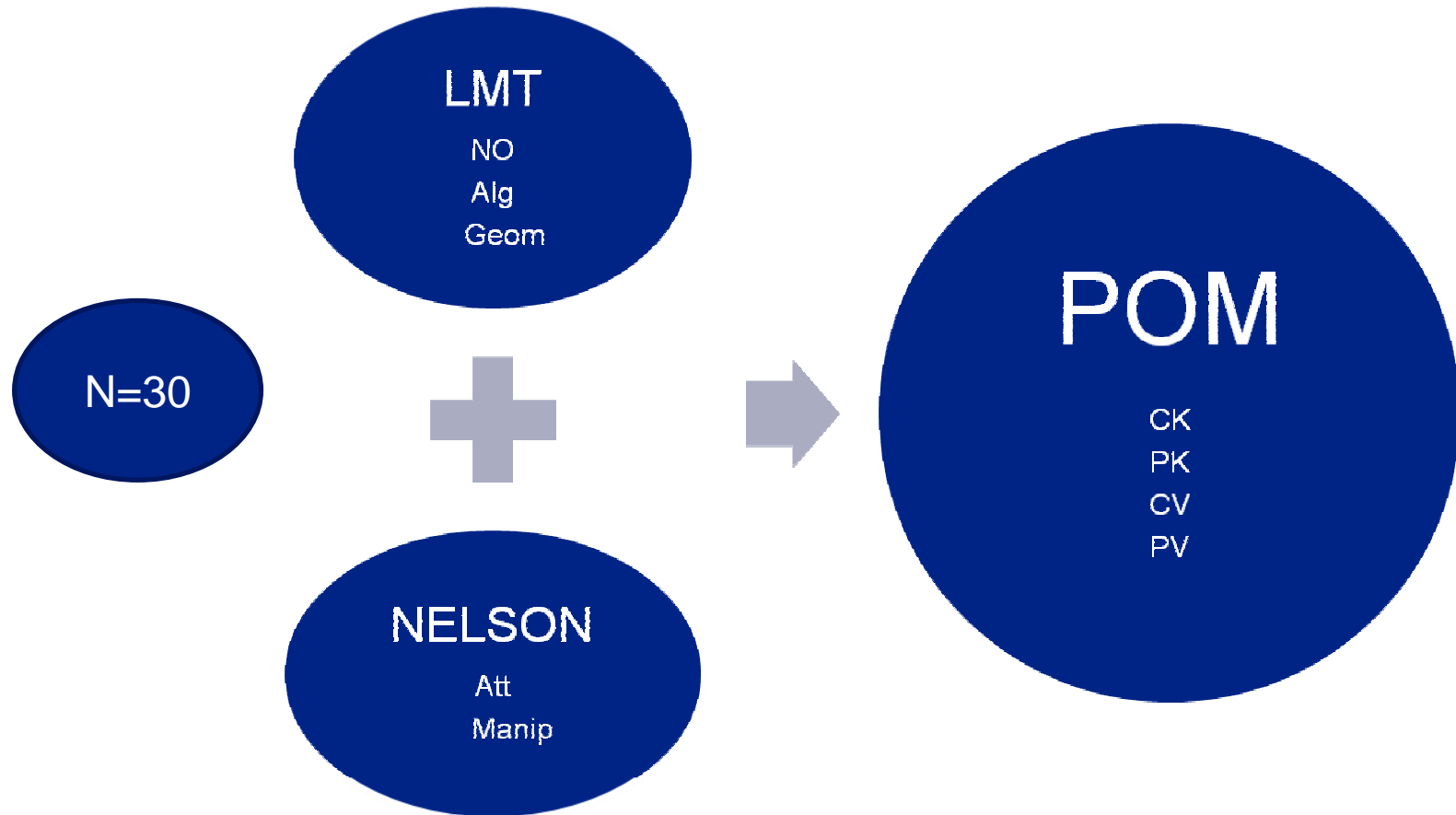
The *Perceptions of Mathematics* (POM) survey (Kajander, 2007) was designed to examine beliefs about mathematics, as well as to study participants' knowledge and understanding of elementary concepts

The lens of 'procedural' and 'conceptual' understanding was used to unpack the mathematical ideas, to build on participants' strengths

Validity and Reliability of the POM

Values Cronbach's Alpha Coefficient: 0.72 - 0.82

Knowledge Cronbach's Alpha Coefficient: 0.82

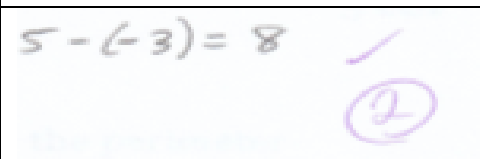
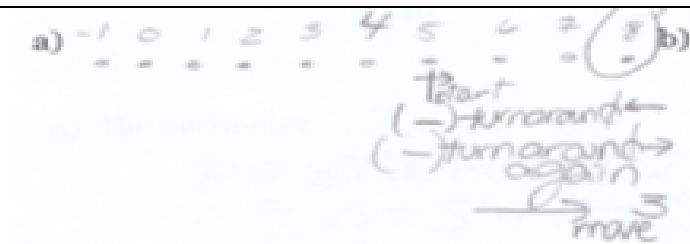
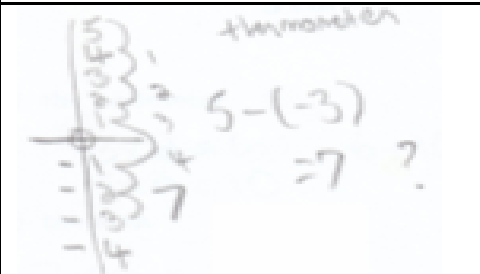
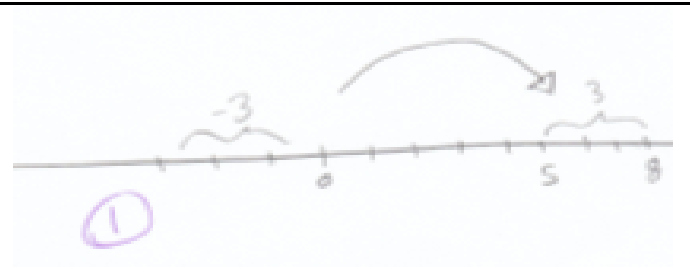
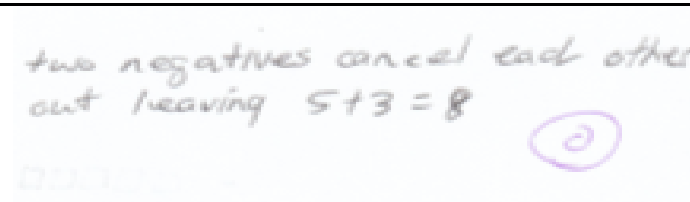


for questions 1 to 3 below on this page:

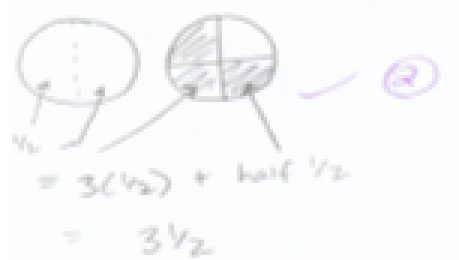

PART a): **Answer** the questions, showing your steps as needed to illustrate the method you used.

PART b): **Explain** what you can about why and how the method you used in a) works, using explanations, diagrams, models, and examples as appropriate. If possible, do the question another way.

Examples for scoring questions 2a and 2b

Score	2a (PK) scored out of 2	2b (CK) scored out of 2
2		
1		
0	<p>Incorrect answer and no method shown (or wrong method)</p>	

Examples for scoring questions 3a and 3b

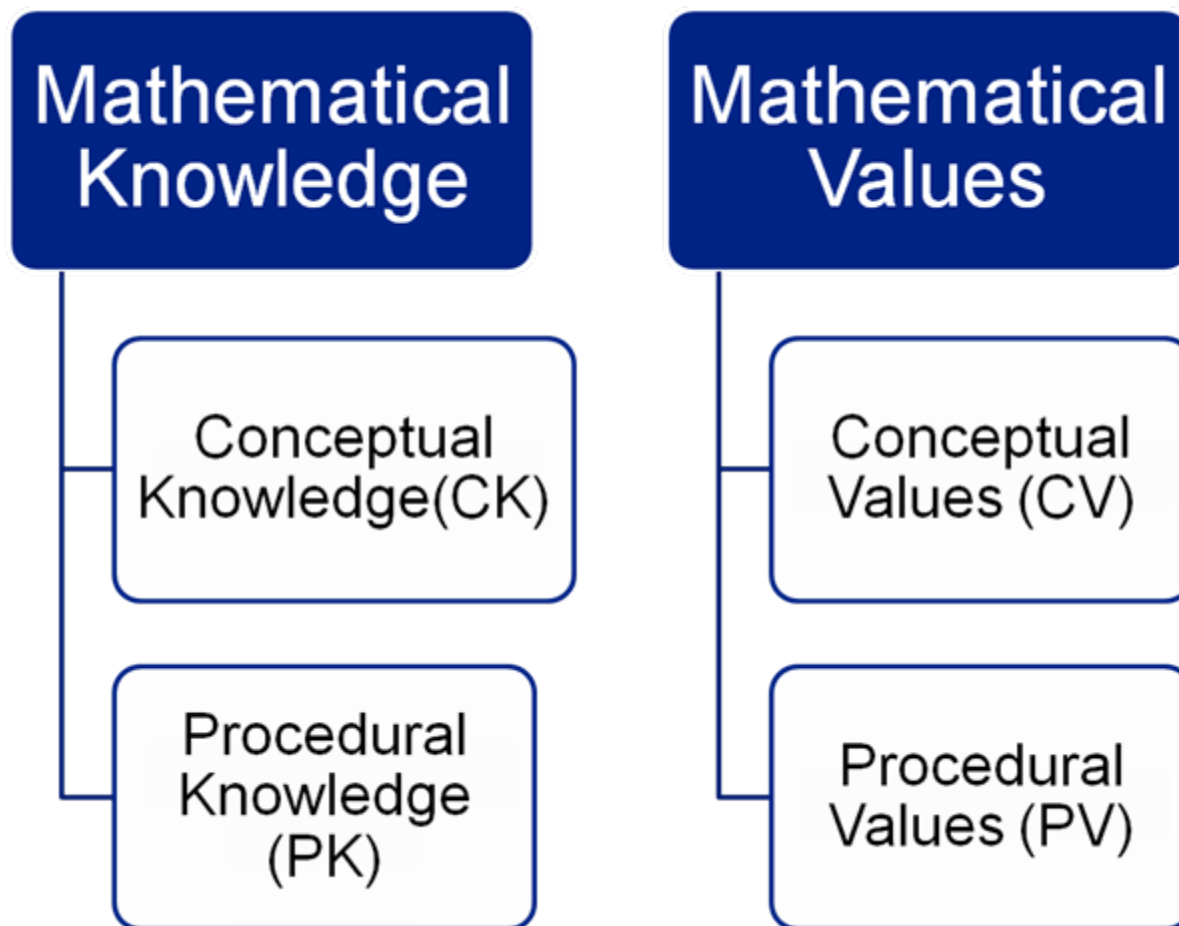
Score	3a (PK) scored out of 2	3b (CK) scored out of 2
2	$1\frac{3}{4} \div \frac{1}{2}$ $= \frac{7}{4} \times \frac{2}{1}$ $= \frac{14}{4} = 3\frac{2}{4} = 3\frac{1}{2}$	
1	<p>3. $1\frac{3}{4} + \frac{1}{2}$</p> <p>a) $1\frac{3}{4} \div \frac{2}{4}$</p> $= \frac{7}{4} \div \frac{2}{4}$	
0	$\frac{7}{4} \times \frac{1}{2} = \frac{7}{8}$	<p>I converted the mixed fraction to a common one, the simply inversed the frac dividing fraction & multiplied. @</p>

Procedural and Conceptual Values

- 1) It is important to me to be able to get the correct answer to mathematical questions. (PV)
- 2) It is important to me to really understand how and why mathematical procedures work. (CV)
- 3) It is important for everyone to be able to accurately do basic mathematical calculations such as addition or multiplication, without a calculator. (PV)
- 4) Everyone needs to deeply understand how and why mathematical procedures work if they are going to make effective use of them. (CV)

Perceptions of Mathematics Survey (POM)

Variables



Pre-service Study

Years 1 and 2: Gathering data on pre-service teachers' initial mathematical capacity, initial beliefs, and how these evolve over the duration of a standard mathematics methods course (Kajander, 2007; Zerpa, 2008)

Years 3 and 4: Program changes implemented based on research outcomes, data continuing to be collected and analysed

Year 5: Final outcomes

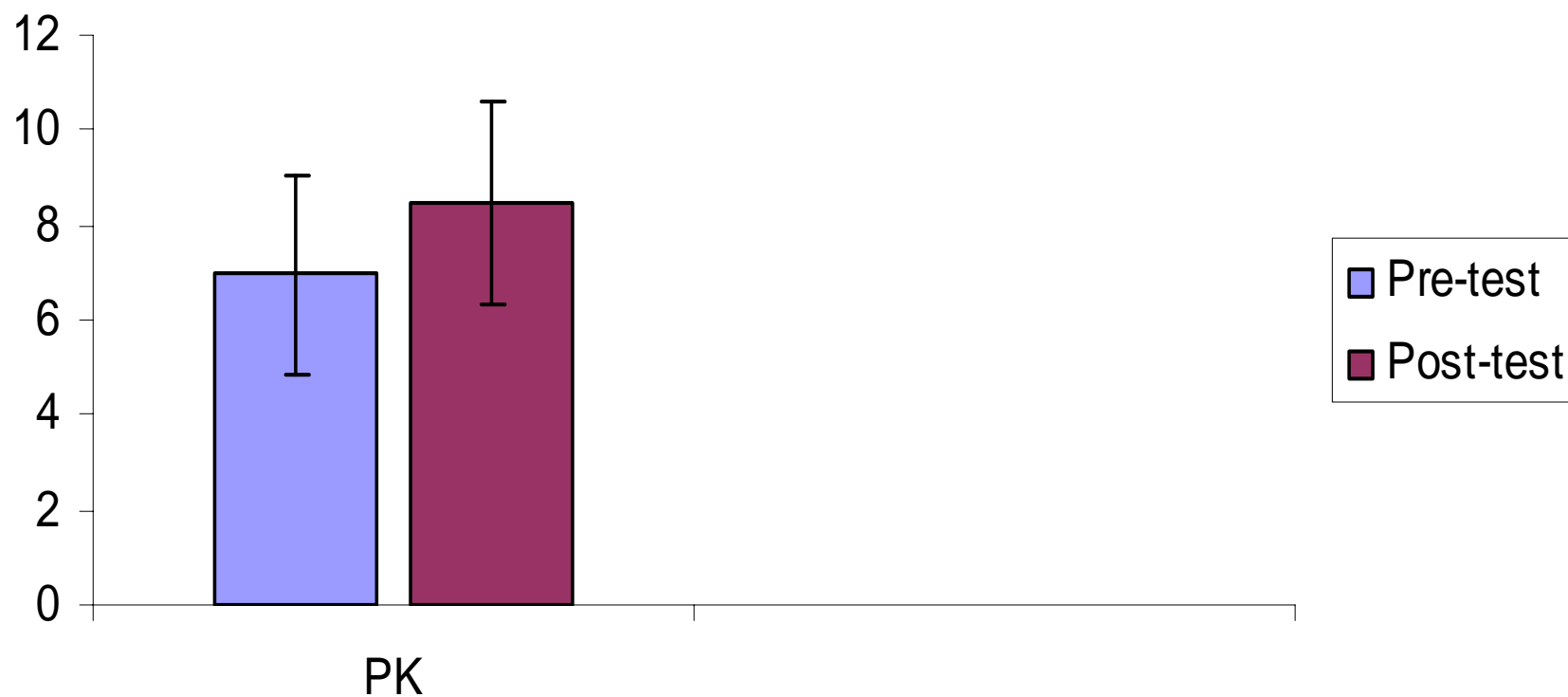
Results Summary – Years 1 and 2

Results were highly consistent from year to year, and strengthen similar claims found in the literature

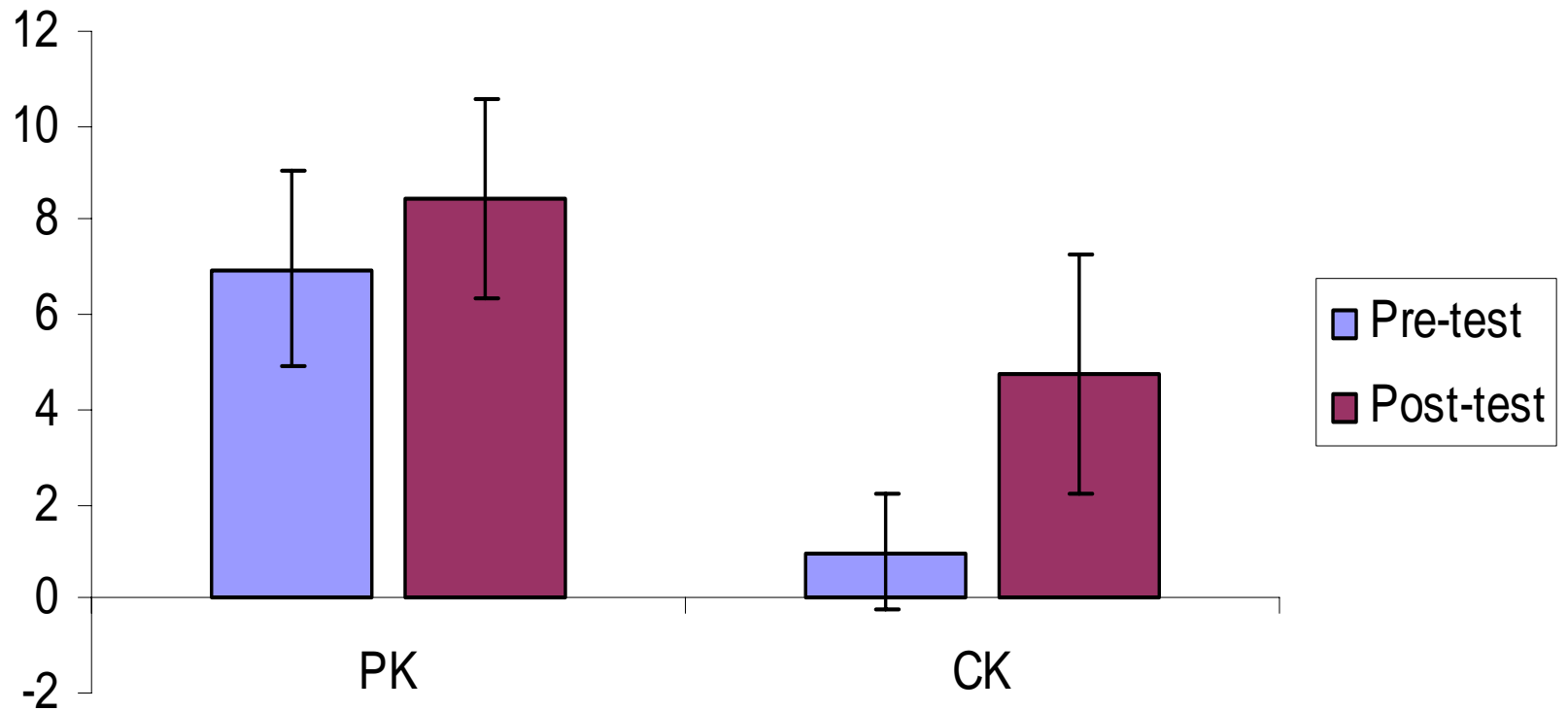
teacher-candidates arriving to our methods courses with highly procedurally oriented backgrounds

teacher-candidates claim to want to help their own students to 'really understand' mathematics, yet are virtually **unable** to explain or model any standard arithmetic procedures at the start of the course (mean score is about 10% in conceptual understanding each year in the scale of 1 to 10).

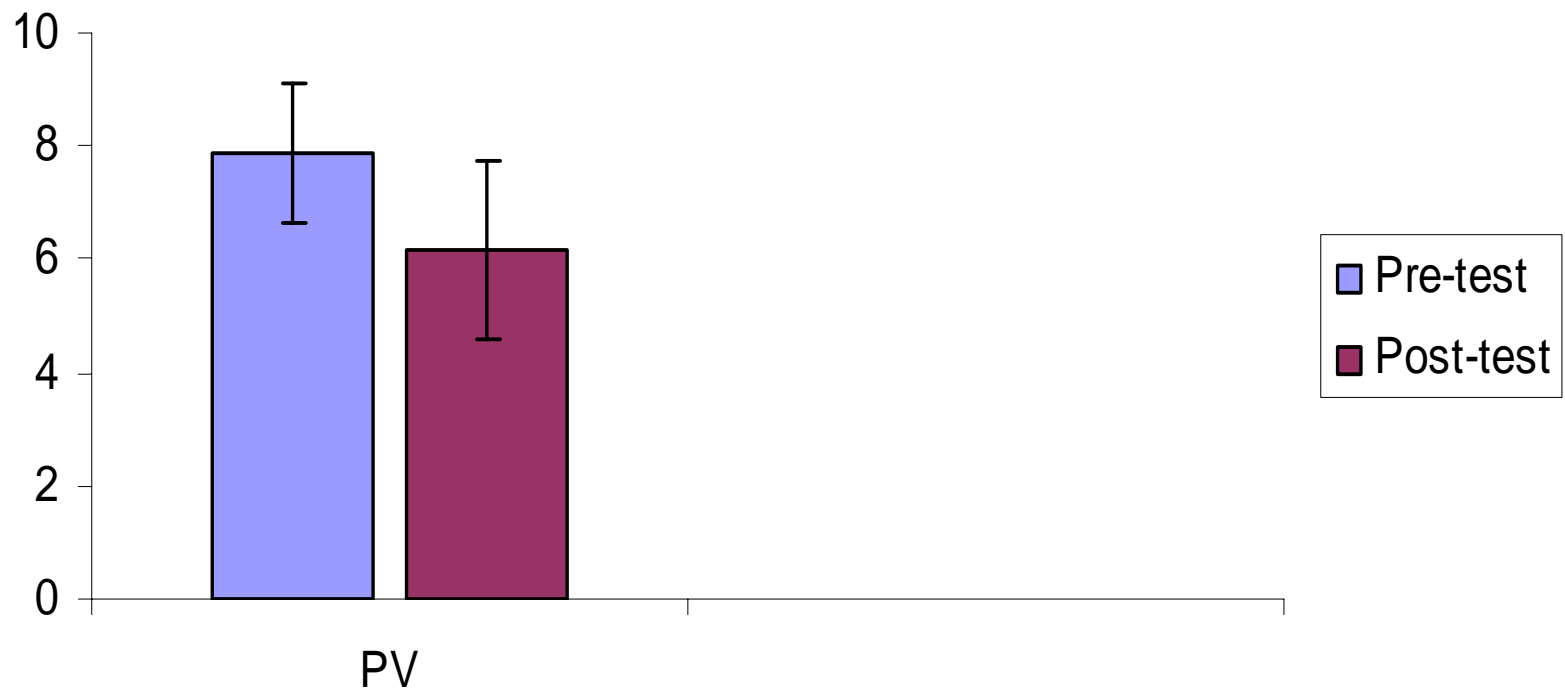
Change in Conceptual and Procedural Mathematical Knowledge



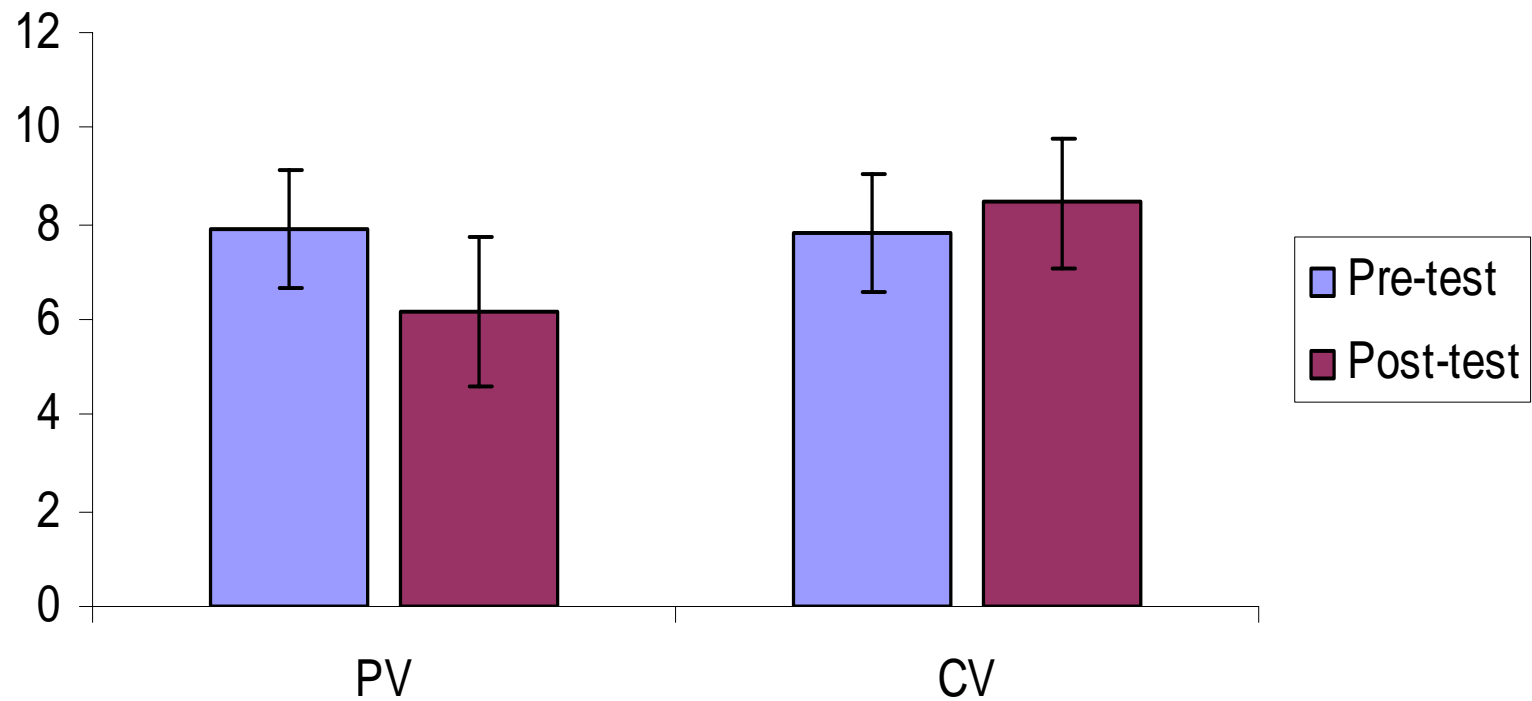
Change in Conceptual and Procedural Mathematical Knowledge



Change in Conceptual and Procedural Mathematical Values



Change in Conceptual and Procedural Mathematical Values



Year 1 and 2 Summary, con't

Mathematical Beliefs

- Beliefs about mathematics appeared generally to shift to a more reform-oriented conception during each year

Mathematical Understanding

- While teacher candidates improved significantly in mathematical understanding, as needed for teaching, over the duration of the teacher education program (which included the 36 hour mathematics methods course), understanding was still far from adequate in most cases, by the end of the course (Zerpa, 2008).


Program Changes, year 3 and 4

Based on the year 1 and 2 outcomes, the following program changes were made in our Faculty of Education, approved by Senate, and implemented as of September 2007:

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graph TD; A[Based on the year 1 and 2 outcomes, the following program changes were made in our Faculty of Education, approved by Senate, and implemented as of September 2007:] --> B[Two optional 20 hour courses called "Mathematics for Teaching" (40 hours total) were designed and offered to students concurrently with the methods course.]; A --> C[A mandatory formal examination in "mathematics for teaching" was created as part of the methods course requirements. Any students not receiving 50% on this examination did not receive their methods course credit until the exam was passed, thus delaying their BEd degree.];
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- Analysis is underway to determine the effect of these program changes
 - Only about 20% of students elect to take the optional math for teaching courses
 - Interview data (end year 3) is very positive about the usefulness of the mathematics content in the methods courses


Interview Data – sample comments

“I really didn’t have any experience with the conceptual methods [prior to the methods course] so I just assumed it was okay to teach the formula and then off you go.”

“It’s almost like I’ve re-learned things to think conceptually, rather than just follow the steps and do it that way. It’s just like my eyes have been opened .”

Math for Teaching Course Comments

Students who also took the optional Math for Teaching courses consistently said these courses helped greatly:



"Well it just kind of furthered my understanding because like I know there's not a lot of time in the [methods] course to cover as much of the material in depth as possible, so a lot of the time I felt rushed, but, um, it really like kind of slowed down and gave you the time to like learn it and I definitely improved. I think."

Future Changes – year 5

The Faculty of Education has just approved a further change, to increase the pass rate for the “Math for Teaching” content exam from 50% to 60% in 2009-2010.

ACKNOWLEDGEMENTS

This study was funded by the University of Manitoba NSERC CRYSTAL project: *Understanding the Dynamics of Risk & Protective Factors in Promoting Success in Science & Mathematics Education.*

ann.kajander@lakeheadu.ca,
czerpa@lakeheadu.ca,
jholm@lakeheadu.ca