Fostering Mathematical Creativity in Teachers

An Examination of Problem Posing and its Impact on Fluency, Flexibility, and Originality

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Overview

This project investigates the effectiveness of problem-posing techniques, specifically the "What-If-Not" method, as an intervention to foster mathematical creativity in pre-service and in-service teachers, measured by changes in their fluency, flexibility, and originality using Bulka's Creative Mathematical Ability Test (CMAT) in a pre-post-test design.

Research Question

Can a targeted intervention utilizing problem-posing techniques (specifically the "What-If-Not" method) effectively foster mathematical creativity in pre-service and in-service teachers?

Research Question

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1. What are the observed changes in teacher mathematical creativity, specifically in fluency, flexibility, and originality, as measured by the CMAT pre- and post-test scores following the problem-posing intervention?
2. Do the two-part treatment assignments (What-If-Not problem posing and subsequent lesson plan with problem posing) provide evidence that the fostered creativity in the teachers is reflected in the design of their instructional materials (e.g., lesson plans)?
3. How do the participants' personal beliefs about mathematics, creativity, and teaching change from the beginning to the end of the course, and does this change correlate with their demonstrated growth in mathematical creativity?
4. Do the participants' work on the final, grand problem-posing project provide a snapshot of their total growth in problem-posing ability and mathematical creativity throughout the course?

Literature Review

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1. Defining Creativity
2. Theoretical Frameworks for Mathematical Creativity
3. Fostering Mathematical Creativity
4. Instrument and Assessment of Mathematical Creativity

Defining Creativity

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General Definition of Creativity:

The widely used definition of creativity as something that is both novel and useful (e.g., Plucker and Beghetto). This also includes contrasting views of creativity as a product, a process, or a person, and the concept of creativity being relative to the individual's experience.

Creativity as Convergent and Divergent Thinking:

Models often classify creativity as a combination of convergent thinking (pattern detection) and divergent thinking (hypothesis creation and testing).

Definition of Creativity in Mathematics:

Mathematical creativity is defined as a novel and useful insight relative to the individual's mathematical background. It differentiates between everyday creativity (school level) and extraordinary creativity (professional level).

Theoretical Frameworks for Mathematical Creativity

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Sriman's Five Principles:

- ✓ the gestational principle
- ✓ the aesthetic principle
- ✓ the free market principle
- ✓ the scholarly principle
- ✓ the uncertainty principle

These principles provide a framework for designing classroom tasks that promote creativity.

Fostering Mathematical Creativity

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- ✓ Instructional Strategies: Practices for fostering creativity
  - ❑ Ill-defined questions
  - ❑ Ambiguous tasks,
  - ❑ Open-ended problems
- ✓ Problem Posing:
  - ❑ Problem Identification
  - ❑ Problem Alteration
  - ❑ Problem Generalization

  Utilizing "what-if-not" for increasing students' flexibility and fluency
- ✓ Depth of Knowledge (DOK): The importance of extended time for thinking and high Depth of Knowledge (DOK) level 4 projects for allowing deeper, more creative exploration.

Instrument and Assessment of Mathematical Creativity

- **Balka's Creative Mathematical Ability Test** (CMAT): The CMAT is a reliable and proven instrument for assessing student mathematical creativity.
- **The Components of Creativity**:
  - **Fluency** number of relevant answers
  - **Flexibility** number of categories/directions of answers
  - **Originality** rarity of the answer

Methodology

Research Design

Sample

Instrument(s)

Procedure

Methodology Research Design

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- **Design Type:**

Pre- and Post-Test Design. This structure is used to measure the effect of an intervention (the treatment assignments) by comparing participants' mathematical creativity scores (the dependent variable) before and after the intervention.

- **Intervention (Treatment):**

The core treatment involved two rounds of assignments focused on problem-posing, specifically using the "What-If-Not" method, and then applying this technique to lesson planning.

- **Setting:**

The study was conducted in a five-week summer course on problem-solving and modeling at a state university.

This design aims to determine if the intentional training in problem-posing leads to a measurable increase in the teachers' mathematical creativity.

Methodology Research Design

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Instruments:

- **Pre-test and Post-test:**

Bulka's Creative Mathematical Ability Test (CMAT), which measures creativity across the three factors: fluency, flexibility, and originality.

- **Supplementary Data:**

A mathematical beliefs questionnaire was administered pre- and post-test to track changes in beliefs.

- **Other Assignments:**

The treatment itself, including the What-If-Not problem posing assignments, the lesson plan assignments, and the final problem-posing project, served as additional data sources to assess growth and application of creativity in teaching.

Methodology Sample Population

The sample population for this study consisted of nine students enrolled in a graduate-level course on problem-solving and modeling at a state university.

- **Affiliation:**

All participants were students at the university where the research was conducted.

- **Diversity in Experience:**

The group was varied in their educational and professional backgrounds:

- some were in their **first semester of graduate school** and were part of a graduate teaching assistant (GTA) program, training to teach at the collegiate level
- others were **classroom teachers** currently enrolled in the graduate program.

- **Context:**

Participation was tied to their enrollment in a **five-week summer course**, meaning all instruments used (pre/post-tests, assignments) were graded components of the course.

Design & Order

- Pre-tests (CMAT & Beliefs Survey)
- Round 1 (What-If-Not 1 & Lesson Plan 1)
- Round 2 (What-If-Not 2 & Lesson Plan 2)
- Post-tests (CMAT & Beliefs Survey)
- Final Project on Problem Possing

Findings

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Descriptive Statistics for Overall Sample on the CMAT

	n	Mean	Max Total Score	Min Total Score	Range of Scores
Pre-Test	9	46.11	65	31	34
Post-Test	9	62	85	45	40

Findings

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Descriptive Statistics for Overall Sample on the Beliefs Survey

	n	Mean	Max Total Score	Min Total Score	Range of Scores
Pre-Test	9	3.99	4.44	3.73	0.71
Post-Test	9	3.93	4.46	3.51	0.95

Beliefs stayed overall steady throughout the study.

The lowest scored questions were negatively phrased

Findings: Students of Interest

Student A: Lowest Pre-test score on CMAT

Tied for greatest Pre-test to Post-test scores increase of 41 points

Ranked 7th on the pre-test of beliefs and 4th on the post-test

Student A Scores on the CMAT		
Overall Results	Pre-Test	Post-Test
Fluency Averaged Score:	13	33
Flexibility Averaged Score:	13	25
Originality Averaged Score:	5	14
Overall Averaged Score:	31	72

Beliefs Survey scored a 3.902 on pre-test and 3.897 on post-test

Findings: Students of Interest

Student E: Highest CMAT Post Test Score

Tied for greatest Pre-test to Post-test scores increase of 41 points

Ranked 4th on the pre-test of beliefs and 3rd on the post-test

Student E Scores on the CMAT		
Overall Results	Pre-Test	Post-Test
Fluency Averaged Score:	20	37
Flexibility Averaged Score:	16	31
Originality Averaged Score:	8	17
Overall Averaged Score:	44	85

Beliefs Survey scored a 4.00 on pre-test and 4.025 on post-test

Discussion (Summary & Conclusion)

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Implications

- Pedagogical
- Curricular

Limitations

- Small sample size (9)
- One participant did not complete all assignments

Suggest Further Research

- Repeat the study with larger n
- Math teachers in the field vs. pre-service teachers

Questions?

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