



A Study of Fractional Understanding in Early Grades: A Partnership in Teacher Education

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Session Overview

- > Study Background & Context
- > Research Design
 - > Methodology
 - > Instruments
- > Findings-
 - > Students
 - > Teacher Candidate Cases
 - > Teacher Content Knowledge
 - > Pedagogical Content Knowledge
- > Implications
- > Next Steps
- > Discussion

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Research Questions

1. Does the use of manipulatives have an effect on pre-service teachers instructional practices & content knowledge?
2. Are pre-service teachers able to transfer the methods & strategies from their university coursework to their teaching
3. What do students know and understand about fraction concepts?
4. What effects do discrete & continuous models have on students fractional understanding & achievement?

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Supporting Literature-Fractions

- > Fractions do not fall into the well-established patterns and counting algorithms of the whole numbers (Bezuk & Cramer, 1989; Behr & Post, 1992).
- > Students must change thought processes from additive ideas to reasoning that is multiplicative (Moss, 2005, p. 310).
- > The struggle may be a direct result of a "curricular emphasis on procedures rather than the careful development of important functional understanding" Behr, Lesh, Post, and Silver (1983).
- > Sharing and partitioning of quantities, must become fundamental to a student's understanding (Lamon, 1996; Hunting, 1986)

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TCK/PCK

- > Ball, Thanes, & Phelps (2008)
- > Ball, Hill, & Bass (2005)
- > Hill, Schilling, & Ball (2004)
- > Bischoff (2003)
- > Capraro, Capraro, Parker, Kulrn, & Raulerson (2005)
- > Kahan, Cooper & Bethea (2003)
- > Mohr (2006)
- > Nilsson (2008)

Efficacy

- Bandura (1981, 86, 97)
- Enochs & Riggs (1990)
- Enochs, Smith & Huinker (2000)
- Tschannen-Moran, Hoy & Hoy(1998)

Beliefs about Teaching

- Ambrose (2004)
- Barlow & Reddish (2006)
- Gresham (2008)
- Vace & Bright (1999)

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Context

- > Fall 2007
- > Integral Part of Undergraduate Program
 - > Teacher Candidate Growth & development
 - > Program Evaluation
- > Outgrowth of Graduate Course
 - > Practical Experience
- > Need in district
 - > Content support
 - > Student Achievement & Understanding

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Teacher Education Program

- Novice
 - Freshman/Sophomore years
 - 2 field experience courses over 4 semesters
 - 1-1 tutoring model then 1-small group model
 - 1 hour twice weekly in schools
- Teaching Associate
 - Junior Year
 - Literacy, math ,science, social studies foci
 - 1 hour daily in classroom
 - Content & PD classes either on PDS or BU campus



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Teacher Education Program

- Intern
 - Senior Year
 - Full year, daily classroom instruction
 - Classroom Teacher & Clinical Faculty from Baylor
 - Seminars & coursework either on PDS or BU campus

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"Brazos River" Elementary PDS Demographics-2007

- Economically Disadvantaged- 82%
- Limited English Proficiency-9%
- At Risk-54%
- Mobility Rate-28%

Ethnic Groups	
•African American	42%
•Hispanic	31%
•White	24%
•Native American/Asian/Pacific Islander	3%

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Participants

- 1 Kindergarten Class (22 students) with 1 Intern
- 2 Third grade classes (46 students) with 3 TAs & 1 Intern
- All preservice teachers female

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Timeline

- Graduate Students Reviewed Literature & Designed study
- 3 days of pre-service teacher training
 - Pre-assessments
- 2 days of pre-assessing students
- Lesson one day per week, six weeks
 - Observations/reflections
- Post-Assessing of students & preservice teachers

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Data Collection Sources Mixed Methods

- Quantitative (Pre/Post)
 - Candidate Content Assessment Pre/Post
 - Instructional Beliefs Survey-Horizons Research
 - Mathematics Teaching efficacy Beliefs Instrument (MTEBI-Enochs, Smith & Huinker, 2000)
 - Student Content Assessment Pre/Post
- Qualitative
 - Taught 6 Research-Based Lessons
 - Observations
 - Video Recording Summaries
 - Anecdotal Notes by TC on Student Understanding
 - TC Post Teaching Reflections
 - Lesson Plans

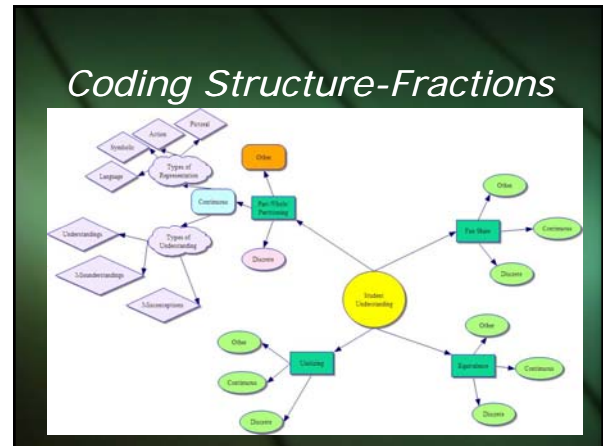
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Validation of Student Content Assessment

	Component			
	1	2	3	4
B8b	.934	-.028	-.096	.107
B8a	.901	-.012	.127	.276
B8c	.852	.211	.156	-.043
B7c	.759	.170	.390	-.307
B7a	.718	.102	.408	-.290
B5b	.705	.158	-.388	-.127
B7b	.700	.418	.030	.287
B3b	.151	.938	-.051	.017
B3a	.032	.930	-.135	-.110
B2a	.297	.806	-.108	.249
B2b	-.017	.707	.203	-.574
B5a	-.120	-.026	.844	.001
B6b	.056	-.194	.834	.047
B9a	.199	.113	-.164	.805
B9b	-.150	.040	.134	.786

Table 1. Final Rotated Component Matrix

- Cronbach's Alpha
 - (α = 0.798)
 - Factor issues being considered
- Recommendations
 - Rewrite or remove certain questions
 - Larger sampling



Coding Structure for Teacher Candidate Data

- Teacher Content Knowledge
- Pedagogical Content Knowledge
- Sample indicators
 - Use of manipulatives
 - Transfer to Practice
 - Instructional Practices
 - Understanding of student learning
 - Use of assessment data

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Results of TC Content Assessment

- Initial gaps in knowledge of fraction concepts
- Inability to model in multiple ways
 - Much stronger with traditional algorithm
 - Non-traditional problems were an issue
- Mixed Gains from pre to post
 - More willing to try a second method
 - Issues with administering
 - Short time frame
- Continuing work on instrument validation

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Overview of TC Survey Results

- Shifts were individualistic
- If changed response--was by only one level
- Aids in understanding case

1c: I enjoy teaching math
 1d: Master math teacher
 3a: Use prior understanding
 3b: Develop conceptual understanding
 3e: Lead investigation
 3g: Cooperative groups
 3h: Students responsible for learning
 3i: Ask questions to gauge understanding
 5n: Effect of general ed on teaching
 5o: Effect of Math methods courses

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 6a: Prep to teach numbers & ops

Cases Findings for students and teacher candidates

- Kindergarten
 - Angela
- 3rd Grade
 - Sarah
 - Tabitha
 - Shandra
 - Julie

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Kindergarten, 2007			
	Pre-Test Mean	Post-test Mean	Significance (2-tailed)
Q1	1.47	3.11	0*
Q2a	2.32	3.63	0*
Q2b	1.17	2.71	0*
Q3a	0.63	3	0*
Q3b	0.38	2.19	0*
Q4	4	4	na
Q5a	1.79	2.05	0.350
Q5b	1.53	2	0.155
Q5c	1.17	2.89	0*
Q6a	3.32	3.37	0.902
Q6b	1.84	3.05	0.014*

Kindergarten, 2007			
	Pre-Test Mean	Post-test Mean	Significance (2-tailed)
Q7a	3.26	3.37	0.742
Q7b	1.71	2.59	0.02*
Q7c	2.17	2.67	0.07*
Q8a	0.84	1.26	0.226
Q8b	0.56	1.06	0.135
Q8c	0.65	1.12	0.104
Q9a	1.26	2.05	0.035*
Q9b	1.26	1.95	0.044*
Q10a	1.47	2.58	0.015*
Q10b	2.11	2.37	0.515
Q10c	1.18	1.35	0.605

Findings Related to Kindergarteners

- Test analyzed with two-tailed t-test
 - 12/22 items significant & + at $p < .05$
- Discrete Model
 - Significant improvement - 100%
 - How could you share 12 pencils between you and a friend?
- Continuous Model
 - 4/15 questions showed improvement
 - How could you share this cupcake between you and a friend?

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Findings Related to Kindergarteners

- Students could name the fractions 1/4, 1/2, and 1/3.
- Understood fair share
 - Most counted one at a time, but exceptions
- Able to match numeric form of fraction to the appropriate visual representation.
- Understood visual representation of the fractional pieces needed to be equal in size, but unable to draw own fractional pieces to represent
- Transfer of knowledge-other context
- Beyond expectation of district curriculum

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"Angela" - Kindergarten

➤ TCK

- Limited content knowledge based on lack of accurate terminology used in TC reflections
- No questions to extend student thinking or address higher level thinking
- TC does not understand in depth the meanings of fractions

➤ PCK

- Importance of playing with manipulatives
- Acceptable to deviate from a scripted lesson
- Classroom management
 - Small group
 - State objective and procedures
- No higher level questions
- Leads responses and no wait time
- Limited connections to student understanding

MTEBI	Efficacy Pre	Efficacy Post	Out Exp-Pre	Out Exp-Post	Overall-Pre	Overall-Post
Angela	3.62	3.67	3.63	3.63	3.62	3.65

3rd Grade, 2007			
	Pre-Test Mean	Post-test Mean	Significance (2-tailed)
Q1	2.69	3.38	0.009*
Q2	2.81	3.32	0.04*
Q3	2.16	2.9	0.003*
Q4	2.26	2.87	0.016*
Q5	1.74	2.55	0.011*
Q6a	2.06	2.31	0.309
Q6b	1.03	2.12	0*
Q6c	0.6	2.1	0*
Q7a	3.62	4	0.032*
Q7b	1.5	2.72	0.001*
Q7c	0.72	2.03	0*

3rd Grade, 2007

	Pre-Test Mean	Post-test Mean	Significance (2-tailed)
Q8a	2.65	3.19	0.084
Q8b	1	2.16	0*
Q8c	0.62	2.12	0*
Q9a	2.72	3.31	0.032*
Q9b	1.97	2.06	0.572
Q9c	3.12	3.41	0.299
Q9d	2.78	2.97	0.405
Q10	1.88	2.88	0.004*
Q11a	1.47	1.97	0.062*
Q11b	2.25	3	0.005*
Q12	2.09	2.25	0.258

Findings Related to 3rd Graders

- > Pre/Post Test analyzed with two-tailed t-test
 - > 16/22 significant & + at $p < .05$
- > Discrete Model
 - > 100% improvement
 - > What fraction of eggs has spots?
- > Continuous Model
 - > 10/16 showed improvement
 - > How would you share this cracker between you and two friends?

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Findings Related to 3rd graders

- > Could identify numerator and denominator and explain what each represents.
- > Exhibited limited confidence in identifying or working with continuous models of fractions
- > Could identify and name fractions represented in discrete models
- > Exhibited limited understanding of equivalent fractions in both models

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"Sarah" -3rd Grade

- > TCK
 - > Solid questioning
 - > Personally understood fractions
 - > Recognized perceptual distracters
 - > Use of manipulatives

- > PCK
 - > Recognized the value of spiraling the content
 - > Saw a value in engaging students
 - > Scaffolding instruction

MTEBI	Efficacy Pre	Efficacy Post	Out Exp-Pre	Out Exp-Post	Overall--Pre	Overall--Post
Sarah	3.46	4.54	4.63	4.63	3.9	4.57

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"Tabitha"-3rd Grade

- > TCK
 - > Realized that more content preparation was necessary to communicate mathematical concepts
 - > Realized the need to extend her own content knowledge specifically related to fraction symbols

- > PCK
 - > Recognized the value of using a variety of models
 - > Changes observed in the questioning strategies during the course of the course of study

MTEBI	Efficacy Pre	Efficacy Post	Out Exp-Pre	Out Exp-Post	Overall--Pre	Overall--Post
Tabitha	4.46	4.54	4.13	4.00	4.33	4.33

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"Shandra" 3rd Grade Intern

- > TCK
 - > Purpose of manipulatives unclear for developing student understanding
 - > Teacher used manipulatives and recorded much more than students
 - > Questioning at low level; did not allow students to share thinking

- > PCK
 - > Poor development of questioning strings; transfer of techniques
 - > Teacher-centered rather than student-centered
 - > Missed teachable moments
 - > Began to move to higher level questions in later lesson

MTEBI	Efficacy Pre	Efficacy Post	Out Exp-Pre	Out Exp-Post	Overall--Pre	Overall--Post
Shandra	3.85	4.08	3.63	3.50	3.76	3.86

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"Julie"-3rd grade

TCK

- Understood role of equivalent fraction and formation of fractions and connection
- Understood need for students to understand fraction basics before equivalency

PCK

- Recognized need to emphasize parts of fractions and representation
- Recognized power of student peers sharing thinking
- **Focused on behavior**
- Improved questioning strategies

MTEBI	Efficacy Pre	Efficacy Post	Out Exp-Pre	Out Exp-Post	Overall--Pre	Overall--Post
Julie	4.08	3.92	3.88	4.00	4	3.95

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Teacher Candidate Reflections- Following semester

- Valued questioning and listening to student explanations
- Able to identify misunderstandings
- Identified teachable moments:
 - Using student thinking
 - Addressing gaps in knowledge
- Observed student transfer of knowledge & ability to retain

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Impact on Teacher Candidates

- Collaborative planning & instruction with mentor teacher
- Better link between assessment & instruction
- **Better organized and more time for planning and reflection**
- Ability to reflect on student learning lacking-- usually focused on management issues-- informs teacher ed program
- **Supported learning of teacher candidates and graduate students (both math content & pedagogical)**
- Reflected NCTM and State standards as well as teacher education standards (PDS/NCATE)

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Conclusions/Implications Student Understanding

- Discrete models supported understandings of part-whole, partitioning & fair share
- Models & manipulatives helped students in development of understanding of fractional concepts
- **Equivalence relationships more easily understood with discrete models**
 - Perceptual distracters evident with continuous model

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Other Outcomes

- **Learning of research protocol**
- Opportunities for University Faculty, Graduate students, PDS faculty and candidates to collaborate in a professional endeavor as peers
- **Presentation opportunities at local, regional, and international conferences**
- Stronger connection between student assessment and learning and teacher candidate learning
- **PDS & University faculty professional development**
- Experience of theory to practice of both undergraduate and graduate students

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Next Steps

- **Implemented Second Study in Fall, 2008**
 - Worked with K – 3rd grades
 - Made adjustments and revisions to Lesson Plans
- **Focused on First Grade**
 - New lesson plans were written for 1st grade
 - New materials and manipulatives were organized
- **TAs had more time for collaborative planning and reflection**
 - Better communication with classroom teachers
 - More formal planning within each classroom
- **"Mock" Administration of Assessment**
- **Revised experiences with Fractions in Methods course**
- **Continue longitudinal study in Fall, 2009**
- **Continue data analysis**

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Challenges/Barriers to consider

- **Scheduling**
 - School site, rooms, equipment, observers
- **Content Focus**
- **Communication/Availability**
- **Teacher Candidate Stage of Development**
- **Materials & Resources**
- **Labor Intensive**
- **Student Backgrounds and Experience with Constructivist Lessons**

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