Mathematical Literacy and the Explicit Inquiry Routine

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Influence of Technology

- Today's expanding global market
  - necessitates a fundamental understanding of algebra
  - connects algebraic reasoning and productivity

Need for Mathematics Literacy

- ability to carry out basic calculations no longer ensures a living wage
- computers create consumers of mathematics
  - quantitative model > forecasts dress demand
  - mathematical algorithm > designs truck delivery routes
  - digital readouts > monitor critical operations (e.g., bakery)
  - web-based tools > manage health and retirement plans
- computers do the calculations, BUT using the model without understanding leaves individuals vulnerable

Need for Effective Mathematics Instructional Methods

- below Proficient in mathematics
  - 64% of fourth graders
  - 70% of eighth graders (NAEP - 2005)
- at least 26 states require
  - a course in algebra
  - minimum competency test

Mathematics Instruction in the General Education Setting: Inquiry Learning

- build on background knowledge and skills
- provide opportunities for invention and practice
- analyze different possible solutions
- provide mathematical explanations
- reflect on mathematical characteristics
- in-depth analysis of problem categories (Hiebert, 2003).

Mathematics Instruction in the Special Education Setting

- carefully selected and organized content
- explicit, focused, and predictable instruction
- integrated into the larger context

Limited Number of Algebraic Interventions

- six empirically based studies (1999)
- content covered includes:
  - signed numbers; combining like terms; equations; exponents
  - rational word problems
  - proportion word problems
  - two-variable, two-equation word problems
  - inequalities; graphing

Explicit Inquiry Routine (EIR) Goals

- implement scaffolded inquiry with research proven methods
  - direct instruction
  - concrete- representational- abstract
- improve the mathematical understanding
- impact students with LD
- improve mathematical performance

EIR Teaching Sequence

- Explicit Sequencing
  1) Identify an essential concept or process
     Single variable equations - equations that include only one variable in a variety of structures
  2) Break the concept or process into to its smallest bites*
     $x+3=10$ $3x=12$ $2x+3=21$ $5x-4=11$
     $2x+3x=x$ $1x+2x+5=35$
  3) Establish the sequence of instruction
     Simple: $x+3=10$ $x-3=10$ $x+3-2=12$
     $x+3+2=14$ $x-3-2=13$ $3x=12$
  4) Generate word problems for each bite
     Tom has a box of cards and three fewer cards. Jim has ten cards. Tom and Jim have the same number of cards. How many cards are in Tom's box?

*A bite is the smallest instructional unit of a concept
(e.g., for the concept one-variable equations $x+3=10$ is one bite)

EIR Teaching Sequence cont.

- Experimental Inquiry
  5) Instruct each bite using the Explicit Inquiry Teaching Routines
     Instruction Routine ***Representation Routine***
- Scaffolded Instruction
  6) Expect student mastery before progressing to the next bite
  7) Build concept or process one bite at a time

EIR Teaching Routines

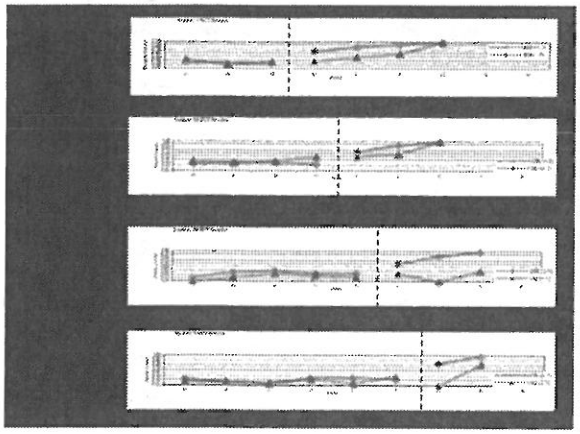
- Representation Routine - situation and process
  - Concretely Display
  - Graphically Record
  - Mathematically Express

EIR Teaching Routines

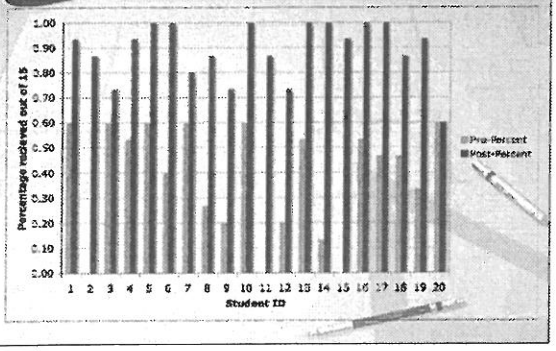
- Instruction Routine
  - Teacher - all solve together
  - Peers - student pairs solve together
  - Individual - independent solving

Participation Criteria

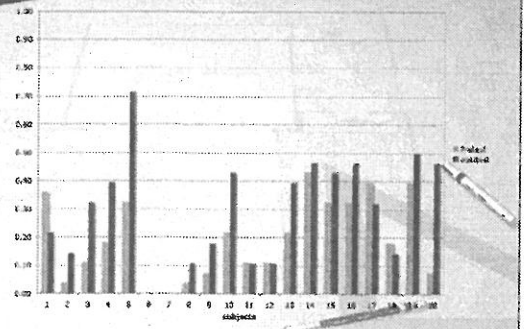
- identified as LD (IQ > 85)
- math achievement < 25 percentile
- one-variable equation solving < 50 %



Concrete Manipulation



Generalization Measure



Conclusions

- EIR is an effective method to instruct students in the solving of one-variable equations
- students with LD can participate in structured inquiry processes
- students with severe mathematical disabilities can be taught to manipulate and solve basic algebraic problems
- using EIR provided the instructor with a unique insight into students' mathematical processing and understanding
- students with math LD can generalization algebraic understanding

Limitations

- specialized school
- small number of participants
- restricted population
- researcher provided instruction
- controlled language word-problems
- limited transfer of ability

Next Steps

- replicate findings in control-group study with larger groups and teacher providing instruction
- expand student populations using EIR
- expand content covered using EIR
  - Area and perimeter
  - Real world problems

Thank You

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