



What's The Rule? Factors Influencing Strategy use on Functional Thinking Problems

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Focus

Functional Thinking skills within elementary school children

- Cross-sectional differences in problem solving strategies
- How problem format affects strategy choice

Functional Thinking

• **Functional Thinking** is a component of algebraic reasoning which deals with coordinating relations between two sets of numbers.

• Requires **Covariational Thinking**

• A **Function** is a relation that uniquely associates members of one set with members of another set, for which there exists a *rule of correspondence* for generating a single value in set B from each element in set A. (Vinner & Dreyfus 1989)

• Cultivating this reasoning is a fruitful way to develop algebraic reasoning because it transitions the focus from particular instances to sets of allowable values.

• Children often begin with a **recursive strategy**, where they only consider change across one set, but a **functional strategy**, which considers the relationship across both sets, is needed for correct algebraic reasoning

X	1	2	3	4	5	10	15	100
Y	5	6	7	8	9	14	19	104

Method

Three Function Table problems were administered to each of 232 2nd through 6th graders as part of an assessment development project in one of three parallel Problem Format between-subjects conditions

Grade	N	Function Type (n/s)	Problem Format (n/s)
2	53	Additive $Y = X + 4$	Indexical
3	50	Multiplicative $Y = 3X$	Non Indexical
4	25	Combination $Y = 3X + 2$	Story Context
5	60		
6	44		
All	232		

Strategy Differences by Grade

Subjects' work was coded for strategy use

•Correct Functional Strategy

- Used correct rule to predict Y value from X values
- Considering Functional XY relationship, correct: $Y = X + 4$

X	2	3	4	5	6	14	32	41
Y	6	7	8	9	10	18	36	45

•Incorrect Functional Strategy

- Use incorrect rule to predict Y values from X values
- Considering Functional XY relationship, but incorrect: $Y = X + 5$

X	2	3	4	5	6	14	31	41
Y	6	7	8	9	11	19	36	46

•Recursive Strategy

- Predicts next Y value from previous Y value
- Considering Recursive Y_1, Y_2 relationship: $Y_2 = Y_1 + 1$

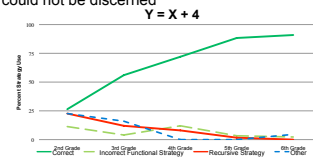
X	2	3	4	5	6	14	15	41
Y	6	7	8	9	10	11	36	37

•Unclear

- A consistent rule could not be discerned

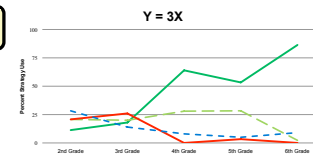
Additive

Equal use of Correct and Recursive Strategy in 2nd Grade



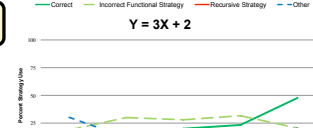
Multiplicative

Equal use of Correct and Recursive Strategy in 2nd & 3rd Grade



Combination

Greater use of Recursive Strategy in 2nd & 3rd Grade, and equally prevalent as Correct in 4th grade



Overall

Students are more likely to use a recursive strategy when a function is challenging

Overall rates of recursive strategy use decrease with grade

Overall rates of correct functional strategy use increase with grade

Effects of Problem Format

The effects of **Problem Format on Strategy Use** was examined Between Subjects

Indexical Function Tables

•X values increase sequentially by one

This format is conducive to a recursive strategy (Carragher, Martinez, & Schliemann, 2008)

X	2	3	4	5	6	14	41
Y	6	9	12	15			36

What is a rule for figuring out what number belongs in column Y?

Non-Indexical Function Tables

• X values increase non-sequentially

Encourages a functional approach, as recursive strategy cannot be applied (Warren & Cooper, 2005)

X	2	4	5	7	8	14	41
Y	6	12	15	21			36

What is a rule for figuring out what number belongs in column Y?

Story Context Function Tables

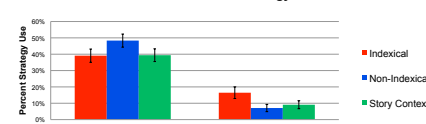
•Indexical X values, but with a story context

Helps understand the functional relation more intuitively, grounds the functional relationship (Schliemann, Carragher, & Brizuela, 2003)

Cost of Present (X)	2	3	4	5	6	14	41
Cost of Present with Gift-Wrapping (Y)	6	9	12	15			36

At a gift shop, you can pay extra to have your present gift-wrapped, as shown in the table below. What is the total cost of the present with gift-wrapping if the cost of the present is \$6? \$14? What about \$41? If the total cost of a present with gift-wrapping is \$36, what was the cost of the present itself?

What is a rule for figuring out the total cost of the present with gift-wrapping?



-The Indexical Format encouraged the use of the Recursive Strategy relative to other formats

-The Non-Indexical Format encouraged the use of the Correct Functional Strategy relative to other formats

-The Story Context Format did not encourage the Recursive Strategy, but it also did not encourage the Correct Strategy

-Effects tend to be more pronounced when the Function Type is challenging for the grade level

Conclusions

- Within elementary functional thinking, recursive strategies are thought to be the predominant strategy for young children. Our results suggest there are ways to facilitate thinking functionally.

-The recursive strategy seems to be the fall back strategy, used when the problem is too difficult or when the indexical X axis encourages it.

-Children can use functional thinking when given adequate supports

- This has implications for Math Education, as Function Table problems are typically presented Indexically

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Acknowledgments

The first author is supported by a predoctoral training grant provided by the Institute of Education Sciences, U.S. Department of Education, through Vanderbilt's Experimental Education Research Training (ExpERT II) grant (David S. Cordray, Director, grant number R305B080025). The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education.

This work was also supported by an NSF CAREER Grant (#0810746565) awarded to Dr. Bethany Rittle-Johnson.

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This poster was printed by the Graphics Core of the Vanderbilt Kennedy Center, Vanderbilt University, supported in part by NICHD Grant P50 HD15952. The Vanderbilt Kennedy Center for Research on Human Development is devoted to unlocking the mysteries of the brain and child development, and improving the lives of people with disabilities. www.vanderbilt.edu