

Strategy Discovery in Kindergartners Solving Addition Problems

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Introduction

Problem-solving strategies have been investigated to determine how children reach solutions and the conditions which facilitate problem solving. To precisely focus on the interface between the problem solver and the task environment during periods of rapid change in strategy use, Siegler and Jenkins (1989) examined preschoolers' acquisition of addition facts. The present study builds on their research and investigates strategies children construct (discovery) to cope with the demands of an addition problem solving task. According to Siegler and Jenkins, a strategy is "discovered" when it is used for the first time; discovery can involve sudden discontinuous changes leading to dramatic insights, or a series of smaller realizations may gradually culminate in a breakthrough.

The present study examined the effect that two variables had on strategy discovery: the presence of manipulatives and the level of difficulty of the addition problem. Strategy discovery was examined using a microgenetic design which combines dense sampling over an extended period of time with an intensive trial-by-trial analysis.

Method

27 kindergartners ($M_{age} = 6.1$ years) in public schools in Birmingham, Alabama were randomly split into two groups: 13 with manipulatives (WM) available (forty small plastic bears) and 14 with no manipulatives (NM). Children were given no instruction on strategy use or addition and were tested individually during two sessions per week for 12 weeks between February and May. Each session consisted of 12 addition problems: six small addend problems (both addends ≤ 5), three large addend problems (one addend ≤ 5 and one between 6 and 9), and three challenge problems (one addend > 10 , the other < 5). Problems appeared on a computer monitor and were read aloud ("How much is $3 + 5$ ").

Results

The presence of manipulatives did not aid discovery. The problem type had a dramatic effect on discovery of three of the four strategies examined: nearly 90% of the time, shortcut sum (count on fingers from one), count aloud from one, and retrieval were discovered on a small addend problem.

Interestingly, the min strategy (count from the larger addend) was discovered exactly equally often on all three problem types. Siegler and Jenkins (1989), in contrast, found discovery of min occurred on small addend problems 71% of the time and on large addend and challenge problems 14.5% of the time each.

Conclusions

Did manipulatives aid discovery? Are strategies discovered more frequently on easier or more difficult problems? The type of problem seemed to influence strategy discovery, whereas the presence of manipulatives did not. It was expected that the additional support provided by the manipulatives would spur on discovery, yet the median of the discovery trials for each strategy scored was not significantly different between the groups. It seemed that children in both groups were content to use their fingers and did not need the added support to discover strategies: children_{NM} used their fingers 30% of the time; children_{WM} only used manipulatives on 9% of the trials but used their fingers 19% of the time, for a combined total of 28%. Thus, each group used some kind of external aid with about the same frequency.

Both groups displayed remarkably similar patterns of discovery, usually (at least 88% of the time) discovering strategies on small addend problems (except in the previously mentioned case of min), and all discovery trials were highly accurate (78% or higher). This is consonant with Siegler & Jenkins' (1989) conclusion that strategy discovery was not due to an inability to solve problems correctly using extant strategies and provides additional evidence to contradict the previously accepted notion that an impasse is a required precursor to discovery.

Large addend and challenge problems were expected to provide an incentive for the discovery of more elegant or efficient strategies. Though such an incentive proved unnecessary for discovering the less advanced strategies (shortcut sum, counting aloud from one) and retrieval, it did seem to aid in the discovery of the more elegant min strategy.

References

Siegler, R. S., & Jenkins, E. (1989). How children discover new strategies. Hillsdale, NJ: Erlbaum.