Title

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Learning through verbalization (2): Understanding the concept of "schema"

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When one starts to learn a new topic, it is essential to understand the terminology, to the point where one can use them comfortably. For such learning, balance is required between concrete experiences and their abstract verbalization, but how to achieve the balance has not yet been studied systematically. In this report we compare three sets of learning activities to see the effects of the amount of concrete experiences and their verbalization on learning. While a short demo with high demand on abstraction does not yield significant verbalization, ample practices with reflection appear to solicit natural generalization.

Comparison of three classes

Three undergraduate classes were taught the concept of schema through structured activities around the "Day arithmetic" (Lindsay & Norman, 1977), where the students were to solve problems like

When Wednesday + Tuesday = Friday,
what is Tuesday + Friday?

The classes differed in the amount of practices of the problem, as well as in the types of verbalization required to summarize this experience. In Class 1, students solved three problems, while Class 2 solved 3 and then 20, and Class 3 solved 3, 72, 60, and 60 problems in chunks. This practice was followed by the question of what strategy they would choose to solve many Day arithmetic problems. After that, a transfer problem, "m+b=?" was posed. At the end of the unit, each class was asked to summarize their experiences. For the numbers of the students, see Table 2.

Amount of experiences and choice of strategies

Table 1 shows the students' choices of strategies to tackle many problems, either rote memorization of the answers, use of a table of answers, or of rules such as "to add a Monday, answer the next day of the addend." Rules are highly effective, but this fact was only graspable after a relatively many practices.

Table 1: Strategy choice

Class	No. of Trials	Strategy choice		
		Memory	Table	Rules
1	3	20.0%	70.0%	10.0%
2	23	16.2%	32.3%	51.5%
3	195	15.2%	15.2%	69.6%

Micro-generation of a schema

To the transfer problem of m+b, many students answer "o," paralleling this to the Day arithmetic. Some even extended its rule and solved this by just going down the alphabet two more letters from m, without counting. Both cases indicate that the students generate a schema-like understanding, applicable to a similar problem. Table 2 itemizes the ratio of types of this micro-generation. The success rate of the micro-generation of the schema is quite high, and sparing the practice time does not affect the generation pattern.

Table 2: Answer types of "m+b"

Class	Count-up	Transfer	No answer
1 (n=81)	50.6%	44.4%	4.9%
2 (n=71)	59.2%	38.0%	2.8%
3 (n=92)	63.0%	35.9%	0%

Abstraction at the end of the unit

At the end of this unit, the students were asked to summarize their experiences, in different instructions. The answers were categorized as "Concrete" when they only referred to specific examples and/or procedures; as "Moderate" when they referred to the strategies and effects; as. "High" when they included explicit comments on their commonality and/or generalizability. Class 1 students were asked to describe what kind of knowledge their rules were, which was too difficult to answer, particularly after a short demo. Class 2 students were encouraged to explain the Day arithmetic to their friends. Most students chose to stick to concrete procedures, ignoring the schemas. Contrastingly in Class 3, the students were asked to comment on the most important points of the unit. Possibly scaffolded by the ample amount of experiences as a base for reflection, this attempt was most successful among the three classes.

Table 3: Abstraction levels of summaries

	Ratio of answerers	Answer abstraction levels		
		High	Moderate	Concrete
1	23.4%	15.8%	42.1%	42.1%
2	91.5%	6.2%	1.7%	92.3%
3	100%	24.7%	25.9%	49.4%

The overall pattern indicates the importance of concrete experiences, as a basis for significant reflection. A short demo with highly abstracted explanation might appear to save time, but could impair the quality of learning.

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References

Lindsey, N., & Norman, D. (1977). Human information processing. New York:Academic Press