Learning through verbalization (1): Understanding the concept of probability

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Schematizing experiences plays a critical role in learning. Verbalizing experiences at a proper abstraction level has been identified as important for effective schematization (Shirouzu *et al.*, 2002), or learning (Chi *et al.*, 1989), but its details need to be studied further. For instance, in a statistics class, a dramatic demonstration can help students grasp basic concepts like the law of large numbers. Though the students remember them well, what they could verbalize differs depending on the class activities and has different effects on learning. We report here that the students asked to verbalize a demo one hour after could express the important aspects of the event 18% more than their counterparts who did the same twelve weeks later.

Learning the concept of probability

When asked what it means that "The probability of getting ONE pip when you roll a die is one-sixth," it is not rare that even a college student answers that you get ONE once per six rolls of a die. To change this misconception a curriculum was devised. In Activity 1 each student rolled a die 50 to 100 times, counted each pip, and the class tallied the results to yield a histogram of over 3000 trials. This was followed by Activity 2 using a deformed die, with four sides of 1.5 lengths of the other two. Each student rolled the die 200 times, checked the probability of appearances of the pips of ONE and SIX (on shorter sides). Then the class collected all the data to histogram them. The comparison of these two patterns aims to clarify the relationship between the probability and the likelihood of event occurrences, based on the law of large numbers.

Comparison of two classes

Using the curriculum, two undergraduate classes in cognitive science dept. were taught the concept of probability. Two classes were organized differently to compare the timing effect of abstracting the experiences. While Class 1 emphasized teacher-guided abstraction, Class 2, taught by the same teacher, focused more on the students' own verbalization. In Class 1, the teacher explained the law of large numbers, had the students engage in Activity 1. One week later, he showed to the class the histogram of all the data, explained the law, and engaged the class in Activity 2. The results were tallied three times, for 20, 200, and 1800 trials. The students were only explicitly requested to verbalize the meaning of their experiences twelve weeks later, at the term examination. In Class 2, the class did Activities 1 and 2 consecutively in one day (in two classes), without teacher's explanation of the law. Explicit verbalization was requested at the end of the class, in the form of revisiting the starting question. The students had a chance to discuss among themselves.

Results

The verbal reports of the two classes were categorized in terms of their degrees of abstraction. The reports of category "High" refer to the meaning of the law; "If you roll the die infinitely, the ratio of getting the pip ONE approaches 1/6." "Moderate" reports mention the effect of large numbers; "You get the pip ONE roughly 1/6 times if you roll the die many, many times." "Concrete" reports may refer to their class size as an example of a large number, but not its effects. "Others" often include their previous knowledge about the probability, "The pip ONE occurs 1/6 times because it is one of the equally possible six events." Table 1 summarizes the results.

Table 1: Abstraction levels of verbal reports

	Ratio of answerers	Answer abstraction levels			Other
		High	Moderate	Concrete	
1	85.3%	5.3%	16.0%	45.3%	18.7%
2	92.1%	0%	39.4%	10.5%	42.1%

In Class 2, more students moderately abstracted their experiences than concretely. Lacking the chance to do the same, some 45% of the students in Class 1 reverted to the concrete level answers when tested. In order to bridge concrete experience with abstraction, the "moderate" expressions may play an important role.

Requiring students only to verbalize from memory may have had them focus on resultant pattern of 1/6, bringing them back to their previous "common sense" from textbooks. There seems to be certain duration of time to properly ponder on the exact cause and effect of the "surprising" phenomena, to be able to scrutinize their newness carefully enough to be able to generalize them.

Acknowledgments

This research is supported by JPS to the 1st author and by MECSST and CREST/JST to the 2nd author.

References

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