Chinese Students' Understanding of Probability

Li Jun, Nanyang Technological University

June 2000

Abstract

In our modern society, people are faced more and more often with making decisions in an environment that involves uncertainty. Within this environment the teaching of probability is an important topic. The literature suggests that probability is a complex concept with many dimensions. Probability can be interpreted descriptively using words such as never, impossible, unlikely, probably, certain, and so on, but how they are used in probability may be different from the real-life use of these words. Probability can also be interpreted quantitatively using three approaches: theoretical, empirical and subjective. These approaches are complementary, since different approaches could be appropriate in different situations. However, it should be noted that in some situations more than one of the three approaches could be applied in the same situation.

Researchers who have investigated probability have identified many misconceptions, such as representativeness, availability, outcome approach, equiprobability, and so on. The results of the research show that the use of some misconceptions decreases with age, while others are very stable and even grow stronger with age. The research has usually been undertaken in Western countries.

This study investigated the following three questions: What are the main misconceptions of probability Chinese students have? What is the developmental structure of students' understanding of probability? Can an

activity-based short-term teaching programme improve ordinary grade 8 students' understanding of probability?

The research was divided into two parts. The first two questions were answered in the first part, referred to as the main study. The sample was 567 Chinese students from three grades (6, 8 and 12) and two school streams (ordinary and advanced). Eighty-three items, most in multiple-choice plus explanation form, in four categories (identification of impossible, possible and certain events; interpretation of chance values; chance comparison in one-stage experiments and chance comparison in two-stage experiments) were organised into nine distinct questionnaires. Sixty-four out of the 567 students were interviewed the day after the questionnaires had been administered.

The second part is referred to as the teaching intervention. Six activity-based lessons which focused on empirical probability were given to two grade 8 classes (each with about 25 students) in an ordinary school. The approaches were parallel except that one class had the opportunity to see computer simulations of a long series of experiments, while the other class was given the data in written form. During most of the teaching time the two classes did the same activities. All the students were tested and interviewed both prior to and after the teaching intervention.

Fourteen groups of misconceptions were observed in this study. The outcome approach, chance cannot be measured mathematically, compound approach and equiprobability were the main misconceptions for each grade and each stream of students. The context and data used in an item were found to play a role in eliciting some misconceptions.

The SOLO taxonomy was used in this study to describe students' hierarchical understanding levels on the concept of probability. It was found that, generally, there was no improvement in developmental level at grades 6 and 8, the two grades without any formal probability training. Grade 12 students have a better understanding than the younger students.

It was found that students' understanding of the frequentist concept of probability was the weakest. Most students in this study applied at least one misconception related to the frequentist definition of probability in their written questionnaire.

The results of this activity-based short-term teaching programme show that even a short intervention can help students overcome some of their misconceptions, such as chance cannot be measured mathematically. However, in this particular teaching experiment there was little change in the students use of the outcome approach and equiprobability, but it is possible that an alternative teaching experiment designed specifically to overcome these misconceptions might have a positive impact. Students in the two classes, one class with and one class without computer simulations, improved substantially in their answers and reasoning but no statistically significant difference was found between the classes.

Probability is not part of the present Chinese school curriculum, except in a very few cities such as Shanghai where there is a very limited unit in grade 12 of approximately 8 hours. This situation is currently under review and the findings of the study can be used to inform change. For example, the results show that Chinese students develop misconceptions about probability prior to any formal introduction. In introducing probability, this information

needs to be considered, and the data from the teaching intervention shows that an activity-based teaching programme, whose design considers the specific misconceptions that students have, can be effective in overcoming some misconceptions, even when computer simulations are unavailable.