Children’s understanding of probability and certainty: an intervention study

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The children’s progress in measures of probability concepts

We used three assessments of the children’s understanding of probability: one focused on their understanding of randomness, the second assessed their ability to generate a sample space and the third evaluated their skill at comparing the probability of two events. These three concepts were taught in sequence starting in the Summer term when the children were in Year 5 and ending in the Spring term, when they were in Year 6.

Randomness

In the assessment of children’s understanding of randomness they were asked about the difference between determined and random events and about the independence of random events. For example, some people think that if you draw 4 purple marbles in a row from a box that contains an equal number of purple and yellow marbles, and always put the marble back in the box before drawing the next one, it is more likely that you will draw another purple marble next. Others think that it is more likely that you will draw a yellow one next. Neither of these answers is correct: the probability of drawing a marble of either colour continues to be the same, as each draw is independent from the preceding ones.

The same test was used to assess the children’s understanding of randomness at pre-test as well as immediately after the teaching ended (immediate post-test) and about three months...
later (delayed post-test). The figure shows the mean scores for each group on each testing occasion. The mean scores for the children in the probability group increased with teaching and the gap between the performance in this group and the other two groups remained the same three months after the teaching about randomness had finished.

**Sample space**

In the assessment of sample space, the children were asked to write down, for example, all the matches that could be played by 4 children in a tennis championship if each child played every other child and no matches were repeated. Because different tests were used at pre-test and for the post-tests in the assessment of the children’s ability to construct a sample space, the graph describing the children’s performance in this assessment displays the means for their post-test performance controlling for differences at pre-test.

At the immediate post-test, the probability group already performed better than the other two groups and there was no sign of a decay in their performance in the delayed post tests, one given 4 months and the other given 6 months after the teaching had been completed.

**Quantification of probability**

The same tests of the children’s ability to compare the probability of two events were used at pre-test, immediate post-test and delayed post-test. The children were asked to indicate from which of two boxes they would rather draw a card if the winner in the game was the one who pulled out a card with a circle; one box had, for example, 2 cards with a circle and 4 with a square, whereas the other box had 3 cards with a circle and 6 with a square. In this case, the probability is the same and the child’s answer should be that it does not matter from which box they pull out a card, an option clearly explained to them at the time of testing.
The children did not differ in their performance in the measures of understanding randomness and sample space at the start of the study. At that time, they did not participate in an assessment of their understanding of quantification of probability. After the probability intervention group had learned about randomness and sample space, in the first two terms of the study, they participated in Test 3, before they started to learn about how to measure the probability of an event. Although the specific teaching had not started yet, the probability group performed slightly better than the other two groups, but the difference between the probability group and each of the other two groups was not statistically significant. In contrast, after the lessons about the quantification of probability, the difference between the probability group and each of the other two groups was statistically significant. These results support our hypothesis that, by learning about randomness and sample space, the children start to develop an understanding of how probabilities should be quantified.

One can also see in the graph that the children’s performance did not decay between Test 5, given immediately after they completed the teaching, and Test 6, given about 2 months after the teaching programme had ended.

These three results show quite unambiguously that the teaching was effective and the children learned significantly more about these important probability concepts than the groups who did not participate in the lessons. Therefore, although children may learn many things outside school, teaching can have a decisive role in helping them to understand probability concepts.