* Strand D *PROBABILITY* Introduction

Introduction to Topics

Probability is a remarkably interesting area of mathematics used by many people to solve real problems. It is the foundation on which statistical theory is based and is a crucial building block in the application of mathematics to real world problems.

Although it is no longer included in the National Curriculum, this is not in line with what happens in mathematically high-performing countries. Not only is probability a relevant and topical application of mathematics, it is also a very meaningful and interesting use of fractions.

Historical Context

Place Value

Probability owes its origins to gambling but is now defined as 'the chance or likelihood of something happening' and is of real importance in today's commercial world.

Gambling is an activity that has been practised by humankind for many centuries. Archeologists have found evidence of games of chance being played in Egypt as early as 3500 BC, and six-faced dice dating from about 3000 BC have been found in Iraq and India.

However, it was not until about 1500 AD that any real thought was given to the probabilities which underlie any game of chance, and the work done was very fragmented – more in the nature of speculation than reasoned argument. The generally accepted view of the beginnings of probability are these:

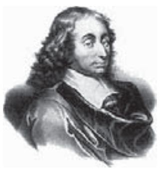
In about 1650, the *Chevalier de Méré*, who was an able and experienced French gambler, found that his own reasoning on the subject did not agree with his observations. Realising that it must be his reasoning which was wrong, he wrote to *Blaise Pascal* (1623-1662), a leading French mathematician at that time, and explained his dilemma. They considered the problems:

"Are you more likely to obtain one six in 4 tosses of a die than to obtain at least one double six in 24 tosses of two dice?"

The now famous exchange of correspondence between Pascal and another French mathematician, *Pierre de Fermat* (1601-1665) took place: these letters are now accepted as being the beginning of the theory of probability. One of the earlier (and easier) problems they dealt with was,

"How many times must one throw a pair of dice before expecting to get a double six?"

Blaise Pascal



Pierre de Fermat

Other problems considered at this time included,

"Are you more likely to obtain a total of 9 when three fair dice are tossed, than a total of 10?" (*Galileo* and *Duke of Tuscany*)

"Which is more likely: one 6 when six dice are tossed or two 6s when 12 dice are tossed?" (*Pepys* to *Newton*)

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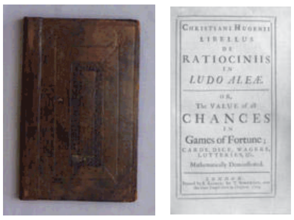
Christiaan Huygens (1629-1695), a Dutch mathematician, on a visit to Paris, learnt of the correspondence and, as a result, in 1657 published his own book. 'De Ratiociniis in Ludo Aleae' (On reasoning in dice games) – the first published work of importance on probability.

Christiaan Huygens



The cover and title page of Huygens' publication

More recently, probability forms the basis of risk-taking, which concerns all large companies in their business transactions. In the decade before the financial crisis of 2008, many banks and money lenders had taken excessive risks and when the financial markets lost confidence and share prices around the world tumbled, these companies were either forced to cease trading or were 'bailed out' (with financial help) by their governments. Many of these organisations had ignored the advice given by their statisticians. It was not that the probability analyses were incorrect but simply that human greed to make greater and greater profits caused people to ignore the warnings.

In addition to being the basis of risk analysis, probability is also fundamental to Genetics, especially in recent developments in genetic fingerprinting in criminal cases and paternity disputes and in the process of comparing different medical treatments.

Misconceptions

- It is a fact that the probability, p, of an event must be less than or equal to one, i.e, $p \leq 1$. Any probability answer that is greater than one, i.e, $p > 1$, must be incorrect.
- If you obtain 4 Heads in a row when tossing a fair coin, then the probability of Heads on the fifth throw is still $\frac{1}{2}$, a result which often seems to be in conflict with the expectation that over a period of many tosses of the coin, the number of Heads will approximately equate to the number of Tails. However, learners must realise that each toss of the coin is an *independent* event.
- As the probability of obtaining a 6 on a fair dice is $\frac{1}{6}$ it is a misconception to deduce that obtaining two 6s when throwing the dice twice is $= 2 \times \frac{1}{6} = \frac{2}{6}$. (In fact, the probability of two 6s is $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$ as each throw is an independent event.)