13. Out of 2000 families with 4 children each, how many would you expect to have
(i) 2 boys (ii) no girls (iii) at least one boy?

$P(r \text{ successes in } n \text{ trials}) = \binom{n}{r} p^r q^{n-r}$

Bernoulli Trials

$n = 4$

$p = P(\text{Boy}) = \frac{1}{2}$

$q = P(\text{Girl}) = \frac{1}{2}$

(i) $P(2 \text{ boys}) = \binom{4}{2}\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^2$

$= 3/8$

Expect $= 2000\left(\frac{3}{8}\right) = 750$

(ii) $P(\text{no girls}) = \binom{4}{4}\left(\frac{1}{2}\right)^4\left(\frac{1}{2}\right)^1$

$=$

Expect $= 2000\left(\frac{1}{16}\right) = 125$

(iii) $P(\text{at least one boy})$

$= 1 - P(\text{no boy})$

$= 1 - \frac{1}{16} = \frac{15}{16}$

Expect $= 2000\left(\frac{15}{16}\right) = 1875$

15. A fair coin is tossed repeatedly until the third head appears.
Explain how you would use the binomial distribution to work out the probability of this happening.

$P(r \text{ successes in } n \text{ trials}) = \binom{n}{r} p^r q^{n-r}$

$n = n$

$r = 3$

$p = P(H) = \frac{1}{2}$

$q = P(T) = \frac{1}{2}$

$P(3 \text{ Heads}) = \binom{n}{3}\left(\frac{1}{2}\right)^3\left(\frac{1}{2}\right)^{n-3}$

$= \binom{n}{3}\left(\frac{1}{2}\right)^n$