

Mathematical Model:

It is a simplification of a real-world situation. It is used to make predictions and forecasts and help improve the understanding of real-world situations.

The model aims to include all the main features of the real-world situation but with some assumptions to help simplify the situation.

Advantages	Disadvantages
1. They are relatively quick and easy to produce	1. Simplification can cause errors
2. Usually a much more cost-effective way of analysing the real-world situation	2. Assumptions may eliminate important aspects
3. Enable predictions	3. Model may only work in certain situations
4. Improve understanding of the real situations	
5. Help show how changes to certain variables affect the outcomes	
6. Help simplify complex situations	

Designing a model

There are 7 stages for designing a model

1. Recognition of the real-world problem
2. A mathematical model is devised
3. We use the model to make some real-world predictions
4. Experimental data are collected from the real-world
5. We compare the data from the real-world against the model predictions
6. Statistical concepts are used to check how well the model describes the real-world problem
7. Model is refined and steps 2 to 6 may need repeating

Example:

A scientist is investigating the population of owls and notices that the population varies year to year. Give a summary of the stages that are needed to create a mathematical model for this population variation.

- 1 Some assumptions need to be made to ensure the model is manageable. Birth and death rates of owls should be included, but food supply and environment changes should not.
- 2 Plan a mathematical model which will include diagrams.
- 3 Use this model to predict the population of the owls over a period of years.
- 4 Include and collect fresh data that match the conditions of the predicted values. You may also use historical data from the previous years.
- 5 Analyse the data using techniques you will meet in this course to compare the predicted data with the experimental data.
- 6 Use statistical tests that will provide an objective means of deciding if the differences between the model's predictions and experimental data are within acceptable limits.

If the predicted values do not match the experimental data closely enough, then the model can be refined. This will involve repeating and refining steps 2–6. This model is then constantly refined making the model more and more accurate.