Models in the search for knowledge

10. A model is a simplified representation of some aspect of the world. In what ways may models help or hinder the search for knowledge?

Models as representations of one or another aspect of the world are applied in a vast number of areas. There are many types of models in numerous areas of knowledge including the natural sciences and mathematics. Models are valuable tools, though sometimes imperfect, that help us in the search for knowledge. Models are not only visual representations but also possess an epistemic value. Therefore the term model could be divided into two main categories, that is, physical and conceptual representations. In most areas of knowledge these two are integrated together to help us understand various phenomena better and eventually gain knowledge.

Models have purposes; they help us look for solutions to certain problems. For example, models in the field of engineering are developed in order to get a basic idea on how to control or prevent certain properties of materials, processes and procedures. These observations can then lead to imagination of what could happen during the processes or to an improvement in the performance of the system.

Models have objectives; what they actually represent in the real world. Models give us knowledge because they represent these supposed objectives more or less accurately – analysed in terms of resemblance or concept. In most areas of knowledge where models apply, they represent evident phenomena. Most scientific models assume that there is an obvious relationship between the structure of a model and that of the real world system, that is, the objective. For example, computers that model the path of hurricanes are created by scientists and consequently their ‘ objective’ is to predict the path of a hurricane.

Modellers use these indirect representations to analyse the real world phenomena. The term indirect in this case would imply the construction of simple models with fewer properties attributed compared to the ‘ objective’. If this is the case, then naturally, models exhibit a lot of idealizations, abstractions and approximations. Models are formed in such a way that the problem is easily accessible and approachable more than once so that they can be dealt with in an organized manner.

However, models being too ‘ simplified’ may hinder the search for knowledge. A child may see a paper-plane as a model that represents its ‘ objective’ that is, a real aeroplane. The basic physics of a paper-plane has some similarity to that of real aeroplanes. For example, in both cases, the wings are an important factor as the ‘ lifting’ of a plane occurs when the wing slices the air to cause more pressure underneath it. However, paper-planes often lead children into confusion when compared with a real one – an actual aeroplane floats longer and a paper-plane eventually rests to ground. Maps are also another example of ‘ simplified’ representations as they define the Earth on a flat surface with some semantic approach. Maps are created in order to communicate information to the map readers and consequently they represent their objectives according to the intentions of the readers. However, cartography being called modelling can be questioned – if the reader lacks map reading skills and is unable to locate himself, won’t maps then hinder the search for knowledge for that individual?

Mathematical models play a vital role in almost all kinds of fields, especially those in the natural sciences, engineering and the human sciences. A mathematical model represents a structure or a system using mathematical language which can exist in many different forms. These include statistical models in the human sciences, exponential growth in the natural sciences and differential calculus in engineering fields. Mathematical terminology and symbolic equations are difficult to understand and therefore the theoretical aspect of the models is reinforced by visual representations such as charts, graphs and diagrams.

For example, a building can be modelled not only by creating replicas on small scale or creating a three dimensional visualization but also by mathematics, as I learnt this when I was working on my mathematics portfolio. This falls under the discipline of architecture, which is both an engineering discipline and a social science. The task was to design an office block with certain specifications in a curved roof structure and the scopes and limitations were given. The concepts of differential calculus and optimization were to be applied in this case. From such a model we can determine the maximum volumes of cuboids within a curved structure and eventually maximise and minimize office space and wasted area respectively. This type of mathematical model appears to be accurate and the architect can ensure the contractor that the building is going to be stable, will utilize maximum space and have aesthetic values.

Mathematics is a vital area of knowledge when it comes to models. Scientific modelling today comprises all aspects of modelling, including physical, conceptual and mathematical aspects. Scientific modelling is the process of generating a model that would help develop a proposed hypothesis. Scientific models provide a scenario of the actual system where the elements are easier to read and interpret as they are ‘ simplified’. The ‘ objective’ of these is to portray pragmatic objects and their phenomena and processes in a logical manner.

However, not all mathematical models are so accurate. An example is that of exponential growth where a mathematical function is used as a model to represent certain rate of growth. Human population trends can be expressed as exponential growth. Such a model is weak and leads to vague knowledge. This is because there are numerous factors affecting human population and it is difficult to predict accurately what is going to happen in the future. Also, this model would apply to a limited region only. In addition, the exponential growth model is only valid for a certain period of time as in the long run it does not make sense to people who argue that nothing can keep on growing forever or for the case of human population the model is not credible for people who believe in the judgement day.

Global warming is a recent trend that people are concerned about which describes climate change due to human activity and other factors. In physics this year I learnt that models are developed in order to help scientists predict the future climate state of our planet. These are, but are not limited to, changes in the component of green house gases, volcanic activity and cyclical changes in the Earth’s orbit. Though the warming of the Earth is caused by certain natural forces, scientists believe that humans have been enhancing these effects by contributing to the greenhouse gases since industrialization began.

Such models help us know about the current climate state of the Earth and the models might be accurate for a short period of time. There are knowledge issues that are brought up in the case of models and reliability and accuracy are the most important of these in my opinion. Some experts claim that the Earth might end up in a cooling phase instead of getting warmer. However, because there is comparatively more evidence to support the warming of the Earth, these claims are easily countered. But what if the global climate change has nothing to do with humans, and it is an unavoidable natural cycle? There are some contributing factors like increased solar flare activity and volcanic activity which are inevitable. Nonetheless, these models suggest that humans have enhanced this rate by contributing to the overall warming and show rapidity of this effect.

As previously mentioned, assumptions are part of models, and therefore the more assumptions that are made in a scientific model, the less accurate it becomes, which affects the resulting knowledge. While models help scientists to simulate real systems that are difficult to get access to and conditions do not allow room for experiment, direct measurement will always have an advantage over just ‘ simplified’ representations.

The degree of imagination is also important when it comes to model making. A modeller has to define his imagination well in order to convey the ‘ objective’. This leads us to the importance of language in a model. If the model is not expressed well in any kind of language, be it symbols in maps, equations in mathematical models or even flow diagrams in human sciences, the model is not effective and can affect the search for knowledge.

If models are defined as simplified representations of an aspect in the world, then what about complex systems that exist and yet cannot be put into simplified representations with a valuable objective? If models help us in better understanding of certain aspects of the world, then why can we not model human or animal behaviour? These questions cannot be directly answered but they can be resolved to some extent by expressing a narrowed definition of the term model and its limitation of application.

Models are somewhat useful in areas of natural sciences and engineering as mentioned in this essay. Conversely, models are not whatsoever useful when it comes to certain areas of knowledge, for example ethics. This is because a model cannot represent moralistic situations and it is difficult to predict human behaviour. To create a model that would help resolve an ethical dilemma of what is right or wrong simply does not make sense. Human psychology cannot be predicted logically and therefore even if such a model existed it would create many conclusions and in the end the ‘ objective’ of the model becomes vague. The same applies to religion where the entire area of knowledge is based on beliefs and ‘ facts’ that already exist – there is no need of models for prediction; the future has already been decided. Therefore whether models help or hinder the search for knowledge significantly depends on the area of knowledge.