Welcome to the Mathematical Methods, Unit 4 set of videos on how to develop a modelling or problem-solving task, and this one is on probability and statistics. The Copyright of this presentation is owned by VCAA and can't be reproduced except in accordance with the permission from the copyright officer at the VCAA.

This PowerPoint presentation with its accompanying set of videos, outlines a process for developing a modelling or problem-solving task and illustrates how this can be done using a sample task. It also includes information on the purpose, nature and structure of a modelling or problem-solving task, and also helps to devise a related assessment scheme. Now what's interesting about modelling or problem-solving is that you can have modelling within a problem-solving task, or you can have problem-solving techniques within a modelling task.

The purpose of modelling or problem-solving tasks, is for students to model a problem-solving problem or a related set of problems in some depth, and that word depth is important because in the application task in Unit 3, we look at a context in width, but we're looking at one context within depth from a probability and statistics area of study, and this can involve random variables, discrete or continuous, probability distributions and density functions, statistical inference and relevant content from other areas. And the most obvious content from other areas is area under a curve.

We can apply the modelling or problem-solving in real life contexts or what some teachers don't realise that you can also do it in a mathematical context, theoretical context, these of interest to you. But real-life context could include heights of students or adults, and that's what this task is about, heights of trees, the weight of puppies, the number of eggs laid for large samples. So the point is to choose something that interests you.

Mathematical modelling is a process of using mathematical constructs, to represent real world in a simple and concise way. An obvious thing that is being done at the moment is during the coronavirus that there are mathematicians working all the time on mathematical models that will predict behaviour of the pandemic. We use this to analyse particular aspects or solve problems of interest and we make predictions. In mathematics, problems are generated from issues, questions, conjectures and hypotheses from a range of contexts. And my advice is always choose a context that is interesting to you as a mathematician. And then you will write a better task if you're interested in exploring it yourself. When you're in the process of writing a problem, new problems may arise in their own right either from your own thinking or from the students, and you can vary and reformulate or generalise the problem.

Modelling and problem-solving are complementary processes, and the framework is written and described very well by the I M squared C, the International Mathematical Modelling Challenge. The link is there, where they suggest you describe a real-world problem, identify and understand the practical aspects of it. You specify the problem, you formulate a mathematical model, making assumptions, sometimes you have to simplify the assumptions so the students can manage it, choose variables, estimate what you're going to decide and justify your decisions. You then solve the mathematics and you interpret the solutions. Then you consider what that means in terms of the real world meaning that you started with. Then you evaluate the model and you make a judgement. Was your model reasonable or would it be questioned? You report the solutions and then you rethink what the model might be and start the circle again. This is a simple schema that's been around for a long time that helps you think about what a modelling or problem-solving process is.

You can start on the top left with a real world or theoretical context. You develop the mathematical model, or you formulate the problem for the students to look at. You apply mathematical models for problem solving strategies and techniques. So there are particular techniques that you might want them to look at. You then ask the students to interpret the results and you refine the model, and then you can actually start the cycle again. You can say my model wasn't very good, or there is something very interesting that's been thrown up, and I make up a new real-world model and start the cycle again. VCAA asks that this modelling or problem-solving task be of two to three hours duration over a continuous period of one week.

Now, the structure is that you introduce the context, situation or problem, and you start with simple examples, so this is your scaffolding. Now, these examples can be like straightforward fact questions. So the students have become familiar with the context or scenario. Then you develop the model by generalising it, putting in parameters, increase the complexity and consider a variation or special cases, and then you use the model to find solutions. Then the third step is to evaluate the model. Was it a good model? Discuss the limitations. Did the model actually suit what we started with? Refine your modelling process, and interpret the solutions in context.

Now, for developing a task, there are four aspects. You choose the context, and I've said in my previous videos, it's worth choosing a context that is interesting for you. And mathematicians are often people who will be on holidays or go for a walk and look at something that is interesting, something that they would like to explore. You identify questions of interest. You relate these questions to the relevant skills that the students need to do in this probability and statistics part of the task, and then you devise your assessment scheme. For this task that I'm presenting, it's a three-part sample task, and it will be developed using, first of all, the normal distribution and then the normal approximation to discrete random variables.

So, let's start. We describe the context. We explain how the context was chosen. We identify questions of interest. We identify relevant information and sources. We give the task a title, and then we show the title and I will actually show you the task in the next videos.

Now, the context. This modelling or problem-solving task considers the distribution of human heights in several contexts using normal distributions of the random variable. And I have a link there where I started to think about, what about heights? Looking at the variations of age and country. I decided to look at a normally distributed population of males and females with the following parameters. So I started with some male and female, males with a mean of 176 and a standard deviation of 7.5 and females of 162 centimetres and a standard deviation of 7. So the beginning, I'm beginning to look at the differences between male and female heights, and this is something that the students would be familiar with.

Now, the context that was chosen, what I found interesting was this quote from the link below, "People today are taller on average than their ancestors were a hundred years ago." And this is true for every country in the world, but how have human heights changed and how does this vary? And the fact is that the average young adult today is around eight or nine centimetres or about 5% taller than their ancestors a hundred years ago. So this is the context in which this problem-solving task is placed. For the task I gave was a simple one, Height Distributions.

So I'll finish this first video by looking at two very familiar equations. The difference with normal curves, bell curves, between Maths Methods and Further Maths, is that Further Maths students understand the bell curve. They understand the X scores and the Z scores using their calculators. But in Maths Methods, we actually look at what the formula actually is.

And it's a very interesting, given that it's an exponential function and the exponential function gives the students information about the asymptotic nature of this function, which helps us understand why when we put something in our calculator, we make the lower and upper boundaries, either negative infinity or infinity because being exponential, these graphs don't actually ever touch the x-axis. So the familiar standard normal distribution is one on root two Pi, e to the negative half X squared. So I would suggest starting with that, getting the students to draw that. And then the normal distribution introduces the parameters of standard deviation and mean.

So the next video will be about the task itself.

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