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QUANTITATIVE REASONING FOUNDATION MODULE

Audience

Quantitative Reasoning Foundation modules are part of the initial suite of modules taken by University Scholars Programme students in their first two years of study. The University Scholars Programme is an interdisciplinary programme that attracts some of the best students at the National University of Singapore. Each student has a home faculty, and students may therefore have very different preparations for a QRF module: Students in the Faculty of Arts and Social Sciences, for instance, may have had very little background in the sciences during their last two years of high school; in contrast, a student in the Faculty of Science may have taken science subjects almost exclusively during the same time. As much as possible, QRF modules should draw on the different strengths that our students have, and not disadvantage or advantage any group of students.

Pedagogical Goals

Quantitative reasoning modules may include (but not be limited to) the following:

- Reading and analyzing data associated with real-world situations
- Supporting conclusions based on sound mathematical reasoning
- Differentiating correlation from causality
- Understanding the link between data quality (and quantity) and the soundness of inferences that can be drawn from them
- Using new evidence to falsify some models from a family of plausible models
- Characterizing the nature of relationships between variables
- Quantifying the strength of relationships between variables using appropriate mathematical and/or logical structures
- Constructing and validating models using categorical and continuous data
- Employing validated models for social, technological, and scientific applications

They should also encourage students to think critically about the way in which quantitative reasoning might be applied to any particular problem, and about the kinds of problems that quantitative reasoning might solve.

Module Structure

Each module will address a thematic topic, selected by the instructor. Current and planned topics include Epidemics, DNA Evidence in a Court of Law, Mental Events, Global Climate Change, and Analysing Global Events.

While individual iterations of the Quantitative Reasoning Foundation Module can vary in terms of assessment, they should follow a common basic pedagogical sequence outlined below:

1. Introducing the Problem

Introductory seminar-style discussion of the problem that will be addressed in the module. Readings will be assigned in order to provide the background. The seminars will be directed so that students have a comprehensive grasp of the problem, focusing attention on why the problem is interesting or important, surveying the various contrasting views/positions, and setting the stage for why a quantitative approach would allow for more clarity as well as a more structured, objective and hence more useful analysis of the issues.

2. The Place of Quantitative Reasoning

The seminar discussions will address how far one can go with a qualitative discussion to settle debate in the problem. We will also discuss what would be important to quantify, and how one might go about doing that? This part of the module initiates a more quantitative discussion paying attention to suitable technical approaches to the problem. The discussions will drive at discriminating between alternatives more objectively, and initial ideas of how that might be possible. First introduction of relevant mathematical models; explore characteristics of solution to simple models and their inadequacies in describing the real problem.

3. Establishing a Model

Detailed discussion of the "variables" in problem, establishing a model by getting students to articulate qualitative relationships between these variables. Then the discussion will focus on quantifying these variables and relationships and constructing a quantitative model.

4. Developing a Model

In this part of the module, the students build and analyze the model using tools such as spreadsheets. The instructor will work closely with the students to help with difficult technical details. The emphasis will be deriving insight from the model rather than on learning technical skills, particularly in addressing issues/problems that are not clearly resolved through qualitative arguments.

5. Reflecting on Quantitative Analysis

Discussion of the efficacy or limitations of the model. The aim of this part of the module is twofold. First, the students will be asked to revisit their qualitative picture of the problem in their first paper in order to understand what they have done with a quantitative approach to the problem. Second, the students critically assess the approximations or constraints or limitations of their quantitative analysis in order to understand where the weaknesses are, and to identify directions that might be useful for improvements.

