Visualising chance: learning probability through modelling

Stephanie Budgett and Maxine Pfannkuch, The University of Auckland

Project dates: January 2014 to January 2016

Introduction

The project team devised innovative learning tasks, including software tools, in order to orientate introductory university students' probabilistic reasoning towards a conceptual understanding and way of thinking that is more closely aligned with the practice of applied probabilists. The tasks incorporate learning probability using a modelling perspective, static and dynamic visualisations, and theory. We aimed to consolidate and build on knowledge about a modelling approach to probability and learning strategies that involve the development of static and dynamic visual imagery and language for promoting student conceptual growth.

Our research question was:

- What conceptual understanding of probability and what probabilistic reasoning is promoted when introductory university students are exposed to a modelling approach to probability and to learning strategies focused on dynamic and static visual imagery and language?

What we did

The project involved five phases. In the first phase, through collaborative meetings, interviews with professionals who make use of probability modelling in their work, and reviewing the probability education literature, the project team conducted a conceptual analysis in order to identify some of the essential conceptual ideas underpinning probabilistic reasoning. The second phase involved a qualitative thematic analysis of the interviews, project team deliberations, and literature review, to identify the main problem areas and conceptual ideas that needed addressing. In the third phase, the project team identified four significant areas for development of probabilistic reasoning for which tasks and software tools could be developed. For each area, a conceptual analysis of the underpinning concepts and possible conceptual pathways was undertaken. The fourth phase involved trialling each of the software tools and associated tasks with three pairs of students who had already completed an introductory probability course. In the fifth phase, a retrospective analysis was carried out, followed by modifications to the tools and tasks.

Key findings

- The ability to see structure in, and apply structure to, a problem situation is an important aspect of probability modelling, which is founded on the key concepts of randomness, conditioning, distribution, and mathematics.
- The four dynamic visualisations and tasks, especially designed to expose students to a modelling approach to probability, have the potential to deepen and enhance students' probabilistic reasoning.
- Engagement, an important component for the learning of probability, may be promoted by providing relatable contexts and by incentivising students to make conjectures prior to interacting with technological tools.
- Flexible use of representations, essential for developing probabilistic thinking, may be supported through the experiencing and linking of a variety of chance-generating mechanisms.

Implications

- Seeing structure within problem situations draws upon a diverse range of learning experiences in multiple contexts and requires teaching strategies that deliberately enhance transferability to new situations.
- New learning trajectories incorporating dynamic visualisations will require careful development to support students as they experience simple through to more complex representations.
- From a pedagogical perspective, encouraging students to make conjectures which they then test and analyse through the use of technological tools requires careful consideration around how to scaffold students' thinking and how to draw their attention to salient features.

Our Partners

The project team includes the following partners:
Conceptual developers/statistical graphics experts: Professor Chris Wild and Associate Professor Paul Murrell
Probability lecturers: Associate Professor Ilze Ziedins,
Associate Professor Rachel Fewster
Professional Teaching Fellows: Dr Marie Fitch and Dr Heti Afimeimounga
Masters' Student: Simeon Pattenwise

Contact details

Dr Stephanie Budgett
Department of Statistics
The University of Auckland
Private Bag 92019
Auckland 1142
s.budgett@auckland.ac.nz
Phone: 64 9 923 2346

A/Prof Maxine Pfannkuch
Department of Statistics
The University of Auckland
Private Bag 92019
Auckland 1142
m.pfannkuch@auckland.ac.nz
Phone 64 9 923 8794