A NARRATED CONCEPT MAP FOR STATISTICS ®

Michael Bulmer
The University of Queensland
Australia

Some students in a service statistics course struggle with the material because they focus too much on the mathematical details and miss the broader issues and relevance to their degree program. It has proved useful for them to have the lecturer narrate a story, which gives a broad overview of the area while simultaneously drawing a rough concept map as an illustration. Of course this is very time consuming and impractical for large classes. We are currently developing and trialing a computer-based version of this setting, creating an interactive concept map with a narrative that students can follow as needed.

INTRODUCTION

An introduction to statistics is becoming an essential course in many degree programs. However, students have usually encountered statistics already, as part of their secondary school mathematics. This leads many to retain the perception that statistics is their "maths" course and that it is all about mechanical calculations and methods. As a result, it is common to see a few students at the end of semester who have no real understanding of what the course has been about and why it is essential to their profession. I have found that one way to give them the “big picture” they are missing is to create a concept map in front of them while also telling them the story of how the pieces fit together and where the maths is actually needed. This kind of narrated diagram has been successful and much appreciated by a number of students but is of course very time consuming for the lecturer. We are currently developing a multimedia equivalent, a narrated interactive concept map, so that the overview can be used more widely. This paper gives a description of project, dubbed *ConceptStats*, the feedback from student participating in the initial trial, and a discussion of issues arising from the trial.

SETTING

Teaching applied statistics is quite different to teaching standard mathematics courses. There is some need for algebraic manipulation and numerical skill, but the overwhelming need is for a qualitative understanding of why statistical analysis is necessary and what are the important ideas involved in it. Cobb and Moore (1997) suggest that “statistics requires a different *kind* of thinking [to mathematics], because data are not just numbers, they are numbers with a context.”(p 801). Following this philosophy, in 1999 a whole introductory course was taught with a qualitative emphasis (Bulmer, 1999), using activities and project work to replace lectures and assignments. This proved very successful and components from that course are now being used in other courses, but the overall approach is too time consuming to use with large first-year classes.

At the same time, statistics teaching is naturally suited to the use of software and multimedia, particularly since data analysis has a strong visual component. Indeed, as discussed by Velleman and Moore (1996), statistical software itself has a dual role in teaching. On the one hand it can be used to illustrate ideas through simulation and visualisation, but at the same time being able to use statistical software is an important professional skill. Velleman’s own ActivStats (Velleman, 1998) has been a successful CD-ROM package that combines an interactive statistics course with statistical software and relates the two together. Packages like ActivStats do a good job of teaching statistics but they still follow the traditional textbook sequence. Links can be provided in these to encourage students to explore relationships, but this could equally well be done with a textbook. The aim of this project in developing an object similar to a concept map is to bring forward the important interrelations in statistics without also carrying the detail of a full exposition.

CONCEPT MAPPING

Concept maps (Novak & Gowin, 1984) have become increasingly popular in recent years. More importantly, they have become increasingly familiar to students, making it practical to use

them in teaching and learning without the overhead of a lengthy introduction. Indeed, this current project arose because a student studying for her statistics exam came for help one day and surprised me by pulling out a big A3 page with a concept map that she'd built. A dialogue ensued with me drawing a concept map of how I viewed the course, and she said that this was just what she had needed to put the pieces together. This was then repeated with a couple of other students who came for help, each having had a lot of trouble following the "big picture" during semester. The narrated building of a concept map gave students a visual structure to the key points I was emphasising with my voice.

Essentially this setting involved a one-to-one overview of the course, taking 30-40 minutes for each student. It would lose its effectiveness in a one-to-many setting since each student had specific areas they needed to focus on. It is thus not desirable or perhaps even possible to provide this kind of contact to a large class of students (around 800 in our introductory statistics courses).

The aim then has been to develop an interactive concept map where students can follow the narrative and the building of the ideas in their own order and at their own pace. We use the term 'concept map' loosely here since we don't necessarily give propositions for each link, these being captured in the narrative. The map is simply a guide to the connections rather than a full summary of their nature.

OVERVIEW AND EVALUATION OF INTERFACE

ConceptStats was implemented using HTML with image maps to navigate the concepts, a simple approach that makes it accessible to most computers. While it could then be easily delivered via the Web, the initial trial version was distributed on CD-ROM because the uncompressed audio narration was very large. The students involved also liked the flexibility of the CD; most had computers with CD drives at home and so were able to play with the concept map at their leisure, without having to be connected to the Internet. However, the current version has used audio compression so that it can be accessed on the Web, making it easier to distribute to a wide audience. In the next stage of development, with graphic designers working to create a rich visual environment, the added complexity may return it to CD.

Students are presented at each stage with a focus concept and all concepts joined to it by a single link, as illustrated in Figure 1. They can listen to and/or read the narrative for that concept and then move onto a related concept by clicking on it, bringing them to a new screen where that concept is now the focus. They begin with the concept of "Data" but there is no defined end to the session.

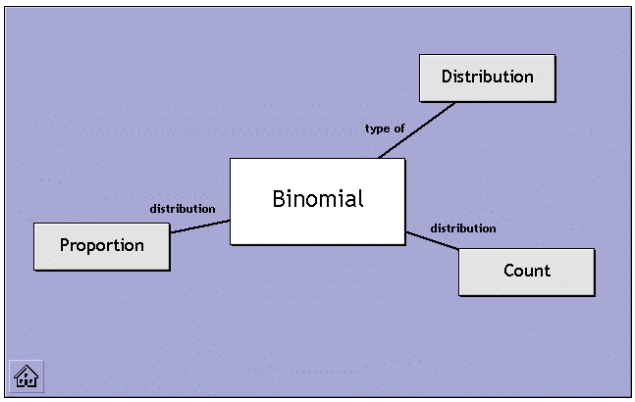

Figure 1. Example Concept from Trial Version.

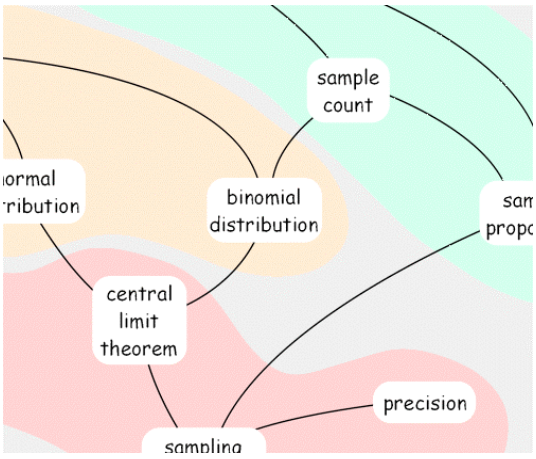

Figure 2. Example Concept from Current Version.

In the trial version, as in Figure 1, each concept and its linked concepts were presented on a single page in isolation to the rest of the map. Some attempt was made so that if, for example, 'Count' was clicked on in Figure 1 then in the new map the 'Binomial' link would be in the top left, giving a physically plausible model of the map. However, this was not always possible and one student wrote that "it might be more helpful to use a simplified version of the map, with a bit more chart for each portion, for it seemed to me that things were clear at the beginning, but after a while I lost myself, like wandering in a palace." Based on such feedback, the current version is created from a single image of a simplified concept map, with each concept focus showing a snapshot of the map, as illustrated in Figure 2. This gives a stronger physical intuition as students explore the map. Additionally, the concepts are coloured according to the module of the lecture notes which describes them, further aiding navigation.

The trial version also included relevant formulas to annotate concepts and links, such as $s/\sqrt{n}$ on the link between 'Sample Mean' and 'Standard Error'. A common response to this was summed up by one student who wrote that "the formulas were good, but what would make it really useful is if some examples were used to give a clear idea as to how the formulas are applied." As outlined in the discussion below, it was felt that adding examples would go beyond the simple aim of the concept map. Instead, the formulas were removed from the current version and made into a separate *Equation Gallery* project which shows the important formulas in the course, together with a description of their role and examples of their use (Bulmer, in press; this gallery idea was motivated by the work of the statistician and artist Peter Smith at RMIT in Melbourne.)

EVALUATION OF LEARNING

The simplicity of the presentation appealed to most students. One commented that it helped their understanding because of "the clarity of the info and that it is straight to the point – unlike the text where it is very round about in explaining things." Indeed several students noted that the concept map had a useful role in complementing the textbook: "I unfortunately missed a lot of the lectures, and this CD in conjunction with the textbook helped my understanding… the CD offered a good starting point to launch my main revision from the textbook."

The project was targeted as a revision tool, a summary that a student who has followed most of the course can use to fit it all together. This was partly an historical accident, since the original concept mapping from which the project grew was done in this context. But some students suggested that this was suitable since "the explanations are clear, but only if you have done a course of stats, for someone with no idea of stats, it probably wouldn't be all that clear." As a learning experience prior to revision, it would be more useful for students to construct their own concept maps of their understanding as they progress through the course, and to share these with others in tutorials.

Following on from this point, it should be emphasised that this project did not aim to provide a perfect concept map for the course. Instead it uses a simplified map as a visual

framework for the overview, then combined with the narration. One student commented that "the maps (really a brilliant idea!), and the audio direction, make the content lively, and easy to follow." Again this returns to the original motivation for the project, providing a surrogate one-on-one interaction with the lecturer.

CONCLUSIONS

There is a delicate balance in this project between presenting the necessary ideas and presenting the entire course material. It is often tempting to elaborate each concept by giving more detailed definitions and more fine-scale concepts. Indeed, some feedback on the model suggested that a hierarchical structure would be useful, being able to click on a concept and have it expand to show the inner details of that concept in a new map. While this would give a natural structure to the course materials, it defeats the original aim of providing a short and simple overview of the key issues in the course. As reported above in the evaluations, this simplicity was seen as a strong point, complementing the detail given in the textbook and lectures.

Overall, the project has achieved its aim of filling a hole in the learning resources available to students in a large first-year course: "The package improved my understanding as it allowed for clarity of subjects." t is currently being developed to enrich the aural and visual interface, as well as looking to develop similar maps for courses such as physics, where again there is the same interplay between quantitative skills and qualitative understanding.

ACKNOWLEDGEMENTS

I would like to thank the students who gave such useful feedback on the trial version during their busy examination period. Thanks also to Greta Kelly, Michael Scott, Paul Smith and Vanessa Kessler at The Teaching and Educational Development Institute of The University of Queensland for their useful brainstorming sessions.

REFERENCES

Bulmer, M. (1999). *Introductory statistics with a qualitative emphasis*. Effective courses / effective teaching at university conference. Women's College, The University of Queensland. http://www.tedi.uq.edu.au/conferences/teach_conference99/ papers/Bulmer.html

Bulmer, M. (in press). Linking images and formulas to promote learning in statistics.

Cobb, G.W., & Moore, D.S. (1997). Mathematics, statistics, and teaching. *American Mathematical Monthly, 104* (9), 801-823.

Novak, J.D., & Gowin, D. (1984). *Learning how to learn*. New York: Cambridge University Press.

Velleman, P.F. (1998). *ActivStats* (CD-ROM). Addison Wesley Interactive

Velleman, P.F., & Moore, D.S. (1996). Multimedia for teaching statistics: promises and faults. *The American Statistician*, *50* (3), 217-225.