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Some principles of flows and steps in designing tertiary statistics curricula for learning

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The fellowship program was a journey ......in discovery, collaboration, dissemination, analysis...... that continues .... when there is time. During the year, I....

- ☐ **visited sixteen universities in six different countries**
- ☐ **sat in on thirteen different courses**
- ☐ **gave seventeen seminars and two public speeches**
- ☐ **conducted five workshops and one forum**
- ☐ **attended four conferences, giving a plenary at one, an invited paper at another, and contributed papers at the other two**
- ☐ **talked with many staff and students, including 22 "collaborators"**

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Some findings from the journey….

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- **Statistics educational needs continue to change**
  - ☐ **Statistics education reform DOES need to expand its vision, move outside its boxes and incorporate more statistics**
  - ☐ **"Seeing through students' eyes" is a never-ending learning curve that requires ongoing interaction with students**

- **Differences & influences of educational culture, environment & student expectations significant**
  - ☐ **greater than generally understood**
  - ☐ **discovered through on site participation**

- **Curricula are not "written on tablets"**
  - ☐ **There's no single right 1st course in statistics**
  - ☐ **Focus should be on principles**
  - ☐ **Careful structuring & flow of story so important**
  - ☐ **Identification of, & alignment with objectives**
  - ☐ **Integrated, purposeful learning & assessment packages**

- **Collegiality between staff & between staff & students key for learning in maths/stats**
  - ☐ **Creating learning environments**

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Findings

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- **Tutorials & practicals are pivotal for learning to *teach***
  - ☐ **Practicalities of learning to teach need more attention**

- **Tutorials/practicals & lectures are equally important for learning**

- **The different worlds in statistics education need better inter-bridging & understanding & respect**
  - ☐ **main ones are statistical practice & research, L&T coalface & s'ship, educational research, workplace learning**

- **Better understanding needed of roles of maths in stats**
  - ☐ **Compare thinking with thinking, procedures with procedures**
  - ☐ **Conflict & dogma are inhibiting**

- **More respect needed for everyday hard yakka of L&T**

- **Sacred cows are everywhere!**
  - ☐ **Different groups have different sacred cows**

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Just a few next steps….

- **More attention to probability and distributional modelling - across all levels of education**
- **Bring statistical modelling and data analysis closer together (paper in ISI)**
- **Alignment of objectives and curricula and assessment**
- **Smoother development paths for statistics majors and statistical training**
- **Postgraduate support across disciplines**
- **More involvement of "mainstream" statisticians**
- **Increase IASE membership**
- **Increase awareness & articulation of "nestedness" of statistical development across educational levels, including explicit teaching of limitations at each level**
- **Improve awareness of mathematical thinking rather than mathematical techniques**

……………

This talk briefly considers

- **Curricula are not "written on tablets"**
- **Structuring & flow of curricula**
- **Structuring of incremental steps within flow for learning**
- **Alignment of objectives and curricula**
- **Some examples taken from:**
  - ☐ **"first" tertiary course in data analysis & inference – two contrasting stories**
  - ☐ **Introductory probability & distributions & modelling**
  - ☐ **Second course in modelling with probability & distributions – stochastic/statistical modelling**
  - ☐ **Second course in data analysis & inference**

Curricula flow

Whether we want our story to flow without ripples..

.. or to bubble along

we know we'll have to duck some obstacles

and try to avoid too many rocks on which students might founder

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Curricula integrity

We don't want to make unnecessary detours …

… to isolated pockets of content

They might be traditional and appear attractive & peaceful to us …

… but students might be left behind on an island

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Curricula purpose

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We strive to avoid fog & to ensure students can see the flow & what they are learning …

…. and we aim for smooth & strong development with interest along the way & vision of more power beyond

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Basic principles of flow are

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- **Connectedness**

- **Smoothness**

- **Direction**

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Curricula flow & integrity

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- **Think of an example of something that**
  - **interrupts the flow, or**
  - **is an unnecessary detour, or**
  - **that takes students away & prevents them rejoining the flow**

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Steps in learning to achieve flow

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We want the learning steps to be 'bite-size' and readily mounted…

… by everyone no matter what their intellectual size

We don't want students to feel in a whirl

We want everyone to be on the same staircase, allowing for different learning styles

and we want them climbing to the right place!

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Steps and climbs in learning

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We don't want any climbs that are beyond them

We want the goals to be clear along the way

And emphasize again – we want consistency and manageability in step size

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Manageable and consistently sized steps in learning

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Can you think of an example of a section of a course in which too much happens at once – usually too many concepts introduced at once – resulting in a too big & too steep step?

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Two different first courses in data analysis, same principles

- **From previous conversations, Michael & I had thought we taught similar courses**
- **Both developed with input from students, tutors, peers, research**
- **Indepth discussion & detail ⟹ surprise**
- **Discovered**
  - ☐ **Different objectives**
  - ☐ **Differences come from aligning curricula with objectives**
  - ☐ **Same principles**
  - ☐ **May not detect from brief content description**

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Course 1 objectives:

Develop skills, capabilities and knowledge to carry out real data investigations in life-related situations with many variables, using chisq, ANOVA, regression, t.

experiential learning of the full data investigation cycle; understand power and limitations of introductory statistical data analysis methods

Course 2 objectives:

Develop understanding, capabilities and knowledge in introductory data analysis, data models and statistical inference involving 1-3 variables

develop sound foundations in statistical inference for ongoing statistical learning and application in other disciplines

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Strong agreement on

1. Traditional section on traditional approach to probability an unnecessary & risky detour
- **Contradicts all principles of flow**
  - ☐ Not connected
  - ☐ Not smooth
  - ☐ No direction within course
- **Isolated island**

2. Introduction of behaviour of sample mean + first sights of confidence intervals + tests in terms of means is too much to climb

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Course 1 (data investigation)

- **Types of investigations, data, problem, plan, collection, handling, exploring**
- **Categorical data: estimate probabilities of categories; introduction to testing; chisq tests**
- **Continuous data: estimate probabilities of intervals; revision of normal; Q-Q plots; confidence interval for proportion – technology & approx**
- **Continuous response, categorical predictors: ANOVA incl interval estimation**
- **Continuous response, quantitative predictors: regression incl prediction**
- **Questions left over: 1 & 2 sample t intervals & tests**

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Course 2 (data & inference)

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- **Real-life examples and rich content to engage student interest and help students retain key ideas**
- **but these are not enough**
- **3 basic modules:**
  - □ **"real" world: data, relationships and descriptive statistics;**
  - □ **"model" world: distributions, models for uncertainty;**
  - □ **relate the two worlds: decision-making or inference, in the presence of uncertainty.**
- **Connect the worlds through analogues and analogies for flow**

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Introductory probability & distributional modelling

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Objectives:

- □ **Develop capabilities, knowledge and problem-solving skills in introductory probability and distributions in life-related problems linking with data**
- □ **Continually identifying & extending prior concepts & knowledge, & problem-solving skills**
- □ **Facilitate students' seeing what they know & can do & building on that**
- □ **Develop awareness of real probability & of themselves as problem-solvers**

Preliminary problem-solving, collaborative learning, everyday real contexts, free choice group project stochastic data (ICOTS7, IASE 2007)

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Second course in probabilistic & distributional modelling

Objectives:

- ☐ Dual development of model building and applications of stochastic/distributional models
- ☐ Identify dual components
- ☐ Separate & combine statistical & mathematical thinking
- ☐ "Bite-size" divisions e.g branching processes

Second course in data analysis & inference

- ?experimental design & regression ⟹ GLM?
- ?GLM then exptal design & regression
- Data investigation cycle & free choice group project
- Dual development of model building and selection/application of models

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Summary

- **Alignment of objectives and curricula**
- **Structuring curricula for flow & incremental steps within flow for learning**

Thank you & best wishes & here's to statistics!

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