STATISTICAL LITERACY and STATISTICAL COMPETENCE in the NEW CENTURY

David S. Moore
Purdue University, USA

THE ENVIRONMENT

• The intellectualizing of work
  – Need analytical, quantitative, computing skills
  – Need interpretive, communication skills
  – Multiple jobs, multiple careers
  – Need statistical skills?

• The democritization of education

  Tertiary education is now replacing secondary education as the focal point of access to rewarding careers.
  
  OECD Education at a Glance 2000
THE ENVIRONMENT

- University for the masses

<table>
<thead>
<tr>
<th>University</th>
<th>Entry Rate</th>
<th>Change 1990-1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>53%</td>
<td>+31%</td>
</tr>
<tr>
<td>Japan</td>
<td>36%</td>
<td>na</td>
</tr>
<tr>
<td>Korea</td>
<td>43%</td>
<td>+66%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>68%</td>
<td>+43%</td>
</tr>
<tr>
<td>United States</td>
<td>44%</td>
<td>+8%</td>
</tr>
</tbody>
</table>

Source: OECD Education at a Glance 2000

- University education now

- No longer a filter, broader clientele
- No longer esoteric, link to career
- Our students are not “us, only younger”
- Larger place for statistics.
THE ENVIRONMENT

• Nonstop education and training: Employed adults in job-related continuing education, 1994–95

<table>
<thead>
<tr>
<th></th>
<th>All employed adults</th>
<th>University educated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>41%</td>
<td>60%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>51%</td>
<td>69%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>56%</td>
<td>79%</td>
</tr>
<tr>
<td>United States</td>
<td>47%</td>
<td>70%</td>
</tr>
</tbody>
</table>

• Wisdom from research in math education

  – Students learn by their own activities

  – Understanding and procedures are separate domains

  – We can’t teach a wide audience what we used to think we covered.

THE ENVIRONMENT

• A changing discipline

  – Back to data, back to science

  – Interdisciplinary emphasis

• Technology

  – Drives changes in the discipline

  – Drives demand for quantitative skills

  – New content emphases

  – New learning tools: The next big change?

  – Enables competition for universities

  – The information flood
This Is a Revolution

Something momentous is happening, something far more consequential than a mere technological innovation. The last time we experienced such an innovation was the invention of the printing press almost half a millennium ago.

Gertrude Himmelfarb

THE NEW STATISTICAL LITERACY

• Data beat anecdotes
  – Power lines and childhood leukemia

• ...and intuition
  – General Electric appliance delivery

• ...and even “experts”
  – For every Ph.D., there is an equal and opposite Ph.D.
• Think broadly: Is this the right question?
  – Who is unemployed?

• Think broadly: Does the answer make sense?
  – “Only 15% of new entrants into the work force will be native white males.”

• Communication: Can you read a graph?
  – France in a population pyramid

• Only big ideas need apply (details automated). One cluster:
  – The omnipresence of variation
  – Conclusions are uncertain
  – Avoid inference from short-run irregularity
  – Avoid inference from coincidence

The rule for staying alive as a forecaster is to give a number or give a date, but never give both at once. 

Jane Bryant Quinn
THE NEW STATISTICAL LITERACY

• Big ideas: Another cluster:
  – Beware the lurking variable
  – Association is not causation
  – Where did the data come from?
  – Observation versus experiment

• Filters for nonsense: Triage on the information flood
  – The Bible Code predicts the future.

It’s easy to lie with statistics. But it is easier to lie without them.  
Frederick Mosteller

THE NEW STATISTICAL COMPETENCE

• Use automated tools gracefully

• What can’t be automated?

• Keep thinking broadly

• Statistical thinking (ASA/MAA)
  – The need for data
  – The importance of data production
  – The omnipresence of variability
  and . . .
THE NEW STATISTICAL COMPETENCE

• The quantification and explanation of variability
  – Randomness and distributions
  – Patterns and deviations (fit and residual)
  – Mathematical models for patterns
  – Model-data dialog (diagnostics)

• This is serious stuff
  – Understanding chance variation
  – One pass through software isn’t enough
  – Models as interpretive tools
  – Strategies, not just methods
THE NEW STATISTICAL COMPETENCE

- Data strategies: an example

PLOT YOUR DATA

INTERPRET WHAT YOU SEE

NUMERICAL SUMMARY?

MATHEMATICAL MODEL?

- But you can choose the details to fit your context

CHALLENGES

- The need to communicate.

- Our teaching is too narrow.

- Is quantitative literacy our turf?

- Does statistics retain a core?

- If the rocket goes up, I don’t care where it comes down.

IASE/ISI Satellite, 2001: David Moore