The Rocky Road to Statistical Literacy

Marion Smith
ACCOLEDS Training, December 6, 2002
What is Statistical Literacy?

• ability to:
  – understand, interpret statistical data
  – critically evaluate statistical information and data-related arguments
  – to use the information in context of daily life
  – to discuss or communicate one’s reactions.
Does it matter?
### Most popular sports

<table>
<thead>
<tr>
<th>Sport</th>
<th>Total Thousands</th>
<th>% of Total</th>
<th>Male Thousands</th>
<th>% of Male</th>
<th>Female Thousands</th>
<th>% of Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>24,260</td>
<td>11,937</td>
<td>12,323</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golf</td>
<td>1,802</td>
<td>7.4</td>
<td>1,325</td>
<td>11.1</td>
<td>476</td>
<td>3.9</td>
</tr>
<tr>
<td>Hockey (ice)</td>
<td>1,499</td>
<td>6.2</td>
<td>1,435</td>
<td>12</td>
<td>65</td>
<td>0.5</td>
</tr>
<tr>
<td>Baseball</td>
<td>1,339</td>
<td>5.5</td>
<td>953</td>
<td>8</td>
<td>386</td>
<td>3.1</td>
</tr>
<tr>
<td>Swimming</td>
<td>1,120</td>
<td>4.6</td>
<td>432</td>
<td>3.6</td>
<td>688</td>
<td>5.6</td>
</tr>
<tr>
<td>Basketball</td>
<td>787</td>
<td>3.2</td>
<td>550</td>
<td>4.6</td>
<td>237</td>
<td>1.9</td>
</tr>
<tr>
<td>Volleyball</td>
<td>744</td>
<td>3.1</td>
<td>394</td>
<td>3.3</td>
<td>350</td>
<td>2.8</td>
</tr>
<tr>
<td>Soccer</td>
<td>739</td>
<td>3</td>
<td>550</td>
<td>4.6</td>
<td>189</td>
<td>1.5</td>
</tr>
</tbody>
</table>

1. Persons frequently play more than one sport.

Recent article:
SFU to revamp curriculum to improve students’ writing skills

“… its graduates don’t always have the writing skills, competency with numbers or breadth of knowledge that are needed in the workplace …”

Janet Steffenhagen
The Vancouver Sun
SFU will overhaul its undergraduate program:

“What we wish…is that our students have a facility in quantitative reasoning, the ability to communicate effectively in writing and some breadth of exposure to subject areas of a liberal arts university”

John Waterhouse
Academic Vice-President, SFU
“all graduates should be ‘good consumers of quantitative information’…they ought to be able to understand statistics…[be able to] …read a report that contains statistical analysis. They ought to be familiar with the logic that goes along with quantitative analysis even though they may never be mathematicians or statisticians.”

John Waterhouse
The Vancouver Sun
Nov 25, 2002
The situation in Canada

Research on literacy
International Adult Literacy Survey

• Statistics Canada and OECD
• 20 nations measured on 3 scales:
  – prose, document, quantitative
• ‘Literacy in the Information Age’
  June 2000
Literacy levels

- **Level 1**: very poor skills
- **Level 2**: can deal only with simple, clearly laid out text
- **Level 3**: suitable minimum skill level for coping with demands of everyday life. Roughly the level required for secondary school completion and college entry
- **Levels 4 and 5**: higher-order information processing skills
Three types of literacy skills

• **Prose literacy** - knowledge and skills needed to understand and use text information

• **Document literacy** - able to locate and use information in various formats

• **Quantitative literacy** - can apply arithmetic operations to numbers embedded in printed materials
Prose Literacy

- Understand and use editorials, news stories, brochures, instruction manuals

Prose Literacy, Canada, 1994

Level 1 lowest / Level 5 highest

Percent

42.2%
Document Literacy

- Job applications, payroll forms, transportation schedules, maps, tables and charts

**Document Literacy, Canada, 1994**

<table>
<thead>
<tr>
<th>Level</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>18.2</td>
</tr>
<tr>
<td>Level 2</td>
<td>24.7</td>
</tr>
<tr>
<td>Level 3</td>
<td>32.1</td>
</tr>
<tr>
<td>Level 4/5</td>
<td>25.1</td>
</tr>
</tbody>
</table>

Level 1 lowest / Level 5 highest

42.9%
Quantitative Literacy

- Balancing a chequebook, figuring out a tip, completing order form, determining amount of interest on a loan

![Chart showing quantitative literacy levels in Canada, 1994]

**Quantitative Literacy, Canada, 1994**

- Level 1: 16.9%
- Level 2: 26.1%
- Level 3: 34.8%
- Level 4/5: 22.2%

Level 1 lowest / Level 5 highest

43%
Literacy, Canada, 1994

Prose / Document / Quantitative

Levels 1&2
42.4%
42.9%
43.0%
Statistical Literacy

• Combines document and quantitative literacy:
  – ability to locate and use information in various formats: schedules, tables, charts
  – knowledge and skills to apply arithmetic operations, either alone or sequentially.
What's happening in classrooms

Some examples
Examples from the classroom

1. Elementary Data Management
2. Creativity in Grade 10 Math
3. Data use in Business Class
4. Using E-STAT for Marketing
5. Social Issues in Math Class
6. Using data in Debating
Data Management in Elementary

Dr. David Mandzuk, University of Manitoba

- Displaying, analyzing and interpreting numerical information — one math strand least effectively taught in elementary
- Use Canadian information in teaching math
- Uses the booklet *Canada at a Glance* with Grade 5 and 6 classes
Canada at a Glance

• Combines Math, Social Studies, & educational technology

• Uses Demographics section: pop. by prov/terr, major urban areas, marital status, age groups, ethnic origin, etc.

• First: teaches graph types: pie, line, bar
Preparation

• Teaches purpose and organization of booklet
• Interprets appropriate tables so that students understand the information
• In computer lab, teaches how to enter data on spreadsheet
• Students prepare a series of graphs following a contract or question sheet
Student results

• Learn how to manage data
• Consider best graphs for display of data
• Produce appropriate graphs
• Show they understand the graphs by answering the contract or question sheet
Major challenges

• Diverse ability among students
• Computer availability
• Need to troubleshoot. Students need to be taught how to deal with data entry errors, double checking, what to do when graph doesn’t reflect the data.
Creativity in Math

Tom Steinke, Marie Brazeau, Joel Yan

• Grade 10 Academic Math students
• Objective: to model data relationships using quadratic and linear functions
• Math can:
  – apply to the real world
  – help model past behaviour
  – predict future trends
Creativity in Math

• Students learned about linear and quadratic functions
• Learned how to use *Dynamic Statistics Software* from Fathom
• Introduced to STC website
• Selected topics of interest and looked for supporting data on website
• Incentive: contest for most creative analysis and results
Creativity in Math

• Each student provided:
  – reasons for choosing their issue
  – their hypothesis
  – the data used
  – results of data modelling: mathematical relationships and equations describing those relationships
  – predictions of future trends
  – conclusions and questions for further analysis
Creativity in Math

• Some topics chosen:
  – college enrollment and employment data
  – motor vehicle deaths vs. seatbelt use
  – youth employment vs. youth crime (does employment decrease incidence of crime?)
Creativity in Math

• Winning project #1:
  – Relationship between women with full-time jobs and the incidence of childbirth in Canada, 1976 - 1999. Hypothesis was that increase of women working full time would result in a decrease of birth rates
  – Also found that the baby boom echo could be closely modeled by a parabola
Creativity in Math

• Winning project #2:
  – Relationship between annual beer production, consumption per capita and percent of population males 20-24
  Conclusion: there is a correlation between average beer consumption and percentage of males age 20-24
  – Correlation did not hold true with % of males in other age cohorts
Creativity in Math

Winning project #3:

- Hockey statistics were used to examine performance of Paul Kariya and Teemu Selanne of the Mighty Ducks
- Conclusion: each player performed better when they played together than when apart
- Conclusion: career hockey statistics can be modeled by a parabola reflecting development, peaking and decline of skills
Creativity in Math

• The teacher’s observations:
  – students who normally performed poorly in a traditional classroom did better in this project oriented environment
  – these students were understanding concepts and methods faster, and sometimes better than the best students
  – students were very motivated.
Using data in Business Class

Donna Brunton, Newport, N.S.

• Data Processing 12
• Students build website for fictional business
• Must show that the business will be successful by using data, eg. unemployment rate, household income, education levels, sex/age, etc.
• Create graphs with E-STAT and spreadsheets.
Using E-STAT in Business Class

Biki Kochhar, Coquitlam, B.C.

- Marketing 11 and 12: Market Segmentation
- Divide population by demographic characteristics
- Discuss target markets for The Gap, Banana Republic, Seattle’s Best Coffee
- Use E-STAT to find size of target markets
- Consider whether locations are appropriate and if there are opportunities for expansion
Using E-STAT in Business Class

• Research market for a hypothetical business
• Data: male/female, single people, selected mother tongue, immigrants, private households
• Use computer technical skills and analytical skills to interpret data
• Draw conclusion: Coquitlam could support a skateboard shop.
Social Issues in Math Class
Geoffrey Roulet, Queen’s University

• Grade 12 Mathematics of Data Management
• Students must “carry out a culminating project on a topic or issue of significance that requires the integration and application of the expectations of the course”
• In preparation, students participate in a full-class activity…
Social Issues in Math Class

Students:

• Define an issue
• Formulate questions
• Locate, extract and analyze data from E-STAT
• Make supported inferences and predictions from statistical measures...
Social Issues in Math Class

First: Formulating the questions:

• “Some people claim that Canadian society is becoming increasingly dangerous and that tough new laws and punishment are required to return the country to the safer conditions of years past.
  – Do you agree or disagree with this view?
  – Is crime on the increase?
  – Are new laws and punishment needed?”
Social Issues in Math Class

Canada: Crime vs. Year

Total Criminal Code

3,000,000

500,000

1962 - 1999 $r = .96$

but 1991 - 1999 $r = -.98$

E-STAT Table 252-0001
Crimes, by actual offenses, annual (Terminated)
Social Issues in Math Class

• Incidence of crime prompts further investigation
• Why does the crime rate vary year to year?
• What causes people to commit more crime in one year than another?
• Frame another task for students...
Social Issues in Math Class

New question:

• “Some people do not see “law-and-order” policies as the best way to reduce crime...there are....social and demographic factors....that might help us...reduce crime...”

• Identify a social or demographic factor that might be related to crime
  – One selected factor is poverty: using low-income data as a proxy...
Canada: Crime vs. Low Income

Table 202-0802 - Persons with low income before and after tax

R = .57
Social Issues in Math Class

• There is not a strong case to link low income and crime
• Students learn that in dealing with complex interacting social conditions easy answers do not necessarily have simple answers
• Another question: is there link between young adult males and crime?
  – Plot crime vs. males 18-24 and 25-30...
Social Issues in Math Class

Canada: Crime vs. Males 18-24

Table 051-0001 - Estimates of population by age group and sex

R = -.18
Social Issues in Math Class

Canada: Crime vs. Males 25-30

Table 051-0001 - Estimates of population by age group and sex

R = .78
Social Issues in Math Class

• Whole class reports their results
• Build on results to suggest measures that society might use to reduce crime
• Debate can be intense, but are reasoned and civilized because of use of data and statistical methods
• Math, technology and STC data combined to encourage serious rational discussion of significant social issues.
Debating with Talented & Gifted

Sam Allison, Greenfield Park, Québec

• Weekly debates, Grade 9
• Involve research, writing, speaking, listening and teamwork
• Avoid ‘whale debates’
• Find issues that genuinely divide the class, eg. moral dilemmas
Debating with Talented & Gifted

• Major problem: finding Canadian evidence to add intellectual depth
• www.statcan.ca good site for evidence
  – eg. TV watching, bullying, teenage smoking
• Canadian rather than American trends
• Long term data cycles
Debating with Talented & Gifted

- Students learn to research and present data to support their argument
- They develop a facility in responding to opponent’s evidence, logic and ideas
- Knowledge of data or even definitions can help win a debate
Debating with Talented & Gifted

- Debates may be both memorable and hilarious
- One debate combined Canadian data on unionization and working hours with information on Santa’s elves.
The technology situation in schools
Technology issues

- equipment:
  - age
  - connectedness
  - tech support
  - variety of hardware/software
- access to equipment by the classroom teacher
  - location: library, IT class
  - few teachers have a computer on their desk
Internet Access: an example

• Surrey School District
  – access through:
    • 1. PLNet (BC Ministry of Education)
    • 2. Firewall - dynamic IP addresses behind firewall
    • 3. MAC nanny
Teacher issues

- large variation in ability, interest
- limited time to find resources and adapt them
- already have a “filing cabinet full of lessons”
- tech-phobia
- stats-phobia
E-STAT

- Schools register, but don’t use E-STAT
- Takes effort to introduce and use E-STAT in the classroom
  – the payoff must be good for the time invested
Education Outreach Program

What do we do?
The outreach program

• Learning resources website
  – pathways for Students, Teachers & Postsecondary users
  – lesson plans, teachers’ kits
  – E-STAT
  – recommended publications & resources
• Education representatives
Lines of communication

- *Learning Resources Bulletin* - e-mail
  - regional reps distribute to certain contacts
  - Network Nuggets (3000)
  - Webbits (1000)
  - TechTalk (700)
  - EdInfo
- *Learning with Canadian Information*
- Geoghist listserv
  - secondary and postsecondary
Major initiatives

• Textbook publishers
• Galileo
• Manitoba Education’s Curriculum Navigator
• Critical Thinking Co-operative
• School Libraries in Canada
From a UBC education student

“I think that by introducing students to StatsCan in social studies classes — perhaps they won’t be scared of stats courses later on in university.”
Thank you