Playing with Numbers: An Examination of Quantitative Reasoning Activities in College

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What is Quantitative Reasoning (QR)?

• Also known as: Quantitative Literacy or Numeracy

• The ability to use and understand quantitative information

• The ability to use numerical, statistical, and graphical information in everyday life

• The higher-order reasoning and critical thinking skills needed to understand and create sophisticated arguments supported by quantitative data
National Assessment of Adult Literacy

- Found no significant gains between 1992 and 2003 in quantitative literacy (QL) at any education level

- About 1/3 of college graduates demonstrated proficiency in QL

- Found significant gaps in QL between men and women and between racial-ethnic groups
The Need for QR

- Employees at all levels must be able to identify problems, analyze and interpret information, and make decisions on that information.

- Examples:
  - **Managers** in all fields deal with scheduling, budgeting, planning and making decisions based on quantitative information.
  - **Chefs** use quantitative information to monitor the nutritional value of meals or assess the cost of those meals.
  - **Journalist** must understand quantitative information to develop informed understandings of news events.
Research Questions

1. What is the relationship between student and institutional characteristics and the frequency of students’ use of QR activities?

2. Are the influences on students’ reported use of QR activities the same for males and females and for STEM and non-STEM majors?

3. Do students at institutions with formal QR programs report more frequent use of QR activities?
Sample

- Data were from an experimental set of questions appended to the 2011 National Survey of Student Engagement

- Over 13,000 first-year and senior students from 33 four-year institutions (9 of these institutions had formal QR programs)

- 61% Female, 97% Full-time, 33% First-generation, 1% Distance education

- 8% Black, 6% Asian, 73% White, 6% Hispanic
Dependent Variable

- Students’ reported frequency of QR activities
  \((\alpha = .90; \text{Range: 0to100; FY: } \bar{X} = 44, s = 28; SR: \bar{X} = 51, s = 29)\)

- How often have you done the following: \([\text{Very often, Often, Sometimes, Never}]\)
  1. Reached conclusions based on your own analysis of numbers, graphs, or statistics
  2. Used numbers, graphs, or statistics to help analyze a contemporary or historical issue
  3. Explained in writing the meaning of numbers, graphs, or statistics
  4. Analyzed others’ conclusions by using numbers, graphs, or statistics
## Independent Variables

<table>
<thead>
<tr>
<th>Student Characteristics</th>
<th>Institutional Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Undergraduate enrollment size</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Public-private status</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>Enrollment status</td>
<td></td>
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<tr>
<td>First-generation status</td>
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<tr>
<td>Transfer status</td>
<td></td>
</tr>
<tr>
<td>Distance education status</td>
<td></td>
</tr>
<tr>
<td>STEM major</td>
<td></td>
</tr>
<tr>
<td>SAT/ACT composite score</td>
<td></td>
</tr>
</tbody>
</table>
Data Analysis

- Intra-class correlations indicated that about 1.4% of the variability in QR activities is between institutions.

- Significant interaction by STEM/non-STEM major for Seniors (SR) but not for First-year (FY) students.

- No significant interaction by Gender for both FY and SR.
## Results: Student and Institutional Characteristics

<table>
<thead>
<tr>
<th></th>
<th>First-Year</th>
<th>SR STEM</th>
<th>SR Non-STEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-7.62 (-0.13)***</td>
<td>-9.24 (-0.17)***</td>
<td>-8.16 (-0.13)***</td>
</tr>
<tr>
<td>African-American</td>
<td></td>
<td></td>
<td>5.15 (0.04)**</td>
</tr>
<tr>
<td>Asian</td>
<td>4.39 (0.04)**</td>
<td></td>
<td>6.29 (0.04)**</td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAT score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First-generation</td>
<td></td>
<td></td>
<td>3.35 (0.05)**</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>-0.48 (-0.05)*</td>
</tr>
<tr>
<td>Transfer status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td></td>
<td></td>
<td>7.25 (0.06)**</td>
</tr>
<tr>
<td>Distance education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEM major</td>
<td>9.86 (0.17)***</td>
<td></td>
<td>---</td>
</tr>
<tr>
<td>Enrollment size</td>
<td>0.10 (0.05)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Institution</td>
<td>4.92 (0.07)***</td>
<td>4.33 (0.05)*</td>
<td>3.01 (0.05)*</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.052</td>
<td>.041</td>
<td>.029</td>
</tr>
</tbody>
</table>
Results: Formal QR Programs

• The ANCOVA for FY was significant indicating that FY students at institutions with formal QR programs report more frequent QR activity (partial eta-square = .003)
  - $\bar{X}_{adj-(QR\ Program)} = 46.7$
  - $\bar{X}_{adj-(NO\ QR\ Program)} = 43.2$
  - Cohen’s d=.13

• The ANCOVA for SR was not significant
Limitations

• Only examined student and institutional characteristics

• Used a coarse measure of intervention to promote QR (the simple presence or absence of a QR program)

• Convenience sample of 33 institutions, not a nationally representative sample
Discussion

- Both FY and SR STEM majors report more frequent QR activity

**Average QR Score by major category**
Discussion

- There was a consistent absence of a relationship between frequency of QR activities and SAT/ACT scores
- Females consistently reported less QR activity than males
- QR activities differed by race/ethnicity
Discussion

- Students attending private institutions reported more frequent QR activities

- The larger the institution, the more frequently FY students reported using QR

- QR programs may be one way institutions can increase students’ exposure to QR activities, especially for FY students and students in non-STEM disciplines
Conclusions

• With the growing use of quantitative information in the workplace and in everyday life, it is essential that all college students – not just STEM majors – develop QR skills.

• These results suggest that certain students are at risk for not developing these important skills.

• These findings also provide evidence for a modest, positive impact of QR programs.
Questions/Comments

Thank you for attending our presentation

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