Examining the Effectiveness of Reading Questions in Introductory University Mathematics Courses

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WABASH COLLEGE

http://persweb.wabash.edu/facstaff/turnerw/Presentations/SoTL-2006.pdf

Wabash College

- Private, independent, four year liberal arts college for men
- Grants Bachelor of Arts degrees in 21 majors
- Small (850 students)
- Student-Faculty ratio less than $10:1$
- Selective admissions requirements

Courses

- Introductory mathematics courses
  - MAT 003 : Pre-Calculus (Axtell)
  - MAT 111 : Calculus I (Turner)
- Class meetings three times per week
- Student assessment
  - Daily homework
  - Group work / projects
  - 3 – 4 exams

Reading Questions

- Want students to read the text before class
- Many personal accounts of various techniques (Amick, 1997; Ratliff, 1997; Gold, 1998)
- Research focuses on *whether* RQs help students
  - Much research based on student evaluation responses (Boelkins & Ratliff, 2001)
  - Some research based on student exam scores (Stickles & Stickles, 2006)

Our Question

- What types of questions are most effective?
  - Retention of information
- Three types of questions

  Definitional: reproduce statement from text

  Conceptual: more detailed; requires some thought

  Computational: mimic simple example from text
- Study through reading question assignments and quizzes

Reading Question Assignments

- For every "normal" class period
- Students submit electronically evening before class
- One question of each type
- Grade 0, $\frac{1}{2}$, 1 points per problem

Example (Calculus I)

1. What does it mean to say a function is locally linear?
2. Describe how to estimate the derivative of a function by using its graph. Does this work for every function? If not, what property must the function have?
3. Let $f(x) = \sin(x)$. Use $x = 1.39$ and $x = 1.41$ to estimate $f'(1.4)$.

Quizzes

- 5 – 6 throughout semester
- Similar to RQs for that day — check for retention
  - Same definitional
  - Same or similar conceptual
  - Similar computational
- Additional question not in RQs — check for reading entire section

Example (Calculus I)

1. What does it mean to say a function is locally linear?
2. Describe how to estimate the derivative of a function by using its graph. Does this work for every function? If not, what property must the function have?
3. Let $f(x) = x^2$. Use $x = 2$ and $x = 4$ to estimate $f'(3)$.
4. Let $f(x) = |x|$. Does $f'(0)$ exist? Does $f'(a)$ exist if $a \neq 0$?

Axtell's Results

- MAT 003 : Pre-Calculus
- 18 students
- No-shows not counted
- Reading Question Averages — 387 student scores

Definitional	85.1%
Conceptual	66.8%
Computational	78.8%

- Quiz Score Averages — 6 quizzes; 98 student scores

Definitional	53.1%
Conceptual	61.7%
Computational	63.8%

Axtell's Score Change

- Change in score from assignment to following quiz
- Only students who did both assignment and following quiz
- 88 student scores

Definitional	– 27 pts.	–30.6%
Conceptual	+5.5 pts.	+6.25%
Computational	0 pts.	0%

Turner's Results

- MAT 111 : Calculus I
- 27 students
- No-shows not counted
- Reading Question Averages — 774 student scores

Definitional	90%
Conceptual	74%
Computational	60%

- Quiz Score Averages — 5 quizzes; 126 student scores

Definitional	72%
Conceptual	76%
Computational	54%

Turner's Score Change

- Change in score from assignment to following quiz
- Only students who did both assignment and following quiz
- 109 student scores

Definitional	– 25 pts.	–22.9%
Conceptual	– 8.5 pts.	–7.8%
Computational	– 5 pts.	–4.8%

Combined Results

- Reading Question Averages

  — assumed all students answered all questions on all RQ assignments

Definitional	88.4%
Conceptual	71.6%
Computational	66.2%

- Quiz Score Averages — assumed all students took all quizzes

Definitional	63.6%
Conceptual	69.6%
Computational	58.4%

- Score Change — 197 student scores

Definitional	– 52 pts.	–26.4%
Conceptual	– 3 pts.	–1.5%
Computational	– 5 pts.	–2.5%

Conclusions

- Students copy definitions but do not remember them
- Students retain information conceptual and computational information, but not definitional

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References

L. Amick (1997). Math Class—Have You Seen the Preview? MAA online.

M. Boelkins & T. Ratliff (2001). How We Get Our Students to Read the Text Before Class. MAA online.

B. Gold (1998). Requiring Student Questions on the Text. MAA online.

T. Ratliff (1997). How I (Finally) Got My Calculus I Using Reading Assignments in First-Semester Calculus. MAA online.

J. Stickles & P. Stickles (2006). Using Reading Assignments in First-Semester Calculus. Submitted.