QL Conceptualization
from theory to classroom

David Deville
Northern Arizona University

October 13, 2018
• conceptualizations of QL
Outline

- conceptualizations of QL
- courses under study
Outline

- conceptualizations of QL
- courses under study
- core competencies
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- courses under study
- core competencies
- article analysis results
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- conceptualizations of QL
- courses under study
- core competencies
- article analysis results
- interview results
Conceptualizations of QL

Formative
“the mirror image of literacy” (Central Advisory Council for Education (England), 1959)

Mathematical
ability to use mathematical skills that apply to everyday life
appreciation of mathematics
high school mathematics with applications
Conceptualizations of QL

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"integration of mathematics, communication, cultural, social, emotional and personal aspects of each individual's numeracy in context" (Maguire and O'Donoghue, 2002)

"numeracy situations" "embedded in a context that has some personal meaning" (Gal, 1997)

optimal solutions are open to interpretation
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MAT 114:

- modified emporium style
- class meetings 75 min once per wk (standard lecture with short activities/quizzes)
- 75 min per wk lab time required
- course-pack with fill-in notes and tear-away quizzes/hw assignments. *Quantitative Reasoning* by Fahy and Nabours (2016)
- 13 modules involving descriptive statistics, probability, statistical inference, linear/exponential models of growth/decay, discrete models
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- mathematical conceptualization
MATH 1313:

- class meetings 2-3 times or 150 min/wk
- balance of lecture and individual/group work
- textbook: *Common Sense Mathematics* by Bolker and Mast (2016)
- emphasis on contextual, real-world situations (media, finance, sustainability, etc...)
- questions, while relating to the real-world, are generally self-contained
- emphasis on classroom discussion and student presentations.
MATH 1313:

- class meetings 2-3 times or 150 min/wk
- balance of lecture and individual/group work
- textbook: *Common Sense Mathematics* by Bolker and Mast (2016)
- emphasis on contextual, real-world situations (media, finance, sustainability, etc...)
- questions, while relating to the real-world, are generally self-contained
- emphasis on classroom discussion and student presentations.
- integrative conceptualization with concessions
MATH 2183

- pre-requisites: MATH 1313 or College Algebra
- class meetings 2-3 times or 150 min/wk
- balance of lecture and individual/group work
- textbook: *Quantitative Reasoning: A Casebook of Media Articles* by Boersma et al. (2012)
- emphasis on contextual, real-world situations (especially in the media)
- questions from casebook relate to whole news articles (less scaffolding than material in 1313)
- emphasis on group work and “news of the day”
Courses

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- class meetings 2-3 times or 150 min/wk
- balance of lecture and individual/group work
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- emphasis on contextual, real-world situations (especially in the media)
- questions from casebook relate to whole news articles (less scaffolding than material in 1313)
- emphasis on group work and “news of the day”
- integrative conceptualization with few concessions
Interpretation: “Ability to glean and explain mathematical information presented in various forms (e.g. equations, graphs, diagrams, tables, words)”

Representation: “Ability to convert information from one mathematical form (e.g. equations, graphs, diagrams, tables, words) into another”

Calculation: “Ability to perform arithmetical and mathematical calculations”
Analysis/Synthesis: “Ability to make and draw conclusions based on quantitative analysis”

Assumptions: “Ability to make and evaluate important assumptions in estimation, modeling, and data analysis”

Communication: “Ability to explain thoughts and processes in terms of what evidence is used, how it is organized, presented, and contextualized”
## QLAR - Results

### Frequency and Prevalence of Core Competencies in Modules 2, 3, 5, 6 and 8 Exercises, Activities and Previous Module “Looking Forward” Exercises in *Quantitative Reasoning* (Fahy and Nabours, 2016)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Number of questions</th>
<th>Percent of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpretation</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>Representation</td>
<td>32</td>
<td>17</td>
</tr>
<tr>
<td>Calculation</td>
<td>105</td>
<td>55</td>
</tr>
<tr>
<td>Analysis/Synthesis</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>Assumptions</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Communication</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
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### Frequency and Prevalence of Core Competencies in the Chapters 5, 8 and 12 Exercises from *Common Sense Mathematics* (Bolker and Mast, 2016)

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</tr>
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<tbody>
<tr>
<td>Interpretation</td>
<td>51</td>
<td>31</td>
</tr>
<tr>
<td>Representation</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>Calculation</td>
<td>79</td>
<td>48</td>
</tr>
<tr>
<td>Analysis/Synthesis</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td>Assumptions</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Communication</td>
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<tr>
<td>Representation</td>
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<td>29</td>
</tr>
<tr>
<td>Calculation</td>
<td>101</td>
<td>43</td>
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<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Communication</td>
<td>53</td>
<td>23</td>
</tr>
</tbody>
</table>
Percentage of questions that require core competency
15 total student interviews
  - 9 MAT 114 students
  - 4 MATH 1313 students; 1 MATH 2183 student

3 portions
  - Habit of Mind Instrument
  - Responses to course-like materials
  - Course impressions and general discussion
I'm not kidding anymore. I don't play games. I'm not trying to waste my time, or anybody else's time. So, I figured if I was gonna participate in this, I need to be, you know, honest and forthcoming.

What facts did the author use to support the main point(s)? Research over a period of time in correlation to the trends of lead

Were there any particular strengths or weaknesses in how these facts were reported? Not really, at least none that really held any weight. However, the argument within the article is quite interesting.
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first thing that comes to mind is, is like a stem-and-leaf plot.
Put, put together statistics showing, you know, these are, these are alarming rates of, of crimes... and, at the same time, during that period the lead exposure was significant as well. Um... boxplots would, would, would work, um... I don’t recall if we use this or not, but for some reason, I’m, I’m thinking a cat-and-whisker plot?
What facts did the author use to support the main point(s)?

Lead abatement started in the mid 1970s and continued through the 1980s. This abatement would have affected young people representing high crime groups in the 1990s and 2000s. Studies have shown exposure to lead can increase violent behavior.

Were there any particular strengths or weaknesses in how these facts were reported?

The statement that studies suggest a correlation between lead exposure and violent behavior should be backed up with evidence such as the statistics, names of the studies, etc... The statement that other developed countries experienced crime drops should have been backed by specific evidence such as name of country, crime rates before and after, lead exposure before and after.
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Harps Food Stores, a grocer with stores in Arkansas, Missouri, and Oklahoma, used the slogan in the poster to indicate that the chicken they marketed had less sodium than that marketed by Harps’ competitors.

1) The poster states, “Our chicken contains up to 5 times less sodium [than the chicken of our competitor].” Explain carefully what this might mean.

2) Using your reasoning from Question 1, if Harps’ competitor’s chicken has 100 mg of sodium per serving, how much sodium does Harps’ chicken have, assuming the ad is correct?

1) Explain what Harps probably meant by the phrase “five times less” and restate the ad slogan with this interpretation. Discuss whether or not you think the new slogan is as effective as the one in the original ad.
A contractor has the opportunity to purchase a lot of 1,000 used bricks at an auction, some of which are cracked and therefore unusable. The contractor wants to estimate what percentage of the bricks are cracked, but can’t inspect all 1,000, so he instead looks through the 40 bricks on top and finds 7 which are cracked.

Match each vocabulary word below with its value or description on the right:

| Population | a) 7/1,000 |
| Sample     | b) 40      |
| Parameter  | c) 7/40    |
| Statistic  | d) Entire lot of bricks |
| Sample Size| e) Percentage of entire lot which are cracked |
|            | f) Bricks which were inspected |
|            | g) Range of values in which 95% of values fall |
|            | h) 7       |
|            | i) 33      |
All interview subjects identified their reasoning on the Harp's problem as something they would expect to do outside of an academic setting. I feel like this is just more useful in real life than this one is and I don't really ever hear terms from this paper. This one makes me think of like real life so I kind of just imagine myself in a grocery store and reading that sign... being like “oh, that sounds pretty good” like I want less sodium in my chicken so obviously I'm going to buy that one... so I definitely applied this more real life...
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4 (out of 14) identified their reasoning on the bricks problem as something they would expect to do outside of an academic setting.

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Course-like Problems - Results

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The bricks question, you would definitely, obviously... you could run into cracked bricks and that type of thing, but you wouldn’t be thinking of it in terms of sample sizes and statistic, though; what it’s asking you to do isn’t what you would do in normal life.

I don’t really ever hear terms from this paper. Of course population, sample maybe, but it’s not really something that a lot of people would be thinking about a lot of the time. I don’t think you really need to know like population and all that, sample sizes, with everyday life no matter like what your profession may be.
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All but one (MAT 114) interview subjects viewed their QR course as different from a typical mathematics course. 11 (out of 14) of the subjects who said the course was different identified applicability to the real world as a reason.

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Course Impressions

MAT 114 students only recalled financial mathematics topics (profit, savings, loans, interest) with any detail. When it came to using the formulas for mortgages and loans... I feel like that's the only thing that made sense. The rest I feel like I didn't need to know.

MATH 1313 students recalled dealing with interest rates, budgeting, tipping, car loans, home loans, taxes (general), property taxes, gas/utility usage, estimation, evaluating claims in media, rainforest deforestation, melting glaciers, and coral bleaching.
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One C student from MATH 1313 student described learning about the finances involved in home ownership as an explosion in [his] mind.

When a C student from MATH 1313 who did not enjoy the course was asked how authentic the applications to real-life were, he described them as authentic and genuine.

One B student from MAT 114 described what she wished her course had been like:

I'd rather learn about what each of those things [savings, loans and interest] really are and like how, how significant they are in real life and like how to make smart decisions about things like that, regarding like finances and loans and interest and you know whatever, buying cars and things like learning more about how to make decisions that make sense and are beneficial in life, and not so much focused on like exactly the amount of money that was saved, or exactly what the interest is, or in, in just example problems.
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Conclusions

Integrative QR courses require more sophisticated reasoning from students. Interview subjects reported that they want to see how mathematics and QR genuinely apply to real-life situations. Fake contexts can lead students to believe that the underlying mathematics is unimportant or not applicable to the real world. Interview subjects from integrative QR courses were better able to recall the ways that the course applied to real-life situations.
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Integrative QR courses require more sophisticated reasoning from students.

Interview subjects reported that they want to see how mathematics and QR genuinely apply to real-life situations.

Fake contexts can lead students to believe that the underlying mathematics is unimportant or not applicable to the real world.

Interview subjects from integrative QR courses were better able to recall the ways that the course applied to real-life situations.
Future Research

- Relationship between real-world context and sense-making
- Quantify the effects of integrative QR courses vs. mathematical QR courses
- Ability to engage in QR
- Attitude toward QR and/or mathematics
- Habit of mind to engage in QR

David Deville

QL Conceptualization
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