

Quantitative Graduation Requirements at US Four-Year Colleges

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Abstract

In 2009 the Special Interest Group of the MAA on Quantitative Literacy (SIGMAA-QL) sponsored a survey of quantitative graduation requirements at all US colleges. The MAA distributed this survey to their 1,554 liaisons. This paper presents the results for US four-year colleges where the response rate was 26%. Of those US four-year colleges responding, only 30% have a traditional math-science division requirement whereas 87% have college-wide quantitative requirement, 68% have a quantitative support center, 43% can satisfy QR requirement outside math, 32% have a pre/entry QR assessment and 20% have a post/exit QR assessment. Of those US four-year colleges responding and giving specific courses that satisfied any part of their quantitative graduation requirements, 92% listed Calculus, 74% listed Statistics or Research Methods, 60% listed Mathematics for Liberal Arts, 54% listed Discrete or Finite Mathematics, 50% listed College Algebra, 30% listed College Trigonometry, 25% listed Computer Science, 19% listed Statistical Literacy, 18% listed Symbolic/Mathematical Logic and 17% listed "Other QR/QL courses." Had the responses been a random sample, the maximum margin of error would have been ± 6 percentage points. The association between colleges listing a QR/QL course and those listing a Mathematics for Liberal Arts course (or a College Algebra course) was negative, weak and not statistically significant. This paper argues that at least a fifth of US four-year colleges offer a QR/QL course to satisfy their quantitative graduation requirements. Survey weaknesses are analyzed and survey improvements are proposed.

Project Overview

In 2009 the Special Interest Group of the MAA on Quantitative Literacy (SIGMAA-QL) sponsored a survey of quantitative graduation requirements at all US colleges. This survey builds on earlier surveys done by Dr. Lynn Steen (past President of the MAA).[4] This survey focuses on the general education QR requirements that are most relevant for liberal arts students in majors that don't have a specific mathematics requirement. The Appendix contains the project background, the MAA Liaisons and the survey response rates at US two and four-year colleges along with the survey questions and the survey results.

Summary of Project Results

The MAA distributed the SIGMAA-QL survey to their liaisons at 1,512 US colleges. Of these, 320 liaisons replied. The response rate by type of college:

- 26% at US four-year colleges: 275 / 1,075.
- 10% at US two-year colleges: 45 / 437.

Because of the lower response rate from two-year colleges, this paper presents just the results from the US four-year colleges. If these 275 responses had been a random sample, the maximum margin of error for questions involving the entire group would be 6 percentage points.

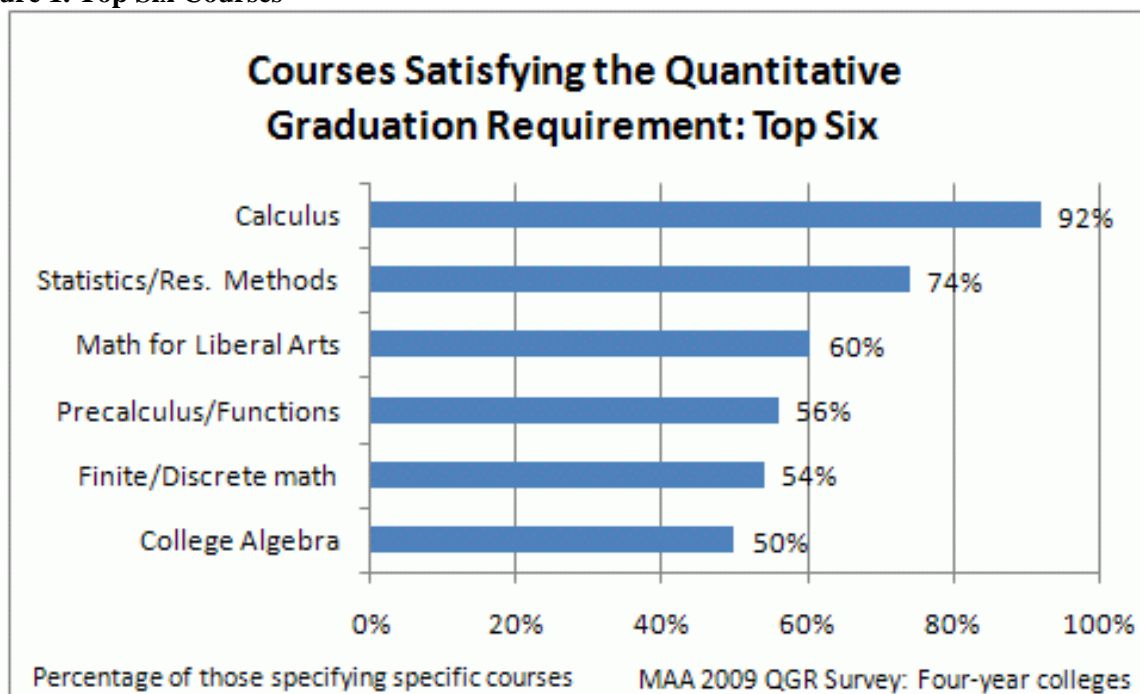
Here is a summary of the different types of quantitative graduation requirements at US four-year colleges:

- 24%: Traditional Math-science division requirement (e.g., 1 math and 1 science)
- 30%: Designated quantitative courses offered by mathematics and by other departments
- 22%: Designated courses all in math/stat dept
- 19%: Other (Formal reasoning; other depts.)
- 5%: Not applicable

Here are some of results from the 2009 Quantitative Graduation Requirements survey:

- 87% have a college-wide quantitative requirement
- 68% have a quantitative support center
- 43% can satisfy their QR requirement outside math
- 32% have a pre/entry QR assessment
- 20% have a post/exit QR assessment
- 7% have a two-Q (small, big) QR requirement
- 90% listed specific courses satisfying their Quantitative Graduation Requirements

The next three figures show the top six, middle six and bottom six courses listed as satisfying at least part of a college's quantitative graduation requirement.

Figure 1. Top Six Courses

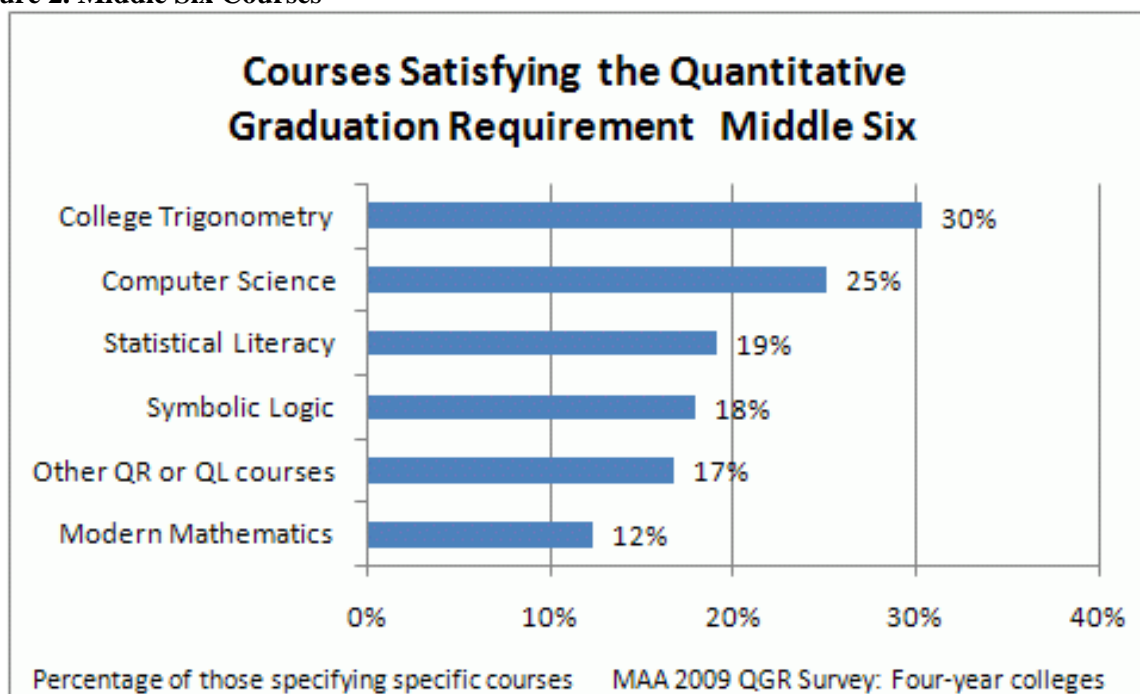
Of the US four-year colleges listing specific courses satisfying a quantitative graduation requirement:

- 92% listed Calculus. One might expect this would be 100%. But some colleges expect that students should be able to take a course that satisfies their quantitative graduation requirement without taking any college-level prerequisites. Otherwise, taking a course with implicit pre-requisites involves a hidden cost to students. Students who may have planned to take this course to complete their quantitative graduation requirement get very unhappy when they learn – at the last minute – that they can only take the course after completing one or more pre-requisite courses.
- 74% listed Statistics (or Research Methods). Again, one might expect this would be 100%. One explanation is that the specific question (question 15) was vague on whether the courses must be offered by a math/stat department. Those colleges where Mathematics just offers the probability course and other departments such as Business/Economics, Psychology and Sociology offer statistics or research methods might not list Statistics since it is taught outside the department. A second explanation might be that some colleges may have pre-requisites for taking statistics such as finite mathematics so that Statistics is not considered viable as satisfying a quantitative graduation requirement for those students whose majors do not require both courses.
- 60% listed Mathematics for Liberal Arts. This may be the most common course used to satisfy a quantitative graduation requirement for those students in non-quantitative majors: majors that don't require any particular mathematics course.

- 54% listed Finite/Discrete Mathematics. This course may be a pre-requisite for taking statistics or Research methods at many schools.
- 50% listed College Algebra. Here is one explanation for why this percentage is not higher:

"The Mathematics and Statistics Department at Arizona State University has removed college algebra from the list of courses students can use to fulfill their numeracy requirements for general studies. The department has taken this action as it believes students requiring only one mathematics course in their college experience should be introduced to mathematics that is more applied in nature. We further believe any student taking college algebra should have every intention of taking another mathematics course." [2]

Figure 2. Middle Six Courses



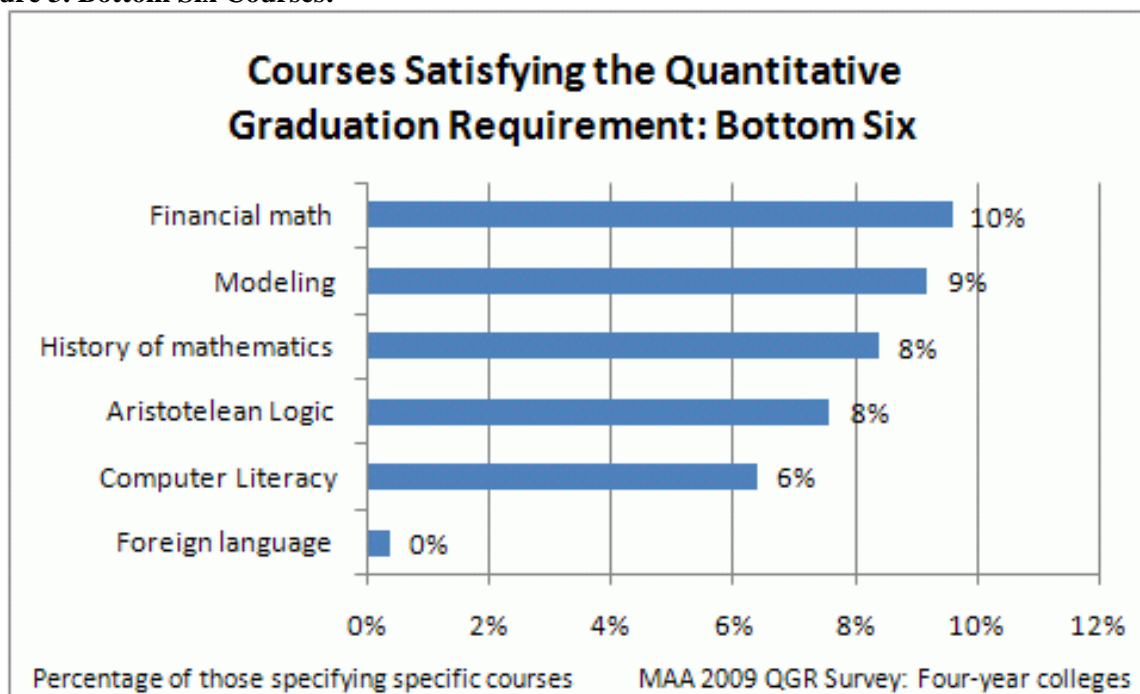
Of the US four-year colleges listing specific courses satisfying a quantitative graduation requirement:

- 30% listed College Trigonometry. One explanation is that this course might be taken by secondary education majors who may be teaching Trigonometry in high school. A second explanation might be that some schools offer a two-semester pre-Calculus functions course where one section is non-trigonometric functions and the other is trigonometric functions.
- 25% listed Computer Science. One explanation for including this course is that it may present discrete/finite mathematics in an applied context.

- 19% listed Statistical Literacy. While the American Statistical Association strongly endorses the study of statistical literacy in their GAISE recommendations, there has been little indication of how a statistical literacy course would differ from a traditional introductory statistics course. More data will be needed to understand this category.
- 18% listed Symbolic Logic or Mathematical Logic.
- 17% listed other Quantitative Reasoning (QR) or Quantitative Literacy (QL) courses. Note that this survey gave no definition or indication of what constituted quantitative reasoning or quantitative literacy. While quantitative reasoning and quantitative literacy have been strongly supported by the Special Interest Group of the MAA – QL, the National Numeracy Network and the American Statistical Association, more data will be needed to understand exactly what different colleges included in this category.

The remaining seven courses all involve less than 15% of US four-year colleges and are not analyzed further in this paper.

Figure 3. Bottom Six Courses:



Conjecture

The preceding data indicates that 17% of US four-year colleges allow a separate Quantitative Reasoning or Quantitative Literacy course to satisfy all or part of their quantitative graduation requirement. But the margin of error associated with the 17% response is five percentage points (assuming the sample was a random sample). So the actual percentage could be as low as 12%.

Conjecture: At least a fifth of US four-year colleges offer QR courses or programs. Obviously this is not a claim that can be deductively proven given this data. Nevertheless, evidence can be given to support it.

Here are four reasons that the percentage may be higher in the population than in this sample:

1. Of the 31 colleges on Steen's 2007 QR list, 68% did not respond to this survey. Had the 20 non-responders all responded and all checked the QR/QL course box, this would have increased the QR/QL percentage from 17% (42/250) to 25% (62/250). But this is not a very strong argument since 78% of the US four-year colleges did not respond (753/1,027). Had the rest of these 753 colleges all responded and if these 733 colleges (753-20) had the same 17% rate as those that did respond, this would add 125 checking the QR/QL box for an overall 18%: $(62+125)/1,027$.
2. Of the ten colleges in both this survey and Lynn's survey, only four indicated having a separate QR course. Since the colleges in Steen's list typically offered a separate QR/QL course, one might expect this percentage to be closer to 100%. One explanation for this lower percentage is that QR/QL courses may be offered under Math for Liberal Arts, under College Algebra or under Finite/Discrete Mathematics. Consider Bernie Madison's "Numbers in the News" course. [1] [3] When taught by Stuart Boersma at Central Washington University, it is a section of Mathematics for Liberal Arts. Placing new QR/QL courses under existing courses allows colleges to trial QR/QL courses without having to obtain college approval for such a course and without having to decide on the particular content or goals of such courses.
3. This survey gave no definition or examples of quantitative reasoning or quantitative literacy. The MAA liaison may not be familiar with this emerging area and may have left the QR/QL box unchecked in ignorance.
4. A college may offer a QR/QL program without offering a separate QR/QL course. They may designate various courses as satisfying a QR/QL requirement without calling those courses QR/QL courses (e.g., a Quantitative Journalism course).

It appears that there is little relationship between allowing a QR/QL course to satisfy a quantitative graduation requirement and allowing a Mathematics for Liberal Arts course (or a College Algebra course) to satisfy a quantitative graduation requirement.

Survey Critique

There are several areas of weakness in this survey:

- Possible response bias given the low 26% response rate.
- Ambiguous words/phrases: What is a “college-wide requirement”?
- Undefined terms: Quantitative Reasoning, Quantitative Literacy and Support Center
- Ignorance factor: MAA Liaison may not know what is happening in general education.

Perhaps the greatest area of weakness was the omission of several common courses that can be used to satisfy the quantitative graduation requirements at four-year colleges.

- Mathematics courses included Mathematics for Elementary Teachers, Intermediate Algebra, Algebra for Liberal Arts Students, Business Calculus or Brief Calculus, Concepts or Language of Mathematics, Number Systems, Linear Algebra and Differential Equations, Probability, AP Calculus or AP Statistics, Business Mathematics and Geometry.
- Non-mathematics courses included Science courses including Geology, Managerial Economics or Econometrics, the International Baccalaureate Diploma, Linguistics, SAT scores, Accounting/Finance, Music (Computer music, Music synthesis) and applied quantitative courses such as Quantitative History or Quantitative Journalism.

Conclusions

Although this survey suffers from potential survey bias and from measurement bias due to ambiguous or undefined term, it is a positive first step that sets forth a worthy goal: monitoring the quantitative graduation requirements at US colleges and universities. It gives some idea on the prevalence of various programs and courses that can satisfy four-year college quantitative graduation requirements. Two major conclusions are: (1) A minority of four-year colleges use the traditional divisional requirement (e.g., one science and one math) – and (2) perhaps a fifth of four-year colleges offer a separate QR/QL course – to satisfy their school’s quantitative graduation requirement.

Next Steps

Conducting this survey of quantitative graduation requirements is the first step in a multi-step process.

The next steps are as follows:

1. Submit these results for publication by the MAA.
2. Survey just those schools that checked having a separate QR/QL course or a Statistical Literacy course. Relevant questions include the textbook used, the type of course and the course goals.
 - Post results on MAA or SIGMAAQL website
 - Submit the QR/QL detailed results for publication by the National Numeracy Network.
 - Submit the Statistical literacy results for publication by the American Statistical Association.

Recommendations

Repeat this SIGMAA-QL sponsored national QGR survey next fall.

- Eliminate some of the open-ended questions
- Send out a copy of the survey with the instruction e-mail
- Send out the survey earlier so liaisons have more time
- Add additional courses such as Science and Mathematics for Education majors
- Review and perhaps define ambiguous or undefined terms
- Review other liaison suggestions and make improvements
- Survey QR courses offered under Algebra, Mathematics for Liberal Arts or Finite/Discrete Math.
- Work with other Special Interest Groups of the MAA to see what questions they might want to include in this type of survey. For example, the SIGMAA-Statistics might want to know what percentage of US four-year colleges accept AP statistics courses as an equivalent for college statistics. They might want to know what percentage of US four-year college business programs requiring statistics also require a calculus or a discrete/finite mathematics course as a prerequisite.

Acknowledgments

To the Special Interest Group of the MAA on Quantitative Literacy (SIGMAA-QL) for taking on responsibility for updating Steen's list. To Maura Mast, SIGMAA-QL President 2007-2009, who directed this survey. To the MAA and Michael Pearson, MAA Director of Programs and Services, who provided access to the MAA liaisons and to Kerry Sullivan, MAA Program Assistant, who generated the survey. And to the 375 MAA liaisons who responded to this survey and gave comments on how it might be

improved. And a special thanks to Lynn Steen who pioneered many areas of Quantitative Literacy including the first listing of colleges having QR/QL programs or courses.

References

- [1] Boersma, Stuart; Caren Diefenderfer, Shannon Dingman and Bernie Madison (2009). *Using Media Article to Drive a Q/L Course*. Slides. www.statlit.org/pdf/2009BoersmaEtcMAA6up.pdf
- [2] Isom, Mathew A. (2004). Mathematical Association of America Southwest News. Copy at <http://oak.ucc.nau.edu/hagood/MAASW/Newsletter047.htm>
- [3] Madison, Bernie; Stuart Boersma and Caren Diefenderfer (2009). *Case Studies for Quantitative Reasoning* (2nd Ed.).
- [4] Steen, Lynn (2007). *QR Courses and Programs at US Colleges*. Copy at www.stolaf.edu/people/steen/Papers/qlprogs.pdf

APPENDIX: 2009 QUANTITATIVE GRADUATION REQUIREMENTS SURVEY DETAILS**Project Background**

In 2007, Lynn Steen hosted an updated list of 30 colleges that had quantitative literacy programs or courses. [4] At that time, Steen turned over that list to the SIGMAA-QL to maintain and update. At the 2009 JMM, Maura Mast, outgoing president of the SIGMAA-QL asked for a volunteer to draft a survey to replace the QL survey maintained by Lynn Steen. I volunteered and was accepted. The goal was to maintain a current list of the Quantitative Literacy programs and courses at US colleges and universities [Schield e-mail Feb 19, 2009]. In a March meeting with J. Michael Pearson (MAA Associate Executive Director and Director of Programs & Services), he indicated the MAA would be willing to disseminate the survey to each of the MAA liaisons, program the survey instrument, collect the results and post the survey results on the MAA website. In our discussion, the project grew from a simple listing of just those schools with QL programs or courses to a listing of the quantitative graduation requirements at all US schools and colleges. Taking a broader perspective would help place QL programs and courses into a broader context. By September 11, a draft of the survey was sent to Maura Mast and Cinnamon Hillyard for review. On October 7, a revised draft and cover letter was sent to Michael Pearson for review. On October 20, Michael Pearson, returned a revised cover letter with his suggestions for clarifying the survey. Michael positioned the project as generating a “database of math graduation requirements.” On October 14, Kerry Sullivan, Program Assistant, created the survey in Survey Monkey. On October 27, the survey e-mail was distributed to the MAA liaisons.

MAA Liaisons at Colleges and Universities

As of the fall 2009, the MAA had 1,554 liaisons at colleges and universities. This list was neither exhaustive nor exclusive of US colleges. Non-traditional colleges such as Phoenix and Capella University were not included. Some institutions such as SIAM are not colleges.

Each institution was identified with a single-character “Institution Type”: T = Two-Year College, B = Bachelors, M = Masters, D = Doctorate, A = ???, U = Unidentified and Blank. Some colleges (usually large universities) had more than one MAA liaison.

- The three “A” institutions are all colleges: Dabney S Lancaster Community College, Lake Region State College and Utah Valley State College.

- The seven “U” institutions are all colleges: Baker College of Flint, Finlandia University, Milwaukee School of Engineering, Ohio Valley College, Stone Child College, Texas A&M International University and Texas A&M University.
- The 14 “blank” institutions included nine colleges (Brookhaven College, CUNY-Medgar Evers College, Hesston College, Neumann College, Pennsylvania State University-Mont Alto, Queens College, Southwest Texas Junior College at Del Rio, Warner Pacific College and Wentworth Institute of Technology) and five non-colleges (General Motors, Math Assoc of America, SIAM, and two unnamed institutions).

Table 1 classifies MAA liaisons by the type of institution (A, B, D, M, T, U or blank) and whether the institution was a college.

Table 1: Institutions by Type and College vs. Non-College

| Institution | blank | A | B | D | M | T | U | Total |
|--------------------|-------|---|-----|-----|-----|-----|---|-------|
| College | 9 | 3 | 680 | 196 | 217 | 437 | 7 | 1,549 |
| Other | 5 | | | | | | | 5 |
| Total | 14 | 3 | 680 | 196 | 217 | 437 | 7 | 1,554 |

Some colleges (usually large universities) had more than one MAA liaison. Generally these involve institutions with branch campuses at different locations such as Texas A&M at College Station and Galveston. In some cases, these involve different departments within the same institution such as the University of Iowa at Iowa City with liaisons in both mathematics and applied mathematical and computational science. Since the majority seemed to involve different locations, each liaison was treated as representing a different institution.

Some institutions were located outside the US. The MAA Liaison list included a two-character identification of the state in which the institution was located including DC for District of Columbia and VI for the US Virgin Islands. The two-character state ID was blank for Jamaica (1) and PR for San German (1). It included two-character IDs for 35 Canadian schools in the following provinces: AB for Alberta (1), BC for British Columbia (7), NB for New Brunswick (2), NS for Nova Scotia (4), ON for Ontario (13), PE for Prince Edward (1), PQ for Province Quebec (5) and QC for Quebec (2). The 37 non-US institutions included the 35 Canadian schools, Jamaica and San German. All 37 non-US institutions were colleges.

Table 2 classifies MAA liaisons by status (two-year status or Other) and by institution (total, at colleges and at US colleges). For US colleges, “other” means a four-year school.

Table 2: MAA Liaisons: Total, at Colleges and at US Colleges

| Liaisons: | Two-Year | Other | ALL |
|----------------|----------|-------|-------|
| Total | 437 | 1,117 | 1,554 |
| At Colleges | 437 | 1,112 | 1,549 |
| At US Colleges | 437 | 1,075 | 1,512 |

Survey Response Rates

MAA liaisons received two reminders: November 23 asking that they return the survey by month end, and November 30 asking that they return the survey by Friday December 11. Table 3 shows the 320 survey responses broken out by type of school.

Table 3: QGR Survey Response

| Response | Four-Year | Two-Year | ALL |
|------------------|-----------|----------|-----|
| MAA Liaisons | 275 | 45 | 320 |
| Max Margin Error | ± 6 pts | ± 15 pts | 320 |

The margin of error shown is applicable for questions answered by the entire group assuming the survey responses were randomly selected from the population. The error margins shown are the maximum possible (e.g., the percentage of respondents answering “yes” is about 50%).

All responses were from liaisons at US colleges. In one case, two liaisons from the same college (North Carolina State) responded. One was in the Operations Research department; the other was in statistics. As mentioned previously, each MAA liaison was treated as representing a separate institution, so both entries were included. Table 4 shows the survey response rates obtained by combining the data from Table 2 and Table 3 for US colleges:

Table 4: QGR Survey Response Rate

| US Colleges | Four-Year | Two-Year | ALL |
|---------------|-----------|----------|-------|
| Contacted | 1,075 | 437 | 1,512 |
| Responded | 275 | 45 | 320 |
| Response Rate | 26% | 10% | |

Survey Questions

These are the actual survey questions that were posted on Survey Monkey by the MAA.

Survey of Quantitative Graduation Requirements

Please answer these questions as specifically as possible. If you cannot locate some of the information requested, answer "Not available." If a question does not apply, answer "Not applicable." Questions marked with an asterisk (*) are required to have an answer of some kind.

- *1. Quote your college's highest level mission statement that mentions mathematics, QR or QL.
- *2. Describe your college's general education quantitative graduation requirement.
- *3. Provide the URL for your college.
- *4. Provide the URL for your college's catalog.
- *5. Provide the URL for your college's mathematics department.
6. Provide the URL for your college's quantitative graduation requirement.
7. Provide an E-mail for a contact on your college's quantitative graduation requirement.
- *8. Does your college have a quantitative graduation requirement that applies to every student? Is every student required to take or satisfy some quantitative graduation requirement? ?
 - a. Yes
 - b. No
 - c. Not sure
 - d. Not applicable
- *9. Can students in non-quantitative majors (majors that don't specify a particular mathematics course) satisfy their quantitative graduation requirement by taking courses outside the Math department?
 - a. Yes
 - b. No
 - c. Not sure
 - d. Not applicable
- *10. Does your college use any entry-level quantitative assessment (other than for algebra or calculus)?
 - a. Yes
 - b. No
 - c. Not sure
 - d. Not applicable
- *11. Does your college use any non entry-level quantitative assessment (besides course completion)?
 - a. Yes
 - b. No
 - c. Not sure
 - d. Not applicable
- *12. Which of these best describes your college's quantitative graduation requirement for students in non-quantitative majors: majors that don't stipulate any particular quantitative requirement?
 - a. Not applicable
 - b. Traditional Math-science division requirement (e.g., 1 math and 1 science)
 - c. Designated quantitative courses all housed in the math/stat department
 - d. Designated quantitative courses all housed in the math/stat dept or Statistics/Research Methods.
 - e. Designated quantitative courses offered by mathematics and by other departments
 - f. Designated formal reasoning courses offered by various departments.
 - g. Other. Describe:
- *13. Does your college have a quantitative support center for students?
 - a. Yes
 - b. No
 - c. Not sure
 - d. Not applicable

- *14. Does your college have a two-level quantitative graduation requirement (such as a “little q” skills course and “big-Q” applications course)? a. Yes b. No c. Not sure d. Not applicable
- *15. At some schools, many different courses can be used to demonstrate quantitative reasoning. Please list all such courses that fit this category at your school. Check all that apply. Select the single best classification for each course. For example an algebra course with a quantitative reasoning emphasis should not involve check marks for both College Algebra and for quantitative reasoning. If your college has a QR requirement or a two-level “little q” and “big q” requirement, list all courses that satisfy either.
- a. Not applicable
 - b. Statistics or Research Methods
 - c. Calculus
 - d. College Algebra
 - e. College Trigonometry
 - f. Finite/Discrete math
 - g. Pre-calculus/Functions
 - h. History of mathematics
 - i. Math for Liberal Arts
 - j. Modern Mathematics
 - k. Modeling
 - l. Statistical Literacy
 - m. Financial math
 - n. Other QR or QL courses**
 - o. Computer Science
 - p. Computer Literacy
 - q. Symbolic or Mathematical logic
 - r. Traditional Aristotelian logic
 - s. Foreign language
 - t. Remedial Mathematics courses
 - u. High School SAT Scores
 - v. Test out by a college qualification exam
 - w. Other courses than listed above. Describe:
- *16. Estimated time needed to complete this survey: a. 20 minutes b. 40 minutes c. 60 minutes
d. 90 minutes e. 2 hours f. 3 hours g. 4 hours h. 5 hours i. 6 hours j. 7+ hours
17. Please include any suggestions on how this survey can be improved for future use.

Related Information

The MAA added related information for each record. This included

- the full name of the college
- the two-character identification of the state in which the college was located. See above.
- A single-character identifying the type of college. T for two-year (45), B for Bachelors (168), M for Masters (62) and D for PhD (44).

Indicators

Based on the survey response data, three new indicators were created.

- IN01: A four year indicator. If the College Type was T, then it was a two-year college, otherwise it was presumed to be a four year school. The one college for which this field was blank is presumed to be a four-year school. This indicator had 45 zeroes and 275 ones for a total of 320 entries.
- IN02: Count of the number of courses that were checked in Q15 as satisfying the schools quantitative graduation requirement.
- IN03: An indicator of whether any courses had been checked in Q15. If the preceding indicator was zero, then this indicator was zero; otherwise it was one.

Survey Results

Since the survey response rate was much lower for two-year colleges and since the survey questions were not properly designed for two-year colleges, the data from two-year colleges is not presented.

Q01: Quote your college's highest-level mission statement that mentions mathematics, QR or QL.

Responses were classified into five types:

Table 5 Q01 Type of Quantitative Graduation Requirement

| Q01 Type | Number | % |
|---|--------|------|
| 4: Some mention of something at the institutional level: mission statement, general education learning goals, student success credo, etc. | 127 | 46% |
| 3: Some mention of something at the science/math division level or at the math departmental level | 49 | 18% |
| 2: Other: AS degree, Academic senate document | 1 | 0% |
| 1: None to my knowledge, in revision, not applicable, not available | 73 | 26% |
| 0: No mention of anything mathematical or quantitative at the institutional level | 25 | 9% |
| Total | 275 | 100% |

Q02 – Q07: Text response. No attempt to classify the answers to these questions into groups.

Q08 Does your college have a quantitative graduation requirement that applies to every student? Is every student required to take or satisfy some quantitative graduation requirement?

Table 6 Q08 College-wide Quantitative Requirement

| Q08 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|-----|-----|----------|----------------|------|
| Count | 240 | 33 | 2 | 0 | 275 |
| Percentage | 87% | 12% | 1% | 0% | 100% |

Q09 Can students in non-quantitative majors (majors that don't specify a particular mathematics course) satisfy their quantitative graduation requirement by taking courses outside the Math department?

Table 7 Q09 Satisfy QGR Outside the Math Department

| Q09 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|-----|-----|----------|----------------|------|
| Count | 117 | 130 | 6 | 22 | 275 |
| Percentage | 43% | 47% | 2% | 8% | 100% |

Q10 Does your college use any entry-level quantitative assessment (other than for Algebra or Calculus)?

Table 8 Q10 Have a Entry-Level QR Assessment

| Q10 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|-----|-----|----------|----------------|------|
| Count | 125 | 169 | 21 | 5 | 275 |
| Percentage | 39% | 53% | 7% | 2% | 100% |

Q11 Does your college use any non entry-level quantitative assessment (besides course completion)?

Table 9 Q11 Have a Non-Entry (Post/Exit) QR Assessment

| Q11 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|-----|-----|----------|----------------|------|
| Count | 73 | 211 | 34 | 2 | 275 |
| Percentage | 23% | 66% | 11% | 1% | 100% |

Q12. Which of these best describes your college's quantitative graduation requirement for students in non-quantitative majors: majors that don't stipulate any particular quantitative requirement?

Table 10 Q12 Type of Quantitative Graduation Requirement

| Q12MathReqType | Count | % |
|---|-------|------|
| a. Not applicable | 15 | 5% |
| b. Traditional Math-science division requirement (e.g., 1 math; 1 science) | 66 | 24% |
| c. Designated quantitative courses all housed in the math/stat department | 61 | 22% |
| d. Designated quantitative courses all housed in the math/stat department or Statistics/Research Methods. | 9 | 3% |
| e. Designated quantitative courses offered by mathematics and by other departments | 82 | 30% |
| f. Designated formal reasoning courses offered by various departments. | 13 | 5% |
| g. Other. Describe: | 29 | 11% |
| Grand Total | 275 | 100% |

Q13. Does your college have a quantitative support center for students?

Table 11 Q13 Have a Quantitative Support Center

| Q13 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|------------|-----------|-----------------|-----------------------|------------|
| Count | 188 | 77 | 9 | 1 | 275 |
| Percentage | 68% | 28% | 3% | 0% | 100% |

Q14. Does your college have a two-level quantitative graduation requirement (such as a “little q” skills course and “big-Q” applications course)?

Table 12 Q14 Have a two-level (Big vs. Little) Quantitative Requirement

| Q14 | Yes | No | Not Sure | Not Applicable | ALL |
|------------|------------|-----------|-----------------|-----------------------|------------|
| Count | 20 | 232 | 18 | 5 | 275 |
| Percentage | 7% | 84% | 7% | 2% | 100% |

Notice that the number that indicated “Not sure” was almost a big as that answering “Yes.”

Q15. At some schools, many different courses can be used to demonstrate quantitative reasoning. Please list all such courses that fit this category at your school. Check all that apply. Select the single best classification for each course. For example a College Algebra course with a quantitative reasoning emphasis should not involve check marks for both Algebra and for quantitative reasoning. If your college has a QR requirement or a two-level “little q” and “big q” requirement, list all courses that satisfy either.

Table 13 Q15 Number of Courses Specified vs. Not Applicable

| Count of INSTITUTIONS # of Courses Marked | Not Applicable | | Total |
|--|-----------------------|------------|--------------|
| | Blank | YES | |
| 0 | 3 | 22 | 25 |
| 1 | 5 | | 5 |
| 2 | 11 | | 11 |
| 3 | 30 | | 30 |
| 4 | 31 | | 31 |
| 5 | 46 | | 46 |
| 6 | 46 | | 46 |
| 7 | 33 | | 33 |
| 8 | 20 | | 20 |
| 9 | 7 | | 7 |
| 10 | 8 | | 8 |
| 11 | 4 | | 4 |
| 12 | 4 | | 4 |
| 13 | 2 | | 2 |
| 14 | 1 | | 1 |
| 15 | 1 | | 1 |
| 16 | 1 | | 1 |
| Total | 253 | 22 | 275 |

Every response that indicated 'Not available' did not check any specific courses so that "Not applicable" was sufficient to indicate zero courses checked. But it was not necessary. So, the percentages in the following table were calculated against the 250 responses ($275-25=253-3$) with some courses specified.

Table 14 Q15 Courses that Satisfy the Quantitative Graduation Requirement

| COUNT | % | COURSE |
|------------|-------------|--|
| 275 | | All US Four-Year Colleges |
| 25 | | Colleges with no courses specified |
| 250 | 100% | Colleges that listed specific courses |
| 185 | 74% | Statistics or Research Methods |
| 230 | 92% | Calculus |
| 125 | 50% | College Algebra |
| 76 | 30% | College Trigonometry |
| 135 | 54% | Finite/Discrete math |
| 140 | 56% | Pre-calculus/Functions |
| 21 | 8% | History of mathematics |
| 151 | 60% | Math for Liberal Arts |
| 31 | 12% | Modern Mathematics |
| 23 | 9% | Modeling |
| 48 | 19% | Statistical Literacy |
| 24 | 10% | Financial math |
| 42 | 17% | Other QR or QL courses |
| 63 | 25% | Computer Science |
| 16 | 6% | Computer Literacy |
| 45 | 18% | Symbolic or Mathematical Logic |
| 19 | 8% | Traditional Aristotelian Logic |
| 1 | 0% | Foreign language |
| 9 | 4% | Remedial Mathematics courses |
| 15 | 6% | High School SAT Scores |
| 45 | 18% | Test out by a college qualification exam |
| 65 | 26% | Other courses than listed above. Describe: |

Table 15 classifies colleges by whether they checked a QR course or a Mathematics for Liberal Arts course.

Table 15 Q15: QR course vs. Math for Liberal Arts course

| COUNT | Other QR or QL course | | |
|-----------------------|-----------------------|-----|-------|
| Math for Liberal Arts | Yes | No | Total |
| Yes | 22 | 129 | 151 |
| No | 20 | 104 | 124 |
| Total | 42 | 233 | 275 |

These two variables are negatively associated but the association is not significant. Checking a QR/QL course was 11% more prevalent among colleges that didn't check a Math for Liberal Arts course (16%) than among those that did check a Math for Liberal Arts course (15%). Had this data been a random

sample, the chi-squared (0.13) with one degree of freedom, $(r-1)(c-1)$, would have a p-value of more than 10%.

Table 16 classifies colleges by whether they checked a QR course or a College Algebra course.

Table 16 Q15: QR course vs. Algebra course

| COUNT | Other QR or QL course | | Total |
|-----------------|-----------------------|-----|-------|
| | Yes | No | |
| College Algebra | | | |
| Yes | 18 | 107 | 125 |
| No | 24 | 126 | 150 |
| Total | 42 | 233 | 275 |

These two variables are negatively associated but the association is not significant. Checking a QR/QL course was 11% more prevalent among colleges that did not check a College Algebra course (16%) than among those that did check a College Algebra course (14%). Had this data been a random sample, the chi-squared (0.13) would not have been statistically significant.

Note that 65 (26%) of the Q15 responses indicated 'Other courses'. These have been tabulated into the following groups:

Table 17 Q15: Other Math Courses that Satisfy the Quantitative Graduation Requirement

| ID | COUNT | DESCRIPTION |
|-----|-------|---|
| M0 | 10 | Math courses already listed in the survey |
| M1 | 14 | Math for Elementary Teachers |
| M2 | 6 | Intermediate algebra; Algebra for Liberal Arts students |
| M3 | 2 | Business Calculus; Brief Calculus |
| M4 | 5 | Concepts/Language of Mathematics; Number Systems |
| M5 | 2 | Linear Algebra or Differential Equations |
| M6 | 3 | Probability |
| M7 | 2 | AP Calc or AP Stats |
| M8 | 1 | Business Mathematics |
| M9 | 1 | Geometry |
| M10 | 4 | Other |

Table 18 Q15: Other Non-Math Courses Satisfying Quant. Grad. Requirement

| ID | COUNT | DESCRIPTION |
|----|-------|--|
| X0 | 1 | Listed in the survey but outside math |
| X1 | 13 | Science courses including Geology |
| X2 | 6 | Managerial Economics or Econometrics |
| X3 | 1 | IB Diploma |
| X4 | 1 | Linguistics |
| X5 | 1 | SAT Score |
| X6 | 2 | Accounting/Finance |
| X7 | 7 | Music: Computer music, Music synthesis |
| X8 | 2 | Quantitative History, Journalism |

Q16. Estimated time needed to complete this survey: a. 20 minutes b. 40 minutes c. 60 minutes
d. 90 minutes e. 2 hours f. 3 hours g. 4 hours h. 5 hours i. 6 hours j. 7+ hours

Table 19 Q16: Distribution of Survey Completion Times: Counts

| Q16Time | Two Year | Four-Year | ALL |
|-------------|----------|-----------|-----|
| 20 minutes | 28 | 230 | 258 |
| 40 minutes | 10 | 32 | 42 |
| 60 minutes | 7 | 8 | 15 |
| 90 minutes | | 1 | 1 |
| 2 hours | | 3 | 3 |
| 3 hours | | 1 | 1 |
| Grand Total | 45 | 275 | 320 |

Table 20 Q16: Average and Median Survey Completion Times (Minutes)

| STATISTICS | Two Year | Four Year | ALL |
|------------|----------|-----------|-----|
| Average | 31 | 26 | 26 |
| Median | 20 | 20 | 20 |

Table 21 Q16: Distribution of Survey Completion Times: Percentages

| Q16Time | Two-Year | Four-Year | ALL |
|-------------|----------|-----------|------|
| 20 minutes | 62% | 84% | 81% |
| 40 minutes | 22% | 12% | 13% |
| 60 minutes | 16% | 3% | 5% |
| 90 minutes | 0% | 0% | 0% |
| 2 hours | 0% | 1% | 1% |
| 3 hours | 0% | 0% | 0% |
| Grand Total | 100% | 100% | 100% |

Q18: Comments: These have been classified into four different types: Applicability, Internal, External and Valuation. Here are the subgroups within each of these: Three liaisons indicated the survey was not applicable to their school (typically universities).

Table 22: Q18 Internal Suggestions

| ID | COUNT | INTERNAL SUGGESTIONS |
|----|-------|--------------------------------|
| I1 | 2 | None |
| I2 | 31 | Clarify/Define things |
| I3 | 4 | Ambiguities |
| I4 | 8 | College vs. University Problem |
| I5 | 3 | Formal Reasoning vs QR/QL |
| I6 | 1 | Math vs. Stats (QM) dept |

Table 23: Q18 External Suggestions

| ID | COUNT | EXTERNAL SUGGESTIONS |
|-----|-------|--|
| E1 | 1 | Fewer questions |
| E2 | 3 | More questions |
| E3 | 2 | List questions in query letter |
| E4 | | Publish results |
| E5 | | Omit open-ended questions |
| E6 | 1 | Allow for updates |
| E7 | 1 | Summarize by type of school (liberal arts) |
| E8 | 1 | Option to save/recall survey |
| E9 | 1 | Say "a few minutes" in indicating time |
| E10 | 1 | Send it earlier |

Table 24: Q18 Valuation Comments

| ID | COUNT | VALUATION |
|----|-------|-----------|
| V1 | 2 | Poor |
| V2 | 0 | Fair |
| V3 | 2 | Good |
| V4 | 2 | Excellent |

Table 25: Comments and Suggestions

| TYPE | COMMENT |
|------|---|
| A1 | This system is on its way out at my school. |
| A1 | Not applicable |
| A1 | Please Note: Cotney is a two-year private liberal arts college. We specialize in providing the first two years of a college education. Students prepare to go on in a variety of disciplines, but no majors are formally declared here. |
| E1 | Do not ask so many questions. |
| E10 | send it earlier [so] that other faculty could participate |
| E2 | More questions about placing students into the correct course |
| E2 | Although we do not currently have a quantitative literacy requirement, more than 95% of our students take at least one mathematics course before graduation. Perhaps a question that asks about what percent of students take any mathematics course might be helpful. (There seems to be consensus among our faculty that we should have a quantitative literacy/reasoning requirement, but we have not as yet determined how to accomplish this.) |
| E2 | Perhaps a question in the beginning asking if there are any requirements whatsoever so that anyone saying "no" does not have to go further? Also "less than 20 minutes" should be an option in #16. |
| E3 | List the questions in the query letter so users can collect materials. |
| E3 | Being able to preview the questions before starting the survey, so if information needs to be looked up it can be done prior to starting the survey. |
| E6 | Please include a link where we can update the information that we have provided. Thank you. |
| E7 | I hope the results will be provided to the mathematical community in summary form. This would be particularly nice if they are broken down according to school type. I am interested to know how Rhodes compares to other national liberal arts colleges. Thank you for doing this! |

| | |
|----|---|
| E8 | Provide the option for save and complete later. Several of the questions take a lot of time to complete and it is hard to do it in one sitting. |
| E9 | It only took me 5 minutes to complete this survey. I kept putting it off because it said "half an hour or less." Do NOT say that. I recommend saying "It will take just a few minutes" because that's all it took me! |
| I1 | None |
| I1 | none |
| I2 | The meaning of questions 10 and 11 are not clear. The sentence in question 15 about 'check marks for both algebra and for quantitative reasoning' is also unclear. |
| I2 | Better clarification of terms: big Q, little q, QR, QL, entry-level vs non-entry-level assessment, etc. |
| I2 | Some of the questions have terms that could have multiple meanings. For example, assessment could be a formal test OR a transcript evaluation. I assumed you meant a formal test for my responses. |
| I2 | Clarify terms. For example, what does "college" mean? Does it mean an academic institution, or can it be a unit within a university? |
| I2 | Question 15 was not clear. We have many of the courses listed and many of them demonstrate quantitative reasoning, so I wasn't sure if I should include only the two required courses. |
| I2 | Does quantitative literacy include computer science literacy for the purposes of this survey? |
| I2 | It is unclear to me if you are interested in the relationship of quantitative education to the mathematics department or just the use of formulas as often presented by other departments. For example, only about 50% of students at TMC take a course from the mathematics department. Instead the business majors (about 50% of the graduates) only take mathematics courses from the business department. Consequently, we only have 2 FTE mathematicians for a campus with 1900 full and part-time students. MAA seems to implicitly assume that quantitative literacy is handled by mathematics departments. I think that it needs to be realized that mathematics, as taught by mathematicians, is seen as a separate and arcane discipline by a large fraction of the academic community and that this is a problem for our profession. I suspect that it derives from the explicit nature of the reasoning required in mathematics classes, but it really needs to be investigated thoroughly. |
| I2 | The terms entry level quantitative assessment and non-entry level quantitative assessment threw me for a loop, especially with the parenthetic qualifications. We use ACT scores as part of our admission criteria (and for math placement) so I checked "yes" for 10. I'm not aware of anything other than using course completion thereafter, so I checked "not sure" for 11. |
| I2 | Define your terms, such as "little q" |
| I2 | Define QR and QL somewhere for people who don't know what they mean. Explain whether, for people at a university, "college" means "university" or whether it means "college within the university". Recognize that mission statements and appropriate people to contact for general education requirements may not be easy to determine at a large school. Allow more space for comments. For example, our bulletin, under the heading Recommended High School Preparation, says: Mathematics (four years recommended): Students entering the University should be able to: 1) understand ratios, proportions, percentages, roots and powers; and 2) perform the mathematical operations of algebra and geometry. While most careers for which University students are preparing require mathematical competency, an increasing number of careers in science and technical curricula require advanced preparation in mathematics." Note: I believe that our online bulletin is not quite up to date in listing math competency requirements. It says that algebra (MAT 0993) suffices, but it does not. |
| I2 | Remove educational jargon as much as possible. I am not familiar with "little q" and "big Q". I assume QR and QI refer to quantitative reasoning and quantitative literacy? |
| I2 | As our school's quantitative requirements are twofold (a one-semester mathematics requirement combined with one additional semester of a Quantitative Intensive), it was difficult in a few items to separate these two when the survey merely asked for a response regarding "quantitative graduation requirement." Perhaps this could be clarified in the future. |
| I2 | From my perspective, there are redundant requests to describe the college's quantitative literacy graduation requirement (2 and 12). |
| I2 | We have a math requirement (1 course) and a science requirement (2 courses) It was not clear from the survey if both should be included. |
| I2 | You asked about a quantitative support center. We don't have that but we have a Learning Center with tutors in all areas. The largest number of tutors are in mathematics. |
| I2 | It may make sense to ask for descriptions of non-standard courses satisfying the requirement. |
| I2 | Not clear to me what questions 10 and 11 are asking |
| I2 | Define QR and QL, big q and little q from the start. |
| I2 | Perhaps you could re-word questions 10 and 13 to be more clear. I don't really know what you're asking in 10, and in 13, we have a tutoring center, but it is not just for quantitative courses. |
| I2 | I answered not sure a lot because I don't know what some of these questions mean. We have a mathematics competency requirement AND a general education requirement with quantitative/reasoning courses. The first is a math course and the second is more general. I don't know if this is "big Q little q" since I am not familiar with the jargon. |
| I2 | Question 15 instructions unclear |
| I2 | "Quantitative literacy" is quite fuzzy and, even though you tried to define it carefully, it's still not clear to what is meant by it. And I was even more confused when you threw in science in #12. I could argue that lots of science courses allow students to demonstrate quantitative literacy but that doesn't seem to be included here. Why not? |
| I2 | Define your terms. I know "big-oh" but not "big-Q". And what is a quantitative support center? We have a math tutorial center, a STEM center, a student success center. |
| I2 | I don't understand your "little q" and "big q" terminology |
| I2 | I am not sure what Question 15 is asking exactly. It would be helpful to clarify. |
| I2 | This survey doesn't fit our situation at all. This is because we substitute passing a lab science course for a Q requirement. This can't be satisfied in the math department at all, but serves the purpose. I have done as well as I can, but the answers are likely to be misleading in the final tabulation. |
| I2 | Q11: Our college has an assessment plan that evaluates the quantitative literacy of a sample of students. However, there is no requirement |

| | |
|----|---|
| | (other than course completion) for students to graduate. So I'm not sure if I answered the question correctly. Q13: I'm not sure what to make of "quantitative support center" but we have the Math Learning Center, which provides tutoring in most GenEd courses. |
| I2 | Give a more detailed definition of QR and QL. |
| I2 | Provide your working definition of quantitative reasoning! |
| I2 | Question # 14 & 15 need clarification, better definition. |
| I2 | The survey is too vague and should address actual math courses required for graduation. |
| I3 | Questions 14 and 15 were phrases in an ambiguous way - I'm not sure whether I understood exactly what was asked here. |
| I3 | My answer to Q9 is really "Yes and No", which is not an option. We do allow students to use a specific course in statistics offered by the Business Administration Department to satisfy our requirement, but we only do so if the student has been placed by our standard entry math placement procedure (through testing) into a level higher than Math 153. This is because Math 153 is prerequisite for that statistics course. So you might include a possible answer of "yes and no" with room for explanation in your Q9. |
| I3 | Ask which students are required to have Quantitative courses to graduate. For example, all our BA students have the requirement, but not our BME or BMT. |
| I3 | This survey does not really apply to Governors State University, which is an upper-division university, only accepting students who have the equivalent of an associate's degree. That degree presumably includes some kind of quantitative requirement. |
| I4 | You made the mistaken assumption that there is only one math program at each university. |
| I4 | All my answers apply to students in the College of Arts & Sciences at Washington University; requirements in the undergraduate college of Engineering School, college of Business, etc. are probably different. If you meant to include those too, then use of the word "college" is confusing. |
| I4 | One comment: The requirement I described applies to students in the college of arts and sciences. The engineering school is separate, and naturally their students take more math. |
| I4 | Our university has about 7 colleges, perhaps use "school". There are multiple locations students go to for Q support (question 13 really should be answered 'no' because there is no single location). I do not understand question 14. |
| I4 | I teach at a small campus of a big research university. It was not clear to me whether I should be answering for the whole university or for my little campus. (I chose the former.) |
| I4 | When stating college it is a little confusing if you meant university or the college we are housed in at the university... |
| I4 | Many of your questions didn't really seem to fit my large state university. Among other things, my university offer virtually no courses below calculus. |
| I4 | The answers to this survey pertain to the College of Letters & Sciences (and not the University). The University requirements are more basic. You could ask about the graduation rate of minorities and questions related to number of faculty from underrepresented groups. |
| I5 | Your survey doesn't quite fit our situation. We do NOT have a QR requirement, but some of your questions almost seem applicable to our FR ("formal reasoning") requirement (see my response to #2 above). If you need more information or clarification, please contact me. Jerry Grossman (grossman@oakland.edu) |
| I5 | don't require answers eg to last question. I often don't complete surveys that require answers that I don't think have an accurate alternative such as that one. |
| I5 | In question #9, the correct answer is "yes" but the "Experimental Statistics Department" is the only other department from which students can take courses that satisfy our "quantitative graduation requirement." So, the two "EX ST" courses that do satisfy our quantitative graduation requirement are taught outside the "Math" Department, but they are taught by a "Stats" Department. |
| I6 | As a statistics department member I was offended by question 9 only mentioning mathematics departments. :) More seriously I don't understand how question 2 and 12 differ. |
| V1 | Get rid of it, this seems to be something of a waste of time. |
| V1 | This is a very frustrating survey and my responses should not be used. BC has 2 year technical degrees, 2 year transfer degrees, and 4 year degrees, and there variations in what math and QR courses are required depending on the type of degree/concentration. I tried to answer as best I could for one of the popular, general degrees (a two-year transfer degree), but I suspect some of my responses are not completely correct. Also, we have a funky 'gen ed' framework that requires students take certain courses that are classified by how much of the course provides instruction in 18 particular 'outcome areas', two of which are Quantitative/Logical and Critical Thinking, Creativity, and Problem Solving. This framework is WAY too complicated to be captured by this survey. |
| V3 | I only took 10 minutes, but I know the curriculum extremely well as I am Chair of the Undergraduate Academic Board and a member of the GER committee on campus. The email of a person to contact is Dr. Bart Quimby who is the Associate Vice Provost for Curriculum and Assessment in the Office of Academic Affairs. |
| V3 | The survey is straight forward and easy to fill out. |
| V4 | Excellent survey |
| V4 | This is a great survey. I'd love to get the results. Our school is currently undergoing some substantial reform in these areas. |