

The Quantitative Reasoning for College Science (QuaRCS) Assessment

----- INSTRUCTIONS FOR INSTRUCTORS -----

This document contains the text of the Quantitative Reasoning for College Science (QuaRCS) Assessment. The QuaRCS is designed to be administered online, however is available here for instructors wishing to examine it, implement it through their own online assessment platforms, or administer it in paper form.

The QuaRCS seeks to measure student skills in the following ten areas of quantitative reasoning: graph reading, table reading, arithmetic, proportional reasoning, estimation, percentages, statistics/probability, area/volume, error, and unit conversions/dimensional analysis. It also probes students' attitudes toward mathematics and the role of quantitative information in science. The assessment includes a short series of demographic and academic background questions. Details about the development and validation of the QuaRCS can be found in the following article:

Follette, Katherine B.; McCarthy, Donald W.; Dokter, Erin; Buxner, Sanlyn; and Prather, Edward (2015) "The Quantitative Reasoning for College Science (QuaRCS) Assessment, 1: Development and Validation," *Numeracy*: Vol. 8: Iss. 2, Article 2.
available at: <http://scholarcommons.usf.edu/numeracy/vol8/iss2/art2>

The QuaRCS is non-proprietary, however we strongly encourage your participation in our national study should you choose to administer it in your course(s). Instructors taking part in the national study will receive:

- a) Access to our online assessment interface. We will administer the instrument for you. You simply assign the link.
- b) Customized participant lists and score/attitude reports after each assessment. We will do all of the grading for you and conglomerate the results into a report.
- c) Reports on improvements in student attitudes and skills from pre to post semester. We can help you quantify whether your course is helping improve your students' quantitative skills and attitudes toward mathematics.

Below you'll find copies of all of the questions that appear in the online assessment. Solid horizontal lines indicate breaks between question blocks, each of which is shown on a separate page in the online assessment. The order of all quantitative question blocks except the first is randomized by our survey software. If you are administering the assessment in paper format, or implementing it online yourself, we advise similar randomization to avoid the effects of test fatigue on results from any one question.

More information about the study and curricular resources can be found at www.katefollette.com/QL. Please also feel free to contact Principal Investigator Kate Follette (kfollette@stanford.edu) with any questions or concerns about the QuaRCS or its implementation.

The Quantitative Reasoning for College Science (QuaRCS) Assessment Pre Semester Survey

You are being asked today to participate in a research study designed to investigate whether introductory science courses for non-majors like the one you are currently taking can improve students' quantitative and numerical skills. The designers of the study hope that this will give us some insight into how to improve the usefulness of courses like this for students like yourselves.

By completing this survey, which should take you 20-30 minutes, and clicking "submit" at the end, you are consenting to participate and to share your responses with its creators unless you e-mail the Principal Investigator and ask that your data be removed from consideration. Your participation is entirely voluntary, and you may withdraw at any time. There are no risks to you associated with your participation in this study.

If your instructor has assigned this instrument as part of your participation grade, he or she will be provided only with your name and told whether or not you completed the survey. Your instructor will not receive your individual results. The general results of the survey for your entire class will also be provided to your instructor at the end of the semester, but your name will be replaced with an anonymous tag. Therefore, your instructor will not be able to match results with individual students.

Your name will be used by us only to match the surveys that you complete at the beginning, middle and end of the semester, and will not be published.

If you have any questions or concerns about this study, would like to receive a copy of the results or to withdraw your data, please don't hesitate to contact Principal Investigator Kate Follette at kfollette@stanford.edu or at (763)213-7110. Thank you!

An Institutional Review Board responsible for human subjects research at The University of Arizona reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

P1. Please select your school below

P2. Please select the name of your instructor from the list below.

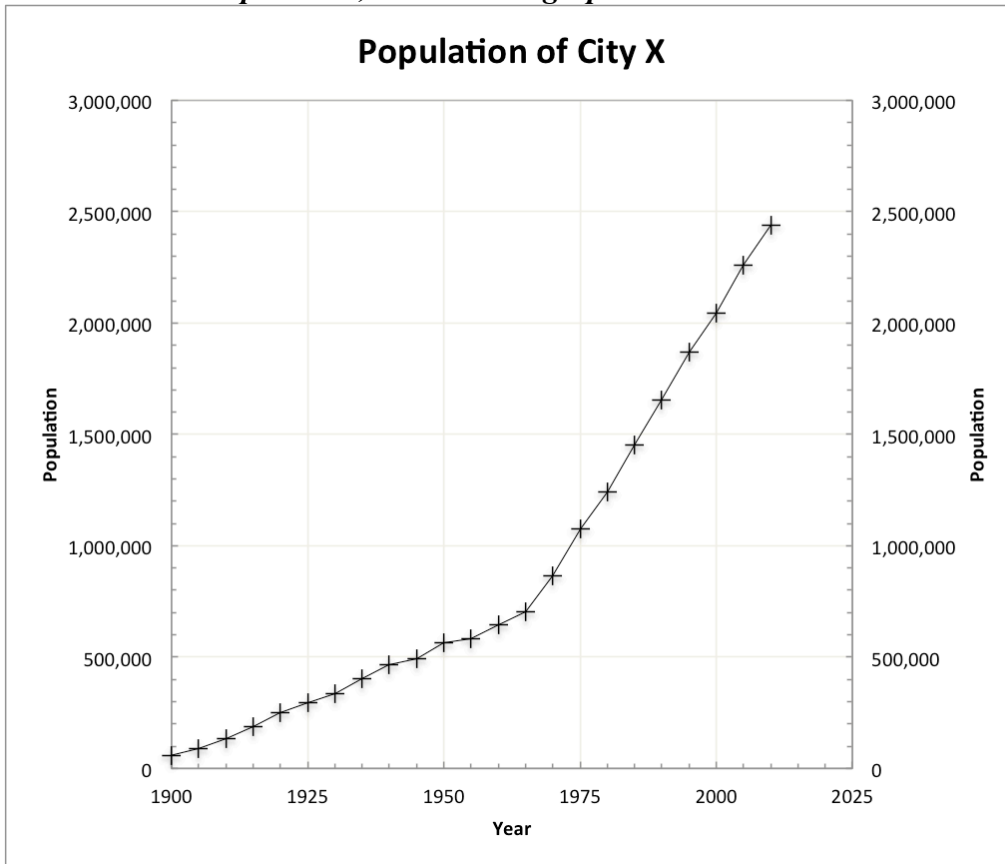
P3. In the field below, please give your name in the form Firstname Lastname, without middle names, initials or prefix/suffixes. If your last name includes a space, please omit it. For example, Oscar de la Hoya would be Oscar delaHoya.

Note: If your instructor has assigned this instrument for participation credit, you must provide your real name in order to receive it. Your name will NOT be published nor will your instructor receive your individual results.

These questions were designed to be answerable without a calculator, but you are welcome to use one if you choose. Choose the best answer for the following 25 quantitative questions, each of which is followed by a question asking you to rate your confidence in your answer. The quantitative questions are followed by a series of short questions about you and your feelings about math. The results of this survey will be used to try to improve courses like yours, so please try your best on all of the questions.

1. a. You have a rectangular fish tank that's 10 inches tall, 20 inches wide, and 15 inches deep. If the volume of one gallon of water is 231 cubic inches, then how many gallons are required to fill the tank?
 - a) 1 gallon
 - b) 9 gallons
 - c) 13 gallons
 - d) 231 gallons
 - e) 3000 gallons
- b. How confident are you in the answer you just chose?
 - a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
2. a. Your grocery store has a 20 ounce jar of peanut butter for \$4.00, and a 45 ounce jar for \$9.00. Which purchase will get you the best price per ounce?
 - a) the 20 ounce jar
 - b) the 45 ounce jar
 - c) the two jars are both the same price per ounce
- b. How confident are you in the answer you just chose?
 - a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
3. a. A college that typically has 50,000 students experiences an increase in enrollment to 55,000 students. By what percentage did enrollment increase?
 - a) 1%
 - b) 5%
 - c) 9%
 - d) 10%
- b. How confident are you in the answer you just chose?
 - a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

For the next three questions, consider the graph shown below.



4. a. According to the graph, what was the approximate population of City X in 1980?
- 750,000
 - 1 million
 - 1.25 million
 - 1.5 million
 - 1.75 million
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed
5. a. If the current population growth rate continues, which is the best estimate for the population of City X in the year 2050?
- 3 million
 - 4 million
 - 5 million
 - more than 5 million

- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed
6. a. Based on this graph, compare the population growth rates (i.e. increase in number of people per year) before and after 1970
- After 1970, the population grew at one-quarter of the pre-1970 rate
 - After 1970, the population grew at one-half of the pre-1970 rate
 - After 1970, the population grew at two times the pre-1970 rate
 - After 1970, the population grew at four times the pre-1970 rate
 - The population growth rates were the same before and after 1970
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed

For the next three questions, consider the peanut butter cookie ingredient list shown below



*3/4 cup peanut butter
 1/2 cup shortening
 1 cup white sugar
 1 and 1/2 cups flour
 3/4 cup brown sugar
 4 Tablespoons butter
 1 and 1/4 teaspoons baking soda
 1/4 teaspoon salt*

7. a. Imagine you have already filled a measuring cup (like the one shown above) with the amount of peanut butter in the recipe and you want to add the correct amount of shortening **on top of** it. Which line on the measuring cup should you fill to with shortening?
- the 1 cup line
 - the 1 and 1/4 cup line
 - the 1 and 1/2 cup line
 - the 1 and 3/4 cup line
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident

- d) I guessed
8. a. If your measuring cup has ounces on the side instead of cups, which line should you fill to when measuring the flour? There are 8 ounces in 1 cup.
- 6 ounces
 - 8 ounces
 - 12 ounces
 - 14 ounces
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed
9. a. You have only a $\frac{1}{2}$ **Tablespoon** measuring spoon. How much should you fill it to get the correct amount of baking soda? There are 3 teaspoons in 1 tablespoon.
- half full
 - two-thirds full
 - three-quarters full
 - five-sixths full
 - full once and then another one-quarter full
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed

For the next three questions, consider the following table.

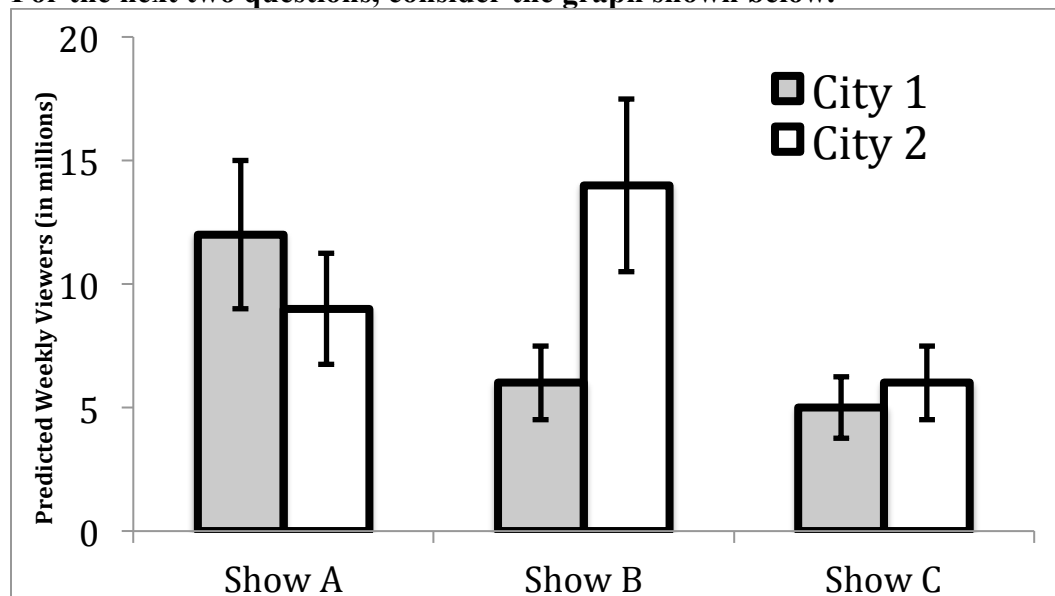
Number of Injuries by Ability Level for Skiers at Resort Y in the Years 2000-2010

Level of Expertise	Total Visitors	Number of Minor Injuries	Number of Severe Injuries	Number of Deaths
Novice	12,152	384	122	1
Intermediate	9,498	96	65	0
Expert	802	11	16	5
Totals	22,452	491	203	6

10. a. How many total injuries (including deaths) were sustained at Resort Y during this time period?
- 694
 - 700
 - 22,452
 - 23,152

- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
11. a. What were the chances of a randomly-selected skier sustaining an injury of any kind (minor, severe or death) while at Resort Y during this time period?
- a) less than 1%
 - b) about 2%
 - c) about 3%
 - d) more than 4%
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
12. a. What proportion of **severely injured** skiers at Resort Y during this time period were **intermediate** skiers?
- a) fewer than 1 in 100
 - b) about 1 in 10
 - c) about 1 in 6
 - d) about 1 in 3
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
-

For the next two questions, consider the graph shown below.



13. a. The graph above shows the **predicted** viewership of three television shows in two cities based on a poll of a small number of residents in each city. The poll has a reported error of 25%, shown as vertical error bars. Which of the following statements about the predicted viewers of Show A is most accurate?
- More people will watch Show A in City 1
 - More people will watch Show A in City 2
 - Either (a) or (b) could be true
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed
14. a. Which of the following predictions can be made based on the information (including errors) shown in the graph?
- Prediction 1: In City 2, more people will watch Show B than Show C*
- Prediction 2: In City 1, Show C will have the smallest viewership*
- Prediction 3: None of the three shows (A, B or C) will be equally popular in Cities 1 and 2*
- Only Prediction 1 is supported by the graph
 - Predictions 1 and 2 are both supported by the graph
 - Predictions 1 and 3 are both supported by the graph
 - All three predictions are supported by the graph
 - None of the predictions are supported by the graph
- b. How confident are you in the answer you just chose?
- very confident
 - confident
 - not very confident
 - I guessed

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15. a. You purchased 100 square feet of solar panels for your roof. However, your local Homeowner's Association requires that solar panels not be visible from the road. You decide to put solar panels on the roof of a shed in your backyard instead. The shed has a flat 5 foot by 5 foot roof. Complete the following sentence:
"To produce the same amount of power as your original design, you need to buy panels that produce _____ more power per unit area than your original panels."
- a) two times
 - b) four times
 - c) five times
 - d) twenty times
 - e) none of the above
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
16. a. If you cover the shed with your original panels, how many **more** of the same size sheds would you have to put up in your backyard in order to fit the rest of the panels?
- a) Three
 - b) Five
 - c) Nine
 - d) Nineteen
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
17. a. Your cable bill is \$36 per month from January 1 through September 30 and then doubles to \$72 per month starting October 1. What is your average monthly bill over the course of the entire calendar year (January-December)?
- a) \$42 per month
 - b) \$45 per month
 - c) \$48 per month
 - d) \$54 per month
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

18. a. If you place \$10 under your mattress every day for the next 40 years, approximately how much money will you have?
- a) \$15,000
 - b) \$150,000
 - c) \$1,500,000
 - d) \$15,000,000
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

A newspaper conducts a survey and predicts that in the local election between Candidates A and B, Candidate A will receive 60 % of the votes. The newspaper estimates the error in this prediction to be 5%.

19. a. If the newspaper repeats the survey with 400 participants, how many people can report that they will vote for Candidate A for the result to be consistent with the original prediction (that Candidate A will receive 60% of the votes with 5% error)?
- a) 228 to 252 people
 - b) 220 to 240 people
 - c) 240 to 260 people
 - d) 220 to 260 people
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
20. a. Several days later, the newspaper conducts another survey with 300 new participants. What is the **minimum** number of votes that Candidate A can receive in this new survey in order to be consistent with the original prediction (that Candidate A will receive 60% of the votes with 5% error)?
- a) 165
 - b) 171
 - c) 175
 - d) 180
 - e) 195
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

21. a. You want to carpet a 15 foot by 20 foot room. You have two carpet options to choose from. One is \$1.50 per square foot and the other is \$3.00 per square foot. How much more will your total bill be if you choose the more expensive carpet rather than the cheaper one?
- a) \$52.50 more
 - b) \$105 more
 - c) \$450 more
 - d) more than \$500 more
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
22. a. To carpet your 15 foot by 20 foot room and a hallway that is 4 feet by 12 feet, about how much total carpet do you need?
- a) about 100 square feet
 - b) about 150 square feet
 - c) about 250 square feet
 - d) about 350 square feet
 - e) about 750 square feet
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
23. a. If one scoop of lemonade powder is needed for every 12 ounces of water, then how many scoops should you add to **three gallons** of water to make it into lemonade?
- 16 ounces = 1 Pint
2 Pints = 1 Quart
4 Quarts = 1 Gallon
- a) 11
 - b) 16
 - c) 32
 - d) 64
 - e) 128
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

24. a. A sweater that was originally \$100 is on sale for 30% off. Which of the following coupons should you use to get the lowest final price?
- a) A coupon for 25% off the sale price
 - b) A coupon for \$25 off the sale price
 - c) Both coupons will result in the same final price.
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed
25. a. You drove 200 miles on 11 gallons of gas. Which of these is closest to the number of miles per gallon that you got?
- a) 16
 - b) 18
 - c) 22
 - d) 24
- b. How confident are you in the answer you just chose?
- a) very confident
 - b) confident
 - c) not very confident
 - d) I guessed

You are done with the quantitative/math questions in the survey!

26. Overall, how difficult were the questions in this survey?
- a) very easy
 - b) easy
 - c) moderate
 - d) difficult
 - e) very difficult
27. In your everyday life, how frequently do you encounter situations similar to problems in this survey?
- a) almost never
 - b) about once per year
 - c) about once per month
 - d) about once per week
 - e) daily

28. Which of the following best describes your calculator usage while taking this survey?
- a) I used a calculator to answer all or almost all of the questions
 - b) I used a calculator to answer about 75% of the questions
 - c) I used a calculator to answer about 50% of the questions
 - d) I used a calculator to answer about 25% of the questions
 - e) I didn't use a calculator at all, or used it on only one or two questions
-

29. How frequently do you do calculations in your everyday life?

- a) Never
- b) Infrequently
- c) Sometimes
- d) Frequently

30. How frequently do you encounter graphs and tables in your daily life?

- a) Never
- b) Infrequently
- c) Sometimes
- d) Frequently

31. Where would you put mathematics (including: doing calculations, reading graphs and tables, reasoning with numbers, etc.) on the following scales between two opposite adjectives.

Interesting	1	2	3	4	Boring
Useful	1	2	3	4	Useless
Easy	1	2	3	4	Hard
Fun	1	2	3	4	Scary

32. Rate the degree to which you agree with the following statement:

“I feel confident using numbers in my non-math courses”

- a) Strongly Agree
- b) Agree
- c) Disagree
- d) Strongly Disagree

33. Rate the degree to which you agree with the following statement:

“I feel confident using numbers in my everyday life”

- a) Strongly Agree
- b) Agree
- c) Disagree
- d) Strongly Disagree

34. Rate the degree to which you agree with the following statement:
“Numerical skills are important to the understanding of science”
- a) Strongly Agree
 - b) Agree
 - c) Disagree
 - d) Strongly Disagree
35. Rate the degree to which you agree with the following statement:
“Numerical skills are important to my everyday life”
- a) Strongly Agree
 - b) Agree
 - c) Disagree
 - d) Strongly Disagree
36. Rate the degree to which you agree with the following statement:
“I am satisfied with my current level of numerical/mathematical skill”
- a) Strongly Agree
 - b) Agree
 - c) Disagree
 - d) Strongly Disagree
-

37. How long ago was your last math course?
- a) I am taking a math course now
 - b) Within the last year
 - c) Within the last two years
 - d) Within the last three years
 - e) More than three years ago
38. How many mathematics courses do you plan to take in college (including any you've already taken and are taking now)
- a) none
 - b) one
 - c) two
 - d) three or more
39. How many science courses do you plan to take in college (including any you've already taken and are taking now)
- a) none
 - b) one
 - c) two
 - d) three or more

40. Why did you choose to take this course? Check all that apply.

- a) It is a prerequisite for courses in my major
 - b) To fulfill a university general education requirement
 - c) It sounded interesting
 - d) It sounded easy
 - e) I heard the class was good
 - f) I heard the instructor was good
 - g) Other _____
-

41. I am a college _____

- a) freshman
- b) sophomore
- c) junior
- d) senior
- e) other _____

42. Please select your major or majors from the list below.

- a) Humanities (e.g. English, Literature, Philosophy, Religion, Foreign Language)
- b) Arts (e.g. Art, Music, Dance, Film, Theater, Creative Writing)
- c) Social Sciences (e.g. Economics, History, Political Science, Psychology, Sociology, Anthropology, International Relations, Geography, Linguistics, etc.)
- d) Education
- e) Science (e.g. Physics, Chemistry, Biology, Geology and sub-disciplines)
- f) Engineering, Mathematics or Computer Science
- g) Business-related (e.g. Business, Marketing, Management)
- h) Health-related (Nursing, Pharmacy, Nutritional Science, Public Health, Exercise Science, etc.)
- i) Trade-specific (e.g. Architecture, Agriculture, Law, Justice, Library Science, Retail, Family and Consumer Sciences, Construction Trades, etc.)
- j) Journalism
- k) General Studies
- l) Undecided
- m) Other _____

43. I chose (or will choose) my major because: Check all that apply.

- a) I like the subject
 - b) I feel that it will help me get a job I will enjoy after graduation
 - c) I feel that it will help me get a well-paying job after graduation
 - d) I am good at it
 - e) I chose a major that would avoid math as much as possible
 - f) I chose a major that would avoid writing as much as possible
 - g) I'm not sure yet
 - h) Other _____
-

44. My age is _____

- a) under 18
- b) 18-25
- c) 26-35
- d) 36-45
- e) 46-55
- f) 56+

45. My gender is _____.

- a) Male
- b) Female
- c) Other

46. With which racial or ethnic group(s) do you most identify? Choose all that apply.

- a) African American
- b) Asian/Pacific Islander
- c) Caucasian (non-Hispanic)
- d) Hispanic or Latino
- e) Native American
- f) Other _____
- g) I prefer not to specify

47. Have you ever been diagnosed with any of the following? Please select all that apply.

- a) A physical disability (please specify if you wish) _____
- b) A cognitive disability (please specify if you wish) _____
- c) A learning disability (please specify if you wish) _____
- d) I prefer not to specify

48. Did you attend elementary, middle and high school entirely in the United States.

- a) Yes
- b) No

If no:

In what country did you attend elementary school? _____

In what country did you attend middle school? _____

In what country did you attend high school? _____

49. Knowing that this survey is being used for research to try to improve courses like yours and that your answer to this question will not be shared with your instructor, please honestly describe the amount of effort that you put into this survey.

- a) I just clicked through and chose randomly to get the participation credit
- b) I didn't try very hard
- c) I tried for a while and then got bored
- d) I tried pretty hard
- e) I tried my best on most of the questions