Date: 4/3/2007
To: Quantitative Skills Committee
From: Milo Schield
Topic: **Approval of GST 200 as 'Q' course**: a 'q' + 'QEM' course.

REQUEST: Approval of GST 200 as a Q course. Doing so will allow majors in the humanities to decide whether to offer a 'q' course and a QEM course within the major, whether to offer just a 'q' course in the major and use GST 200 as a QEM course, or whether to use GST 200 as a Q course ('q' + QEM) for their major.

BACKGROUND: GST 200 is designed for students in majors that do not require a quantitative course. Such majors include English, History and Philosophy. The newly approved plan for the quantitative reasoning skill calls for students to take courses that satisfy the 'q' requirement and the 'QEM' requirement.

Learning Outcomes: Q Courses

1. Students should develop foundational skill in procedures and methods quantitative reasoning. They should become knowledgeable about and skilled in applying quantitative methods that make use of the following core concepts necessary for effective quantitative reasoning. *Appendix 1 presents the four core concepts and summarizes how GST 200 satisfies this core-concept requirement.*
2. Students should recognize implicit and explicit quantitative claims in discourse and should develop the skills to evaluate and test such claims critically. *Appendix 2 summarizes how GST 200 satisfies this critical thinking requirement.*
3. Students should employ quantitative reasoning in decision-making and problem solving. They should demonstrate the ability to pose appropriate questions, provide a representation of quantitative information, apply quantitative methods on a reasoned basis and then reason effectively to provide a decision or solution. *Appendix 3 summarizes how GST 200 satisfies this decision-making requirement.*

To qualify for 'q', a course must:

1. devote at least 25% of course time to teaching and assessing foundational skills in quantitative reasoning.
2. Cover two (2) of the four concept areas in depth and cover one additional area for breadth.
3. Require a student to achieve a 2.0 or higher in the course.

Appendix 4 summarizes how and why GST 200 qualifies as a 'q' course.

To qualify for a QEM, a course must require at least one significant quantitative reasoning project that compromises a significant percentage of the course assessment and that allows demonstration of a student's ability to:

1. Pose quantitative questions (i.e., student generated versus instructor generated questions)
2. Make and communicate reasoned choices as to applicable quantitative methods for the questions/hypotheses posed and the data considered
3. Demonstrate the ability to apply quantitative methods to quantitative information (i.e., student generated data and/or existing data); and use the results of applying quantitative methods to reason and articulate answers/conclusions to the questions/hypotheses posed.

Q courses must require the student to present the project in written form. *Appendix 5 summarizes how GST 200 qualifies as a 'QEM' course.*

Appendix 6 contains a proposed syllabus for this course. Appendix 7 contains a proposed class schedule. Appendix 8 contains a list of the current web-based assignments for this course.

APPENDIX 1: Quantitative Concepts/Skills in GST 200.

1. Mathematical relationships.
   - Graphical representations include charts of counts, rates and proportions, graphs of association and confounding.
   - Numerical representations focus on arithmetic comparisons (difference, times ratio and percentage change) and on various models of a relationship: linear model and weighted averages.
   - Symbolic representations include formulas for percentage change, percentage of difference explained by a confounder, percentage of cases attributed to a predictor, number of cases attributed to a predictor, margin of error, sample size and confidence intervals (See attached list of such formulas).
   - Ordinary English representations of arithmetic relationships. Even though algebra is both concise and precise most people don't speak algebra. Students learn to express arithmetic comparisons in ordinary English. They learn that 8 is 4 times 2, but is only 3 times (300%) more than 2. They learn that 6% is not 2% more than 4%. They learn that one cannot compare temperatures as a ratio or a percentage change (e.g., it is 20% hotter today than last week). At least a fifth of the course focuses on the description and comparisons of ratios (proportions, percentages and rates) using ordinary English to describe and compare conditional probabilities. Students use an on-line program to practice decoding written statements (reading) and another cutting-edge program to practice writing such statements in ordinary English. The latter program, developed by the W.M. Keck Statistical Literacy Project reads ordinary English and gives students immediate feedback on the accuracy of their answer. See www.StatLit.org/pdf/2006BurnhamSchieldASA.pdf
2. Statistical relationships.
   - Data analysis is a substantial component of the course, but the data analyzed tends to be summary data presented in tables, graphs and statements (Blacks are less likely to commit suicide than whites).
   - Elementary probability is a larger part of this course than it is in most introductory statistics courses but again the focus is on ordinary English instead of algebra. Students must distinguish between the probability of A given B and the probability of B given A. E.g., P(A|B) versus P(B|A). But they must do so in ordinary English. They must see that "the percentage of men who are smokers" is the inverse of "the percentage of men among smokers." They must see that "Widows are more likely among suicides than widowers" is the inverse of "Widows are more likely to suicide than widowers." Students must be able to identify which of these two statements has the larger percentage. (a) the percentage of male smokers who are runners (b) the percentage of smokers who are male runners. [In this case if one is larger, it must be the first.].
   - Statistical inference. Although this is not part of the "q" standard, understanding variability and randomness is arguably a central feature of being quantitatively or statistically literate. In this course, students study the relation between margin of error and sample size so they can appreciate how the accuracy of a sample is related to the size of the sample but not to the size of the population.
   - Association vs. causation. Although this is not part of the 'q' standard, it is arguably a central element being quantitatively or statistically literate. In this course, students spend considerable time distinguishing association from causation. They learn that statements such as "Women who eat nuts have a lower risk of breast cancer" do not imply causation. They realize that getting breast cancer is not repeatable, the study cannot be rerun using the same subjects so there is no way to switch a given subject and see what would have happened if they had changed their nut-eating behavior.

3. Logical analysis.
   - Deductive reasoning. Students study some of the basic deductive arguments in statistics. These are not the basic forms of Aristotelian syllogisms. They learn that if two groups have different rates or percentages of a given outcome, then the excess in the larger can be attributed to the associated group and that when that excess is divided by the larger rate, the resulting proportion is the percentage of those outcomes attributable to the associated group. For example, if every year there is one pregnancy per 1,000 readers of car and sport magazines and 20 pregnancies per 1,000 readers of home and fashion magazines, then 95% of the pregnancies among readers of home and fashion magazines can be attributed to their reading home and fashion magazines. ☺
   - Arguments: An ongoing aspect of the course involves analyzing arguments. Students are given news stories, press releases and statistical studies. They must identify the point of the article and evaluate the strengths and weaknesses of the statistics used as evidence for the truth of the conclusion. In each case, they examine how the statistics used might be influenced context (confounding), assembly (choice of definitions and presentation), randomness (chance) and error or bias.
   - Fallacies. Identifying statistical fallacies is a key element of this course. Students learn that a medical test with 99% accuracy may be less than 50% accurate in predicting disease when someone tests positive. They learn that just because most car accidents occur with 25 miles from home" does not mean "they are safer when driving more than 25 miles from home."
   - Counterexamples. Counterexamples are perhaps the central part of the course. Students evaluate the strength of inductive arguments using alternative explanations – hypothetical thinking. For example, suppose a study finds that 69% of kids in middle school are involved in 'bullying.' A statistically-literate reader must realize that 'bullying' is a soft term – there is no generally accepted definition. Such a reader must think hypothetically about how this term could have been defined to change the size of the percentage.

4. **Algebraic Relationships:** algebraic relationships are a key element of the course.

   Algebraic formulas studied include converting scores and ranks to percentiles, calculating Z-scores (standard deviations above the mean), calculating effect sizes (difference in means measured in pooled standard deviations), calculating skewness (difference between mean and median measured in standard deviations), calculating correlation (from slope and standard deviations), and calculating the margin of error and sample size in random samples for both percentage and for quantities. See Appendix 8 for assignments using algebraic formulas.

   However many algebraic relationships are presented in non-algebraic forms.

   For example, students study Simpson's paradox using a new graphical technique instead of using algebra. They may be given data showing that the hospital with the highest death rate is the city research hospital. But when they take into account the condition of the patients this decreases the death rate at the city research hospital. Augsburg College has been the first college in the world to use this new technique which was the cover story in the fall 2006 issue of STATS magazine – a publication of the American Statistical Association. See www.StatLit.org/pdf/2006SchieldSTATS.pdf.

   This graphical/algebraic technique is used to show students (1) how the association between two averages or ratios can change after taking into account the influence of a confounder, (2) how the number of cases attributable to a predictor can change after taking into account the influence of a confounder, and (3) how a statistically-significant association can become statistically-insignificant after taking into account the influence of a confounder.

APPENDIX 2: How GST 200 develops skills in Critical Thinking

Students should recognize implicit and explicit quantitative claims in discourse and should develop the skills to evaluate and test such claims critically.

Students in GST 200 analyze and evaluate essays that involve numbers as evidence in arguments. Their written evaluations must always identify the point of the essay (whether explicit or implicit), and the supporting points. All quantitative claims must be analyzed for four kinds of influence: influence due to context or confounding, assembly of selection of presentation, randomness or chance, and error or bias. The social construction of all statistics promoted by Dr. Joel Best in Damned Lies and Statistics is used as the basis for analyzing 'assembly.'

APPENDIX 3: How GST 200 develops skills in decision-making and problem solving.

Students should employ quantitative reasoning in decision-making and problem solving. They should demonstrate the ability to pose appropriate questions, provide a representation of quantitative information, apply quantitative methods on a reasoned basis and then reason effectively to provide a decision or solution.

Students in GST 200 employ quantitative reasoning in making decisions about the strength of evidence given by numbers in surveys and in news stories. Since much of their reasoning is hypothetical (what would happen if…), much of their problem solving is hypothetical (E.g., How much would a survey percentage change if the non-response rate were 20% and the non-responders were half as likely to agree with the survey question as were the responders?)

- ***Ability to pose appropriate questions**: GST 200 students are asked to pose hypothetical questions about each quantitative claim. In order for the question to be 'appropriate' the answer to the question must be both plausible (supported by other data and not arbitrary) and substantial (the effect size big enough to make a material difference in the statistic or the statistical association.*
- ***Provide a representation of quantitative information:** GST 200 students must be able to represent the relationship between two quantities using a best fit or trend line. They must be able to represent an association between three quantitative variables using a three-factor triangle diagram where one factor is the outcome, one factor is the predictor and the third factor is a plausible confounder or common cause.*
- ***Apply quantitative methods on a reasoned basis:** Knowing which method to apply when is a key element of quantitative reasoning/literacy. Applications of this studied in GST 200 include knowing when to compare two data values as a difference and when to compare them as a ratio (log scale), knowing when to present a single percentage and when to present a relative risk or prevalence, and knowing when to take into account the influence of a plausible confounder.*
- ***Reason effectively to provide a decision or solution:** GST 200 students must be able to calculate the influence of a given confounder on an association, to calculate the influence of a confounder on the cases attributable to a given factor, and to calculate the influence of a confounder on a statistically significant association.*

APPENDIX 4: How GST 200 qualifies as being a 'q' course.

To qualify for 'q', a course must:

1. Devote at least 25% of course time to teaching and assessing foundational skills in quantitative reasoning. *GST 200 easily spends at least 50% of the course teaching and as-*

sessing foundational skills in quantitative reasoning. In fact it is difficult to find a part of the course that does not focus on these skills.

2. Cover two (2) of the four concept areas in depth and cover one additional area for breadth. *GST 200 covers all four areas. It certainly covers the first three in depth.*
3. Require a student to achieve a 2.0 or higher in the course. *This is already a requirement in GST 200 for students to get the QR skill designation.*

APPENDIX 5: How GST 200 qualifies as being a 'QEM' course.

To qualify for a QEM, a course must require at least one significant quantitative reasoning project that compromises a significant percentage of the course assessment. *GST 200 students will conduct surveys using questions which the students have identified. The survey design and analysis component will be between 15% and 25% of the total grade.*

Doing this project allows demonstration of a student's ability to:

1. Pose quantitative questions (i.e., student generated versus instructor generated questions). *GST 200 students will pose a research question to be answered by a random survey.*
2. Make and communicate reasoned choices as to applicable quantitative methods for the questions/hypotheses posed and the data considered. *GST 200 students will be able to make and communicate reasoned choices on the quantitative methods used to summarize and present the data – given the nature of the data. For example, they will know that one cannot calculate an average for attitude like-dislike (ordinal) data.*
3. Demonstrate the ability to apply quantitative methods to quantitative information (i.e., student generated data and/or existing data); and use the results of applying quantitative methods to reason and articulate answers/conclusions to the questions/hypotheses posed.
    - *GST 200 students will be asked to generate questions for a survey and to estimate responses. Students will be asked about what factors might be closely related to the association being investigated. From this information, a population will be inferred and a unique random sample selected. The questions, population and sample will be unique for each student.*
    - *GST 200 students will be asked to apply quantitative methods to the results of their survey. They must be able to convert numeric counts to numeric ratios (rates and percentage) and to generate arithmetic comparisons and association using this data. They must be able to generate confidence intervals based on the confidence level and the size of the random example.*
    - *GST 200 students will be asked to evaluate data generated by a statistical program such as Excel or Minitab. See "Processing Survey Data" by Schield.*
    - *GST 200 students will be asked to articulate their answers and conclusions and to give reasons for these based on the data obtained. They must be able to see whether associations are statistically significant and to do so before and after taking into account the influence of a related factor.*
    - *GST 200 students may be asked to review the project of a fellow-student and to analyze the report for readability and effectiveness.*

Q courses must require the student to present the project in written form. *Student projects must be submitted in written form. They will be evaluated for accuracy, completeness, readability and effectiveness.*

Appendix 6: GST 200 Proposed Syllabus

	GST 200 Quantitative Reasoning (Statistical Literacy)
When	Fall Term, Day Section A: MWF 1:20 - 2:20 PM
Where	Murphy Place 100
Instructor	Milo Schield, Memorial 314
Phone	612:330-1153
Web	www.augsburg.edu/ppages/~schield or www.StatLit.org
E-mail	schield@augsburg.edu
Textbook	"Statistical Literacy" book distributed at book store.
Home-work	All homework (including essays) must be submitted electronically to the class web site (Moodle) or to the teacher: schield@augsburg.edu. All homework must be received no later than the start of class on the day it is due. Late homework is not accepted as the homework answer sheet is given out in class on the due date.
Goal:	To help students read and interpret statistics as evidence in everyday essays.
Outcomes:	To be able to analyze essays using epidemiological arguments involving statistics To describe, compare and interpret count-based data. To describe, compare and interpret measurement-based data To evaluate the role of chance on statistics and statistical associations To evaluate survey data for the influence of assembly, confounding and randomness

Grades		
	5%	Instructor (Attendance, class participation and improvement on final)
	20%	Online assignments (Moodle and other web-based)
	15%	Chapter quizzes: 3%@ for Ch 1 & 2, 3, 4, 6 and 7.
	20%	Mid-term Exam
	20%	Final Exam including final paper on reading essays involving statistics.
	20%	Written Project.

Grading	Based on student score relative to the class average
Tests and Quizzes	Exams are closed books. Exams are not timed (within reason); calculators are OK Exams involve multiple choice (including "None of the Above") and writing. Writing involves comparing numbers and percents (Ch 2), describing percentages in tables and graphs (Ch 4) and analyzing essays using Take CARE.

Appendix 7: GST 200 Proposed Class Schedule

SUMMARY SYLLABUS:

	Date	**Day**	**Activity**
1.	9/06	Wed	Intro, surveys, Assign P01 1 page summary of: DLS paper due next Mon.
2.	9/08	Fri.	Ch 1 Assign homework, C11: Association vs. Causation, due next Wed.
3.	9/11	Mon	Ch 1
4.	9/13	Wed.	Ch 1 Assign C12: Confounding
5.	9/15	Fri	Ch 1. Assign essay E01 Due next Wed.
6.	9/18	Mon	Ch 2. Comparisons. Assign C21: Comparisons
7.	9/20	Wed	Ch 2. Confounding & Assembly. Assign C22 Assembly C23: Confound-
8.	9/22	Fri	Ch 2 Studies Assign C24: Studies Randomness & Bias
9.	9/25	Mon.	Ch 2. Randomness & Error/Bias.
10.	9/27	Wed	Ch 2. Review for Quiz
11.	9/29	Fri	**Quiz Ch 1 & 2 & Essay.** Assign essay E03 Due next Wed.
12.	10/02	Mon	Ch 3. Assign C31: Measures of Center
13.	10/04	Wed	Ch 3. Assign C32: Standardizing
14.	10/06	Fri	Ch 3. Assign C33: Assembly using Measurements
15.	10/10	Mon.	Ch 3 Assign C34: Ranks and Percentile
16.	10/12	Wed	Ch 3 Assign C35, Normalizing and Effect Size
17.	10/14	Fri	Ch 3 Assign C36, Correlation and Regression
18.	10/16	Mon.	Ch 3: Review for quiz.
19.	10/18	Wed	**Quiz Ch 3 with Essay**
20.	10/20	Fri	Review E05. Assign P02, paper on reading essays with statistics, due Wed.
21.	10/23	Mon	Review Ch 3 Quiz. Review for Midterm.
22.	10/25	Wed	**MIDTERM EXAM: DLS, Ch 1, 2 & 3 and essay analysis.**
	10/27	Fri	Mid-Term Break Fri 10/27 - Sun 10/30

23.	10/30	Mon	Ch 4 Percent Grammar. Assign C41 Describe Pie charts using Percent
24.	11/01	Wed	Ch 4 Percentage grammar. Assign C42: Use Percentage grammar.
25.	11/03	Fri	Review Midterm Exam Assign C43: Use Percent & Percentage grammar
			[Friday: *Last day to designate grade option or withdraw*]
26.			
27.	11/06	Mon	Ch 4 Rate Grammar: Assign C44 Rate grammar
28.	11/08	Wed	Ch 4 Non-100% tables
29.	11/10	Fri	**Survey Project**: Formulate questions, estimate results, obtain sample.
30.	11/13	Mon	Ch 6 Simpson's Paradox. Assign C61, Standardizing, due next Mon.
31.	11/15	Wed	Ch 6 Standardizing. Review essay E07. Assign essay E08 due next Wed.
32.	11/17	Fri	**Quiz on Ch 4 and essay analysis**
33.	11/20	Mon	Ch 6 Med test. Review C61. Assign C62, Medical Tests, due next Mon.
34.	11/22	Wed	Ch 6 Review essay E08. Assign essay E09 due next Wed.
	11/24	Fri	**Thanksgiving Break**
35.	11/27	Mon	Ch 7 CI. Review C62. Assign C71, Make Conf. Intervals, due next Mon.
36.	11/29	Wed	Ch 7 Review essay E09. Assign essay E10 due next Wed. Review Qz Ch 4.
37.	12/01	Fri	**Quiz Ch 6 and Essay**
38.	12/04	Mon	Ch 7 Review HW C71 Assign C72, Standardize Stat Significance, due **Fri**.
39.	12/06	Wed	**Survey Project**: Obtain summary of survey data.
40.	12/08	Fri.	**Survey Project**: Evaluate sample using basic descriptive statistics
41.	12/11	Mon	**Survey Project:** Evaluate sample data for confounding. Qz on Ch 7.
42.	12/13	Wed	**Survey Project**: Evaluate sample data for statistical significance.
43.	12/15	Fri.	**Survey Project** Submit written report. Review Quiz for Ch 7.
	12/18	Mon	**FINAL: COMPREHENSIVE: Ch 1-4, 6 & 7, Three Essays. 1 – 3 PM.**
			Grades Due 12/29/2007

42 classes; 1 hour @ = 42 hours of class time plus the final
7 hours for Quizzes (6 quizzes at 1 hour per quiz) and tests (1 hour for midterm).
4 hours for review of quizzes (6 quizzes at 30 min@) and tests (1 hour for midterm).
3 hours for First Class (Intro & Survey) and Last Two Classes (Review).
Net time for textbook: 28 hours, 6 chapters, 4.67 classes per chapter.

Appendix 8: Factual Assignments in GST 200 (All questions have a single answer)

C1D	Determine if event is repeatable or condition is switch-able
C1E	Determine if study is repeatable
C1F	Distinguish Association-Causation in ordinary English
C2A	Calculate size of comparison for different types
C2B	Distinguish appropriate comparison grammar
C2D	Compare 2#: choose base & type compare
C2E	Calculate effect of definitions on grouping subgroups
C2F	Calculate effect of definitions involving measures
C2G	Distinguish Longitudinal vs. cross-sectional
C2H	Distinguish Experiment vs. observational
C2I	Distinguish Controlled vs. uncontrolled
C2W	Write out different types of comparisons
C3A	Calculate & compare ranks from scores
C3B	Calculate percentiles in different size groups
C3D	Calculate & compare means in different groups
C3E	Compare averages from extremes of a distribution.
C3G	Calculate & compare Z-scores
C3H	Calculate & compare Normalized scores
C3K	Calculate & compare Effect Sizes
C3L	Predict outcome given regression & predictor
C3X1	Standardize measures for binary confounder
C4A	Identify part in questions using percent grammar
C4B	Calculate percentages from count tables: % grammar
C4F	Identify part in statements using percent grammar
C4G	Identify part in statements using percentage grammar
C4H	Convert statements: percentage to percent grammar
C4I	Convert statement: percent to percentage grammar
C4J	Identify part in questions using percentage grammar
C4L	Identify part in statements: percent or percentage grammar
C4M	Identify part in questions: percent or percentage grammar
C4P	Identify equivalent phrase-based rate statement given "Per" ratio.
C4X3	Describe percentage in a pie chart or 100% table; use percent grammar
C4X4	Describe percentage in non-100% full-margin tables; use percent grammar.
C4X6	Describe percentages in pie chart or 100% table; use percentage grammar
C4X7	Describe percentage in non-100% full-margin tables; use percentage grammar.
C4Y1	Describe rate in tables using phrase-based rate grammar
C5B	Calculate percentage attributable from percentage/rate data.
C5C	Calculate cases attributable given rates and size of high-rate group
C6B	Compare two related three-factor percentages
C6E	Calculate prediction and explanation in 2x2 tables
C6F	Calculate prediction given prevalence & accuracy
C6X1	Standardize percentages for effect of binary confounder
C6Z1	Standardize Percentage & Cases Attributable for confounder effect
C7D	Calculate Number using Capture-Recapture
C7E	Calculate chance of rare event; use Law of Very Large Numbers
C7F	Calculate Regression to the Mean
C7G	Calculate ME, CI & Sample size for Percentages
C7I	Calculate ME, CI & Sample Size for Averages
C7J	Generate CI & Stat. Significance for two proportions
C7L	Generate CI & Stat. Significance for two averages
C7X1	Generate confounder effect on Stat. Significance for percentages
C7Z1	Generate confounder effect on Stat. Significance for averages