

Quantitative Literacy: Analysis of a Q-course

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Abstract

The University of Texas at San Antonio (UTSA) has developed the Quantitative Literacy Program (QLP) to enhance student learning with quantitative literacy (QL) across the general education curriculum. These enhanced courses (i.e. Q-courses) range from stem disciplines such as math and science to liberal arts such as English, History, and Writing. Since course content varies amongst disciplines, the QLP developed a way to assess student performance across the courses by incorporating common student learning outcomes (SLOs). Student performance was assessed based on an analysis of a pre- and post-test, which focused on QL that is specific to material covered in that discipline. Every item on the test relates to the QLP SLO's and an analysis is conducted to test the impact of student learning of QL in each course. Additionally QL-based assignments are given during the semester to foster student learning and are also categorized using the QLP SLOs. The results of a Q-course analysis may be used to assess Q-course performance and improve QL related pedagogy. Ultimately, the results of a Q-course analysis will be used for assessment of the QLP program.

Keywords: Quantitative Literacy, Quantitative Reasoning, Analysis of student performance, analysis of course effectiveness

1. Introduction to UTSA's Quantitative Literacy Program

The University of Texas at San Antonio (UTSA) has developed a plan to enhance student learning, called the Quantitative Literacy Program (QLP). To assess the effectiveness of the program, several measures have been implemented including:

- the Quantitative Literacy Assessment Test (QLAT); a quantitative test to measure baseline Quantitative Literacy(QL) skills
- enhancing general education courses by integrating QL skills
- developing eight student learning outcomes(EVALUATE) to assess student learning of QL across general education courses

All incoming freshman and transfer students are required to take the QLAT. The test consists of 20 quantitative literacy questions, and establishes a baseline of their QL knowledge upon matriculation to college. As a graduation requirement, all students must take at least one course enhanced by quantitative literacy (a Q-course). During the first three years of implementation, the QLP targeted general education courses. Faculty members submitted a proposal and were selected for funding by a Proposal Review Committee. The general education courses that have been redesigned to incorporate quantitative literacy to date are:

Anthropology	History
Archeology	Math
Contemporary Biology	Philosophy
Biosciences	Political Science
Chemistry	Statistics
Economics	Sociology
English	Writing Composition
Environmental Science	

During the fourth year of the program, upper division courses became the primary target of the QLP as a means to capture transfer students needing to satisfy the graduation requirement of a Q-course. The upper-division Q-courses that will be added during the fourth phase of the plan (AY2014) include:

Architecture	Kinesiology
Communication	Sociology
Criminal Justice	Special Education
Multidisciplinary Studies	

2. QLP Student Learning Outcomes

The overarching goal of UTSA's Quantitative Literacy Program is to instill quantitative reasoning skills in students. In order to meet this goal, three student learning goals have been defined

Student Learning Goal I: The program will help undergraduate students acquire basic quantitative literacy and numeracy skills (Quantitative Literacy).

Student Learning Goal II: The program will help undergraduate students effectively communicate results of their quantitative analysis in writing or by other means. (Communication)

Student Learning Goal III: The program will help undergraduate students acquire discipline-specific advanced quantitative skills (Quantitative Mastery). [1]

In order to meet these goals, eight student learning outcomes were developed to categorize and measure the effectiveness of integrating quantitative literacy. Questions that involve quantitative literacy will directly align to the eight student learning outcomes of the QLP: EVALUATE. Each letter of EVALUATE stands for a specific student learning outcome describing what students should know about quantitative reasoning:

1. **Explore:** define a problem, identify measurements, develop a plan
2. **Visualize:** identify patterns and characteristics of visual representations of data, construct tables, charts, and graphs
3. **Assimilate:** compare and contrast two representations of the same dataset, or two different methods of data analysis
4. **Logic:** compute and interpret probabilities, evaluate risk
5. **Understand:** identify scales of measurement, perform conversions, recognize sampling, bias, validity, and reliability
6. **Analyze:** compute and interpret basic numerical summaries and use appropriate quantitative methods to draw conclusions
7. **Translate:** make correct and meaningful verbal assertions about data, transform verbal assertions into quantitative expressions
8. **Express:** write short summaries about data, communicate results of data analysis, write reports based on a complete quantitative analysis

All Q-courses are required to administer a pre/post-test, and beginning fall 2014, a writing component will be integrated targeting the student learning outcome Express. Pre/post-test questions are required to be the same for analysis purposes. All Q-courses are required to give mid-semester assignments addressing at least four QLP SLO's. The assignment(s) must incorporate at least two of the quantitative components (Explore, Visualize, Assimilate, Logic, Understand, and Analyze) and the two writing components (Translate and Express). Q-courses are encouraged to include many data analysis questions throughout their lecture and embed QL questions on exams. For example, a history course incorporates components called "Q-moments", which are content based quantitative literacy questions during class providing immediate feedback to the students using iClickers.

3. Analysis of a Q-course Pre/Post-test

The following report is based on data generated from various general education Q-courses across the University. The purpose of this analysis is to provide an example of the types of analyses that will be given to instructors regarding student performance of quantitative literacy. Table 1 presents a summary of the number of students in the Q-course who completed specific components of the Q-course. Students who completed at least 50% of their assignments and both the pre- and post-test are considered in the analysis. The results help faculty members revise their pre- and post-test and modify teaching strategies to better address quantitative literacy.

Table 1

Students	Count
Total number of students who took pretest	186
Number of students missing over 50% of their assignments or pretest or posttest data	58
Number of students who completed 50% of their assignments and have complete pretest and posttest data	128

Testing the overall effectiveness of student learning of quantitative literacy, a paired sample t-test (Table 2) determines if there is a significant difference between pre- and post-test performance. A p-value less than 0.05 indicates a significant increase in student performance in quantitative literacy.

Table 2

Variable	Mean	Std Dev	t-test	p-value
Pretest	47.0	15.6	3.23	< 0.01
Posttest	53.8	16.5		

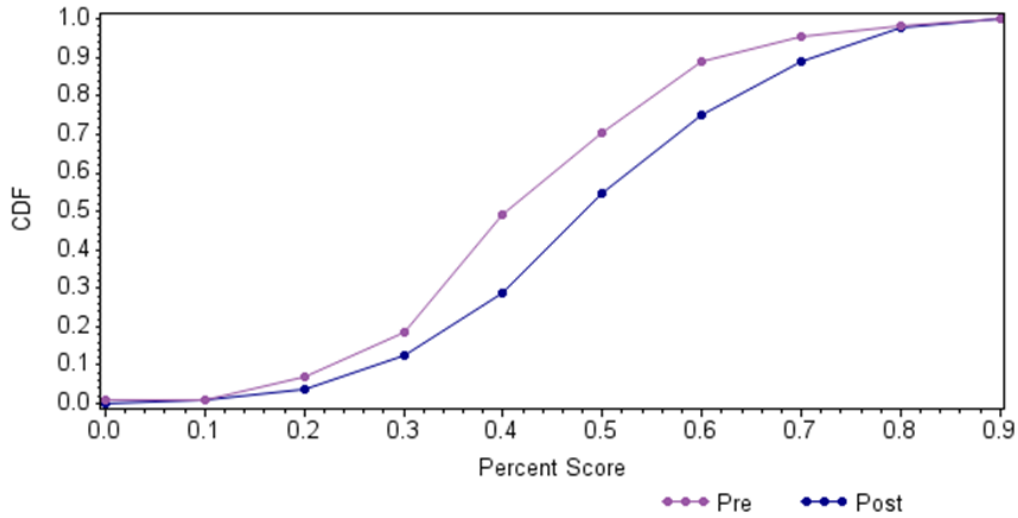
The McNemar's test, which uses a chi-square statistic, was performed to determine if a greater proportion of students scored higher at post-test compared to pre-test. For this example, the chi-square statistic, $\chi^2(1) = 7.24$, $p < 0.05$, yielded a statistically significant result and suggests the proportion of students scoring higher at post-test was greater than those that scored lower. The concordance: the proportion of students performing the same from pre to post was excluded from the analysis and thus not provided in this table.

Table 3

	Low Post-Test	High Post-Test
Low Pre-Test		48
High Pre-Test	25	

Figure 1 shows the cumulative proportion of students performing at or below a given score in pre- and post-tests. A better performance at post-test would be represented by a significant gap between the pre- and post-test curves, with the post-test curve staying below the pre-test curve until the end (i.e. higher test performance or percent correct).

Figure 1



The box and whisker plot in Figure 2 represents overall student performance at pre and post-test. If student learning has increased, the post-test box would be moved towards the positive side (i.e., right side, indicating a higher percent correct) of the axis.

Figure 2

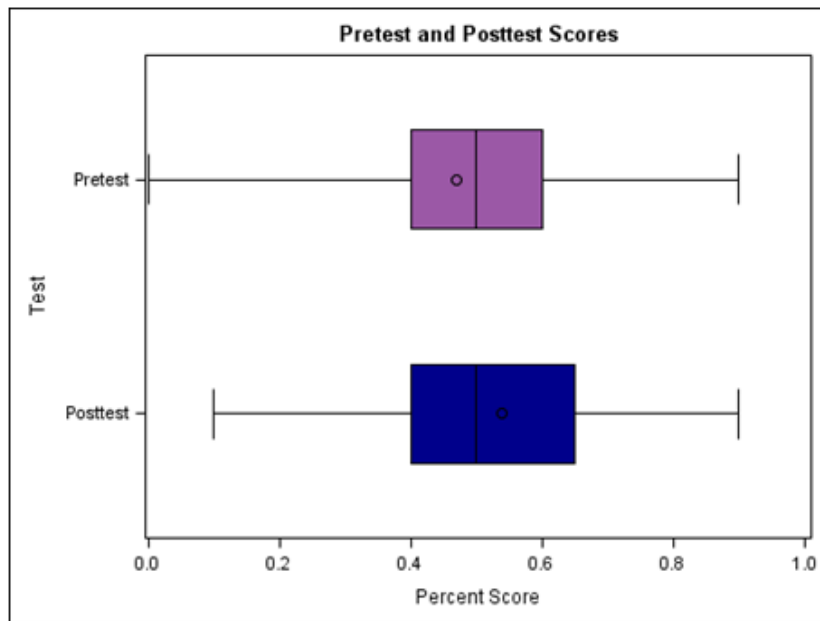


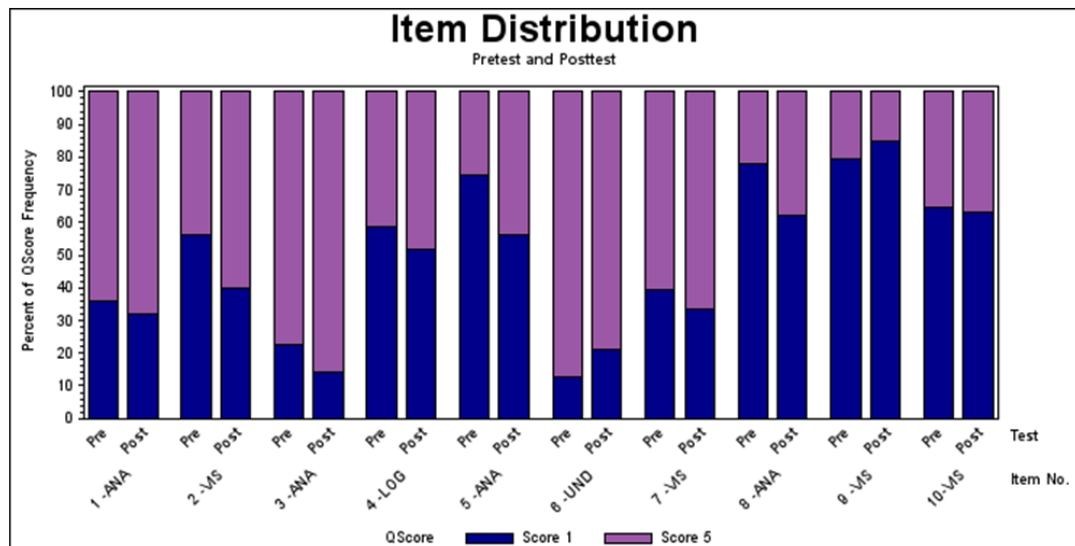
Table 4 provides item level data for each student learning outcome on the pre and post-test. It summarizes the number and percent of students scoring correctly on each question for both pre- and post-test. The column for change indicates the difference in correct responses on each question between the pre- and post-test. A positive change indicates that students performed better on that particular question on the post-test. The overall performance matches that of Table 2.

Table 4

Item No.	Student Learning Outcome	Taxonomy Level	N	Correct Responses Pretest	Correct Responses Posttest	Change	% Correct Pretest	% Correct Posttest
1	Analyze	Basic	128	80	87	7	64.0	68.0
2	Visualize	Basic	126	54	76	22	43.9	60.3
3	Analyze	Intermediate	127	99	109	10	77.3	85.8
4	Logic	Basic	127	51	61	10	41.5	48.0
5	Analyze	Basic	126	32	55	23	25.4	43.7
6	Understand	Basic	128	111	101	-10	87.4	78.9
7	Visualize	Basic	128	77	85	8	60.6	66.4
8	Analyze	Basic	126	28	48	20	21.9	38.1
9	Visualize	Basic	124	26	19	-7	20.8	15.3
10	Visualize	Basic	128	44	47	3	35.2	36.7
	Overall						47.0	53.8

A visual representation of Table 4 is presented in Figure 3 below. Stacked bar charts represent the percent of students scoring a 1 (incorrect score) and a 5 (correct score) for each student learning outcome on the pre and post-test.

Figure 3



Student performance on the pre/post-test helps the instructor understand areas of strength and weakness. For example, for Item #6 and #9, the percent of students scoring incorrectly increases from pre to post-test. On Item #3, over 80% of students are scoring correctly on the both the pre- and post-test. The instructor may evaluate how these topics

were taught and adjust for the next semester. Instructors also may make revisions for the following semester on the pre- and post-test questions.

4. Analysis of Q-course Assignments

Figures 4.1 and 4.2 provide stacked bar plots for each question on the pre/post-test and assignments, with the taxonomy levels (basic, intermediate, or advanced) displayed on the x-axis. It shows the percent of students scoring 1 (incorrect score), 3 (partially correct), or 5 (correct score).

One of the quantitative student learning outcomes, Visualize, is shown in Figure 4.1. There are 11 questions reported on Visualize, four on each pre/post-test, and three on midsemester assignments. Pre/post-test scores only contain a score of 1 or 5 (indicating multiple choice), while midsemester questions include 1, 3, or 5 (indicating room for partial correctness).

Figure 4.1

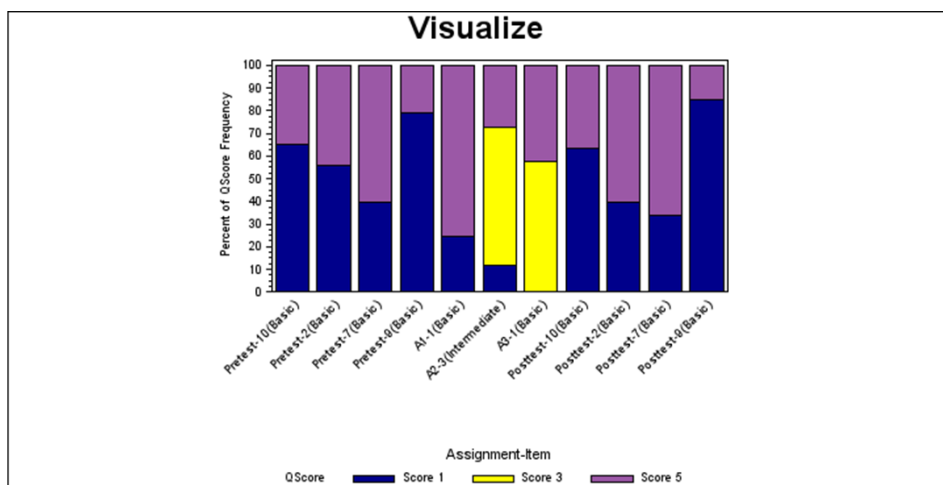
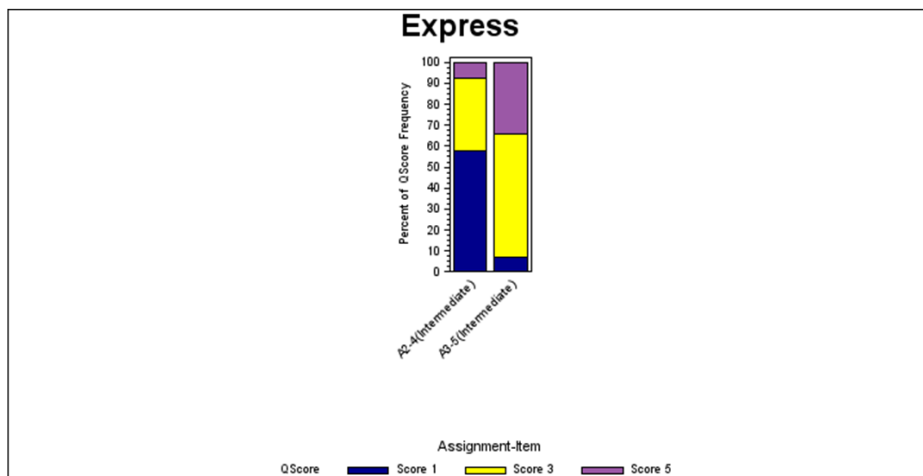


Figure 4.2 contains the stacked bar plot of Express, one of the two student learning outcomes related to writing. Questions on the SLO Express were only administered on the midsemester assignments, due to the inability to grade a writing component on a multiple choice scale.

Figure 4.2



5. Conclusions

To conclude, student performance will continue to be measured based on the QLP student learning outcomes from beginning to end of each semester through the analysis of pre/post-test data. Q-course analysis reports will be generated every long semester to provide feedback to the instructors regarding student performance in quantitative literacy. Q-instructors will continue to revise assignments and lecture material to improve student learning of quantitative literacy based on the results of the reports. Student performance will be tracked and measured across all Q-courses due to the commonality of the student learning outcomes. Student performance will be tracked and measured from beginning to end of their collegiate career as all students take the entrance requirement of the Quantitative Literacy Assessment Test, and the Exit QLAT at 90 hours of coursework completion. In the future, assessment results from the Q-course analyses and QLAT will be used to evaluate the effectiveness of the QLP program.

6. References

[1] N. Kannan, et al., Quantitative Scholarship From Literacy to Mastery, The University of Texas at San Antonio Quality Enhancement Plan, 2010.