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Assessing library impact on student learning outcomes: a case study using the Understanding Library Impacts Protocol

Derek Rodriguez[1] and Lisa Norberg[2]

[1] The Understanding Library Impacts Project, Chapel Hill, North Carolina, USA.
[2] Barnard College, New York, New York, USA.

1. Introduction

Barnard's motto, *Following the Way of Reason (Hepomene toi logismoi)*, is indicative of the College's commitment to the broad intellectual rigor and analytical depth of a liberal arts education. In 2012, Barnard College initiated an undergraduate program designed to help students acquire Empirical Reasoning (ER) competencies across the curriculum. Barnard faculty in several social science disciplines designed ER learning experiences embedded within the undergraduate curriculum for this purpose. The Barnard College Library created an Empirical Reasoning Lab managed by a Data Librarian to support this curriculum. A suite of instruments called the Understanding library Impacts Protocol was adapted to assess the impact of the ERL on student learning. This paper presents methods used in the project, shares preliminary findings from its first year, and discusses future plans.

2. About Barnard and the ER program

Barnard College is a four-year all-women's liberal arts college in New York City, USA. Barnard has close ties to Columbia University and Barnard students have access to the full suite of library services and resources of both Barnard and Columbia. In 2012, Barnard College initiated an undergraduate program designed to help students acquire ER competencies. Over the course of this 3-year grant, Barnard College Library is partnering with faculty members across a range of academic departments and disciplines to create and support the ER curriculum.

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2.1 Defining the ER curriculum

For the purposes of this project Empirical Reasoning (ER) competencies are defined as the interdisciplinary skills needed to analyze and use quantitative and qualitative data to support arguments, conduct independent research, and solve real-world problems. Instead of being given well-defined questions with tractable formal answers, students must learn to shape the problem itself and then cull the information to make sense of it by compiling, refining, and marshaling evidence. College graduates need these critical skills to participate fully as citizens and to thrive in the 21st century workplace.

In the first year of the program, faculty members from the Economics, Urban Studies and Political Science departments at Barnard created assignments which required students to use Microsoft Excel to explore and examine prepared data sets. Exercises emphasized manipulating and graphing the data, developing one or more hypotheses to explain trends found in the data, and communicating an argument to defend the hypotheses in written form.

2.2 The Empirical Reasoning Lab

The Barnard College Library created the Empirical Reasoning Lab to support the ER curriculum with funding from the Andrew W. Mellon Foundation. Led by a Data Librarian, the library's Empirical Reasoning Lab (ERL) provides instruction, point-of-need service and support, and dedicated computer lab space to help students engaged in ER coursework. The Data Librarian prepared Excel Tutorials, led Excel workshops for each group of students enrolled in the ER courses, and trained staff to provide support to students using data in both course-related assignments and independent research. The library also provided dedicated computer workstations and printers for students working on ER projects.

3 About the ULI Protocol

The Understanding Library Impacts (ULI) Protocol is a suite of instruments designed to help colleges and universities understand how students use information services and resources to achieve discipline-specific and general education student learning outcomes (SLOs).[i] The protocol uses quantitative and qualitative methods to examine information use during high impact learning experiences, times when college students are developing and demonstrating the competencies expected of graduates. The protocol includes two instruments: a web-based critical incident questionnaire about their experiences during academic coursework in the major and a learning activities crosswalk which links reported information use to expected student learning outcomes and to assessment of that work. In this project the ULI Protocol has been adapted to focus on student use of the library and ERL services during ER assignments and more broadly to the expectations for students pursuing degrees in the social sciences.

3.1 Logic model

The Understanding Library Impacts Protocol proceeds from a simple assertion that students use information resources, services, and facilities when completing assignments in their academic coursework. Faculty members design this

coursework to help students develop and demonstrate competencies or student learning outcomes in a given domain. Faculty members then assess student performance on these assignments. ULI instruments link library and information use to the student learning outcomes defined and assessed by faculty in ways that can be communicated in terms that resonate with stakeholders. Evaluation of the ERL's impact on student learning in Empirical Reasoning in year one focused on the first three portions of the model (see Figure 1).

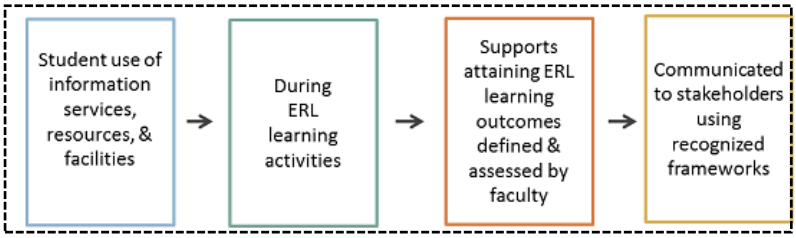

Figure 1 Logic model of the fall 2012 ULI project for the ERL

4 Design

The ULI questionnaire was adapted to match the experiences of the students completing ER coursework. The instrument is an adaptation of the Critical Incident Technique in which respondents are asked to reflect on their experience in a memorable event (their ER assignment).[ii] Open and partially open questions probe students' interpretation of intended student learning outcomes, their use of the tutorials, workshops, services, and facilities/equipment, identify helpful or problematic aspects of this use, and open-ended questions examine challenging aspects of the assignments. Questions regarding student affect (confidence and anxiety) and demographics round out the instrument. Data were collected using Qualtrics and then ingested into a MySQL database for presentation in the ULI web portal. Students' institutional identification numbers were also gathered and stored in an encrypted form with the questionnaire responses.[iii]

5 Results

In fall 2012, data were collected from students enrolled in the first two courses to participate in the ER-intensive curriculum.[1] This provided an opportunity to test our ideas about the best ways to gather data and assess ERL contributions to student learning.

Thirty responses to the Economics (15 responses) and Urban Studies (15 responses) questionnaires were received, accounting for a 36% response rate. Over 90% of the respondents were juniors or seniors at Barnard or Columbia. Fourteen of 15 'Econ' respondents were Economics majors; all of the

[1] The Political Science course was conducted in the spring semester of 2013 so data was not available for presentation at this conference.

respondents in the Urban Studies colloquium were Urban Studies majors. Eighty percent of respondents were female.

5.1 Interpretation of learning objectives

Students identified the deliverables associated with their assignments and noted their interpretation of the learning outcomes associated with the project. All 15 Economics students responded to the questionnaire based on their experience completing the spreadsheet assignment. All 15 Urban Studies students responded in regard to their experience completing their 3-4 page paper and 8 also remarked on their work with the spreadsheets assignment. Student interpretations of expected learning outcomes were consistent with expectations provided by faculty as noted by this respondent: "He wants us to learn how to conduct quantitative analyses that can be relevant or applied to our own research for our papers."

5.2 Use of resources, services, and facilities

The questionnaire probed student experiences in four areas: attending the Excel workshop, using the Excel Tutorials, services, and use of facilities and equipment.

5.2.1 Excel Workshop

Ninety three percent of respondents attended the workshops. Over 70% of respondents reported that "I learned skills I applied when completing the assignment" and "I learned new skills using Excel." Over half reported that they learned new skills working with or visualizing data. Two thirds of respondents reported that the session "covered topics and skills I already knew" but 60% of respondents reported that "it was a good refresher for me." One half of respondents said that "it helped me feel more comfortable with Excel before starting the assignment." However, over one third of the respondents said that "the session was of limited use since I completed the assignment on a Mac."

Among these respondents, there appears to be a wide range of experience using Excel and in future semesters it may make sense to offer separate courses by level of expertise as suggested by this respondent: "it should be divided by experience. If you've never made a graph on excel before, it was too fast at first, so we had to slow down the presenter and encourage it to become a more step by step demonstration."

5.2.2 Excel Tutorials

Fifteen percent of the respondents used the tutorials. None of the students in URBS 3545 used them. Students who used the tutorials reported that they "learned new Excel skills" when using them. Four of five said they referred to the tutorials when completing the assignments, reported "improved confidence using Excel", and "the tutorials were a good refresher for me." Four out of five said they found the tutorials easy to use.

5.2.3 Sources of help

Almost 63% of respondents did not seek help at all when completing these assignments. Over one half of those who request assistance sought help from a classmate and one half reported seeking help from the ERL. 'Most important' sources of help were of benefit during the stages of 'familiarizing myself with the data', 'preparing data for analysis', and 'creating graphs or charts'.

Respondents reported few problems with these sources of help, except for two students who reported their source of help did not have technical expertise needed to support them.

5.2.4 Use of facilities and equipment

Seventy-three percent of respondents said they used their own computers to complete the assignments, 36% used computers in a computer lab on campus, and 20% used a computer in the library. Thirty-seven percent reported using study space in the library when completing their work. Two thirds of respondents reported their personal computers were the most important facility or equipment for their project; computers in labs, printers, and network connections rounded out the top categories. Few to no problems were reported in this area, as most respondents reported the benefits of having access to the software needed for the assignment.

5.2.5 Use by learning activity

Students were asked to name their 'most important' services and facilities used when completing the ER assignments and to identify the learning activities these top-ranked uses supported. As shown in figure 1, most important services and facilities were used throughout the project. However, uses of personally owned computers predominate in these results.

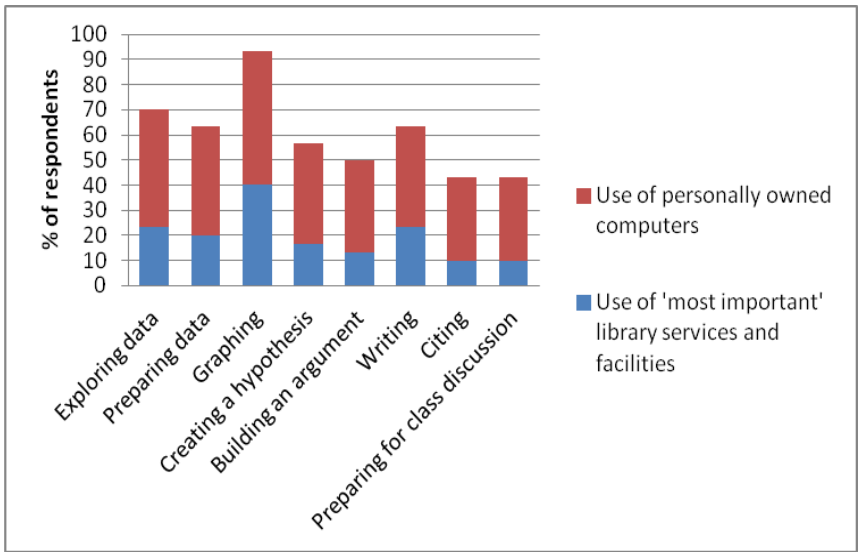

Figure 1 Percentage of respondents reporting most important services, facilities, and equipment by learning activity (n=30)

5.3 Challenges faced

Respondents answered several open-ended questions about a challenge faced during the project. Respondents were asked to describe the challenge, identify the learning activities they were engaged in when facing the challenge, and

finally to explain how the challenge was overcome. Twenty four respondents reported challenges faced during the project.

Challenges were first analyzed by task type and all but one student referred to academic work task challenges related to writing, working with Excel, or working with data, such as:

- "My challenge with the assignment initially had to do with how to use certain aspects of excel like formulas" (Economics)
- "making analytic graphs" (Urban Studies)
- "I had some difficulty analyzing the data without doing outside research" (Urban Studies)
- "I didn't know some terms that only Excel uses. Thus I had to be more familiar with the uncommon terms in the spreadsheet exercise." (Economics)

Students encountered these challenges throughout the life-cycle of their projects as depicted in figure 2.

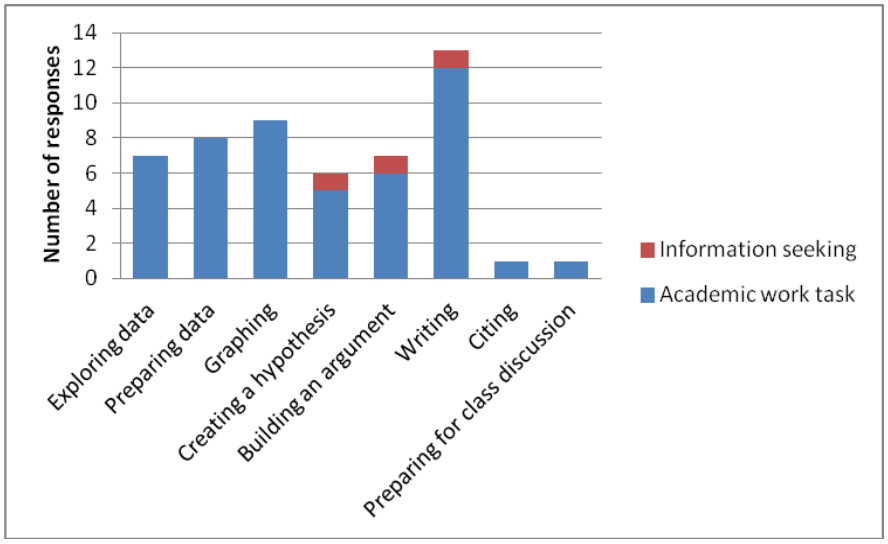

Figure 2 Challenges by task type and learning activity (n=24)

Twenty-three of 24 respondents reported overcoming their challenges, predominantly through their own effort, asking for help, and using resources such as the library computers. Most did so by sheer effort as expressed by this respondent: "Looking back at the readings we have done in class regarding the subject matter, breaking down the data." Eight respondents (33%) reported using a library service or asking for help to overcome their challenge, as in this comment by a student in Economics: "First, I read the tutorials. Then I tried it myself. Finally, I asked for help."

5.4 Student affect

Students were asked questions about their anxiety and confidence before, during, and after completing the assignment. Only 20% of students reported being anxious about the assignment before starting; while 40% reported some level of anxiety when actually working on the project. Over 60% of students reported high levels of confidence with Excel and over 80% reported high levels of confidence working with numeric data before completing the project. Ninety percent of respondents would be confident if in the future they were asked to complete a similar assignment.

5.5 Evidence of student learning

One of the purposes of this project was to explore ERL impact on student achievement of learning outcomes. The ER competencies encompass a range of technical skills using software applications, abilities in handling and working with numeric data, the ability to use that data as evidence in developing a hypothesis, and writing skills necessary for communicating an argument.

Assessment results for the Urban Studies projects were shared with the project to experiment linking student effort and ERL use with student performance on the ER assignments. The Urban Studies faculty shared grades for their students with the project using encrypted student identifiers. These scores were imported into the ULI dataset for analysis. There was very little variation in the grades (on a 100 point scale) reported for all students in the course (M=90.07, SD=3.5). There was even less variation among respondents to the instrument with a range of 87 to 95 (M=91.6, SD=2.82). Linking responses to assessment results with encrypted student identifiers worked well, but grades alone served as a poor proxy for student attainment of ER competencies because of their lack of specificity. That is, one cannot tell from an assignment grade alone how well a student has mastered a given ER competency.

6 Implications and next steps

6.1 Implications for services and equipment offered by the library

In the ER program's first year, faculty members provided the students with datasets tailored to each assignment and provided detailed guidance to analyze the data using Microsoft Excel. One objective of the ER program is to help students build the capacity to find or create their own data sets and apply appropriate techniques to solve problems using ER skills. Plans to ratchet up expectations of students in the ER program will impact the library and the ERL through demands on service provision, demand for workshops, and expenses for computers and software.

First, students searching for their own datasets will likely require more sophisticated assistance from librarians or ERL staff. Second, Microsoft Excel may not always be the best tool for students' projects. Statistical analysis software such as SPSS or Geographic Information Systems (GIS) and specialized software may be needed. Even though students exhibited a range of expertise with Microsoft Excel, the workshops were deemed valuable by a vast majority of participants. In the future, students expected to apply statistical analysis or GIS software will also need workshops and support. From a services

perspective, the library may need to train or hire staff to delivery these workshops and provide necessary support.

Finally, three quarters of the respondents were able to use their own computers to complete the assignments, presumably because they owned a license to Microsoft Excel. Expectations that students use statistical or GIS software may require additional costs for software licenses or new computer workstations.

6.2 Implications for assessment

The project demonstrated the feasibility of collecting quantitative and qualitative data from student responses and linking them to assessment results of student work. Yet, grades on a specific assignment were not granular enough to draw meaningful connections between students' information behaviors and their acquisition of specific ER SLOs. Analysis is further complicated by the fact that faculty from multiple academic disciplines bring their own sets of expectations for student learning, assignment types, and standards for grading to the ER program.

In future evaluations of this program, task-specific analytic rubrics for specific ER assignments could provide the granularity needed to demonstrate connections between student effort in learning activities, student use of the ERL, and student performance. Task-specific rubrics could also support formative assessment for individual students and meet program-level assessment requirements.

Numerous quantitative reasoning (QR) programs have developed curricula and rubrics to support student learning in QR and assessment of that learning.[iv] However, ER competencies extend beyond mathematic and quantitative skills to include data-informed reasoning, building an argument, and communicating that argument using numeric or other data. The American Association of Colleges and Universities developed fifteen meta-rubrics to guide local assessment of a range of broad abilities ranging from critical thinking, to quantitative reasoning, to written communication.[v] ER competencies can be found in several of these meta-rubrics including the quantitative literacy, critical thinking, inquiry and analysis, and written communications rubrics. Elements of these meta-rubrics could be incorporated into an ER assessment rubric. As an example several of the grading criteria for the Urban Studies 3-4 page paper have been mapped to specific elements in four meta-rubrics as illustrated in Table 1.

Table 1. Mapping Urban Studies grading criteria to VALUE rubric elements

Urban Studies grading criteria	VALUE rubric elements
(1) Critical assessment of the data	QL: Interpretation IA: Limitations
(2) Comparative analysis of the data	QL: Application / Analysis, Calculation
(3) Interpretation: offering plausible historical explanations for the mortality patterns and	QL: Interpretation, Application / Analysis

trends.	
(4) Logic of possible directions / hypotheses for future research	CT: Student's Position
(5) Quality and clarity of the graphs	QL: Representation
(6) Organization	QL: Communication CT: Evidence, Student's position, Conclusions
(7) Writing style	QL: Communication W: Genre and disciplinary conventions, Syntax and Mechanics

QL: Quantitative Literacy, CT: Critical Thinking, IA: Inquiry and Analysis, W: Written Communication. See appendix A for descriptions of each VALUE rubric element.

Adopting an ER rubric within or even across departments could support benchmarking student skills in ER capabilities at matriculation, guide the creation of assignments to develop ER competencies, and support tracking student growth by individual student or by cohort over time. Adopting an ER rubric would help articulate connections between specific learning activities and expected ER competencies. For instance, an assignment emphasizing the proper creation and use of Excel formulas contributes to student development of skills in analysis and calculation.

6.3 Next steps

Despite receiving responses from only 35% of the students enrolled in ER-focused courses, these findings provide good baseline data and a great opportunity to make changes in how we approach the project in years two and three.

Given the limited amount of use the online tutorial received, the ERL is unlikely to devote too much time and energy to future tutorials; however, we do need to find a way to address the disparity in students' skill levels. Offering basic and advanced workshops is one solution but may require students to commit more time outside of class and the library may require additional staffing. Offering a recorded version of the workshop students could access online is another option under consideration.

Another important issue raised is the need to provide more support for users of Apple Macintosh computers. Although campus IT and the Library provide IBM-compatible personal computers almost exclusively in classrooms and labs, over half of Barnard students use a Macintosh laptop as their primary computer. We have already added Macintosh computers to the ERL and will make sure Macintoshes are added to the teaching labs as well.

As we enter the second year of this project, we already know we will be working with courses in environmental sciences, history, and English, as well as sociology and psychology. As ER support extends through the Barnard

curriculum, it will be necessary to adapt the ULI instrument to the needs of the various disciplines.

7 Conclusions

As librarians capitalize on opportunities to partner with teaching faculty to support student learning throughout the academy, it is critical to measure the impact of library services and resources on student learning. The ERL project described here demonstrates the value of using an approach such as the Understanding Library Impacts protocol to gather quantitative and qualitative data to assess how the library's ERL initiative contributes to student learning. The ULI protocol successfully generated evidence to support both immediate and long-term service modifications to increase program effectiveness and improve learning outcomes. This paper also shared some of the challenges encountered in performing this kind of assessment work and proposes ideas to address these challenges in future work.

Appendix A: Elements of the VALUE rubrics

Elements of four VALUE rubrics are excerpted below. Refer to Rhodes, 2010 for more details regarding their construction and www.aacu.org/value/rubrics to access the complete rubrics.

Critical thinking is a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion.

Code	Outcome	Performance expectations at the capstone level
C1	Explanation of issues	Issue/problem to be considered critically is stated clearly and described comprehensively, delivering all relevant information necessary for full understanding.
C2	Conclusions and related outcomes	Conclusions and related outcomes (consequences and implications) are logical and reflect student's informed evaluation and ability to place evidence and perspectives discussed in priority order.
C3	Influence of context and assumptions	Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts when presenting a position.
C4	Student position	Specific position (perspective, thesis/hypothesis) is imaginative, taking into account the complexities of an issue.
C5	Evidence	Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis.

Quantitative Literacy (QL) – also known as Numeracy or Quantitative Reasoning (QR) – is a "habit of mind," competency, and comfort in working with numerical data.

Code	Outcome	Performance expectations at the capstone level
Q1	Interpretation	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information
Q2	Representation	Skillfully converts relevant information into an insightful mathematical portrayal in a way that

		contributes to a further or deeper understanding.
Q3	Calculation	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly (clearly, concisely, etc.)
Q4	Application / Analysis	Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.
Q5	Assumptions	Explicitly describes assumptions and provides compelling rationale for why each assumption is appropriate. Shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.
Q6	Communication	Uses quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and explicates it with consistently high quality

Written communication is the development and expression of ideas in writing. Written communication involves learning to work in many genres and styles. It can involve working with many different writing technologies, and mixing texts, data, and images. Written communication abilities develop through iterative experiences across the curriculum.

Code	**Outcome**	**Performance expectations at the capstone level**
W1	Context of and Purpose for Writing	Demonstrates a thorough understanding of context, audience, and purpose that is responsive to the assigned task(s) and focuses all elements of the work.
W2	Genre and Disciplinary Conventions	Demonstrates detailed attention to and successful execution of a wide range of conventions particular to a specific discipline and/or writing task (s) including organization, content, presentation, formatting, and stylistic choices
W3	Sources and Evidence	Demonstrates skillful use of high-quality, credible, relevant sources to develop ideas that are appropriate for the discipline and genre of the writing

W4	Control of Syntax and Mechanics	Uses graceful language that skillfully communicates meaning to readers with clarity and fluency, and is virtually error-free.
W5	Content Development	Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, conveying the writer's understanding, and shaping the whole work.

Inquiry and analysis, Inquiry is a systematic process of exploring issues, objects or works through the collection and analysis of evidence that results in informed conclusions or judgments. Analysis is the process of breaking complex topics or issues into parts to gain a better understanding of them.

Code	**Outcome**	**Performance expectations at the capstone level**
IA1	Existing knowledge, research, and/or views	Synthesizes in-depth information from relevant sources representing various points of view/approaches.
IA2	Topic selection	Identifies a creative, focused, and manageable topic that addresses potentially significant yet less explored aspects of the topic.
IA3	Analysis	Organizes and synthesizes evidence to reveal insightful patterns, differences, or similarities related to focus.
IA4	Conclusion	States a conclusion that is a logical extrapolation from the inquiry findings.
IA5	Design	All elements of the methodology or theoretical framework are skillfully developed. Appropriate methodology or theoretical frameworks may be synthesized across disciplines.

References

[i] The Understanding Library Impacts Project, www.uliproject.com.

[ii] The Critical Incident Technique has been adapted for use in a wide range of LIS projects. See for instance, Carol Tenopir, Don King, Sheri Edwards, and Lei Wu, "Electronic journals and changes in scholarly article seeking and reading patterns," *Aslib Proceedings* 61(2009):5-32; Marie Radford, "The Critical Incident Technique and the Qualitative Evaluation of the Connecting Libraries and Schools Project," *Library Trends*, 55(2006):46-64; and Joanne G. Marshall, "The impact of the hospital library on clinical decision making: the Rochester study," *Bulletin of the Medical Library Association* 80(1992):169–78.

[iii] Qualtrics, www.qualtrics.com

[iv] See for instance Carleton College's Quantitative Inquiry, Reasoning, and Knowledge (QuIRK) Initiative, http://serc.carleton.edu/quirk/index.html and the Bowdoin College Quantitative Reasoning Program http://www.bowdoin.edu/qr-program/index.shtml

[v] Terence L. Rhodes. Assessing Outcomes and Improving Achievement: Tips and tools for Using Rubrics, Washington, DC: Association of American Colleges and Universities, 2010. See also www.aacu.org/value/rubrics