The Key Components of a Numeracy Infusion Course for Higher Education (NICHE): Using Best Practices to Train Faculty

Esther Isabelle Wilder,[1] Elin Waring,[1] Frank Wang,[2] and Dene Hurley[3]

[1]Department of Sociology, Lehman College and The Graduate Center,
The City University of New York, 250 Bedford Park Boulevard West, Bronx, NY 10468

[2]Department of Mathematics, Engineering and Computer Science,
LaGuardia Community College, 31-10 Thomson Avenue, Long Island City, NY 11101

[3]Department of Economics and Business, Lehman College,
The City University of New York, 250 Bedford Park Boulevard West, Bronx, NY 10468

Abstract

Faculty at the City University of New York (CUNY) have developed a Numeracy Infusion Course for Higher Education (NICHE) that teaches best practices for effective Quantitative Reasoning (QR) instruction to faculty in a wide range of disciplines. NICHE is a predominantly online course that consists of 8 separate units: (1) QR and Making Numbers Meaningful; (2) QR Learning Outcomes; (3) The Brain, Cognition and QR; (4) QR and Writing; (5) Discovery Methods; (6) Representations of Data; (7) QR Assessment; and (8) QR Stereotypes and Culture. This paper describes the key components of NICHE and shows how the same strategies recognized as effective methods for teaching QR can be employed in training faculty as QR instructors. Course activities, interactive discussions, and faculty-developed instructional materials are also presented.

Key Words: active learning, assessment, multidisciplinary instruction, numeracy, quantitative literacy, quantitative reasoning

Quantitative Reasoning Across the Curriculum

Whether called numeracy, Quantitative Literacy (QL), or Quantitative Reasoning (QR), the contextualized use of numbers in everyday life is an essential skill for college students and graduates. Moreover, many scholars have called for a multidisciplinary, active learning approach to QR instruction.[1] As Steen (2008: 19) has stated, "The success of writing across the curriculum is an inspiration to those who hope QL will follow in these footsteps. Indeed, the National Numeracy Network . . . is loosely modeled after the

[1] See, for example, Bressoud (2009), Diefenderfer, Doan and Salowey (2006), Fink and Nordmoe (2006), Gordon and Winn (2006), Haines and Jordan (2006), Hartzler and Leoni (2006), Hillyard et al. (2010), Johnson (2006), and Taylor (2006).

National Writing Project, a nationwide system of local coalitions that has provided effective support for writing across the curriculum for over a quarter century." Likewise, Briggs (2006) has stressed the need for collaborative, multidisciplinary QR efforts. Although QR rests on a solid mathematical foundation, it requires more than mathematical or statistical fluency (Madison 2004: 4–5; Madison and Dingman 2010). As Ganter (2006: 13) has pointed out, "QL must be everywhere in the curriculum, in all disciplines and all courses." Indeed, a multidisciplinary approach is central to many QR initiatives. "Like learning to write well or speaking a foreign language, numeracy is not something mastered in a single course. . . . Thus quantitative material needs to permeate the curriculum, not only in the sciences but also in the social sciences and, in appropriate cases, in the humanities. . . ." (Bok 2006: 134). In fact, the social sciences may be especially well-positioned to take the lead in QR initiatives (Steen 2002).

1. Development of a Numeracy Infusion Course for Higher Education

The recognition that QR is the responsibility of ***all*** faculty provides the impetus for the Numeracy Infusion Course for Higher Education (NICHE). NICHE is an outgrowth of a QR faculty development program that was instituted at Lehman College of the City University of New York (CUNY) during the 2010–2011 academic year (Wilder 2012). During that program, faculty met monthly for ten 3-hour sessions to learn about and discuss strategies for effective QR pedagogy. In 2011, faculty from Lehman College and LaGuardia Community College (also of CUNY) received support from the National Science Foundation to develop NICHE, a QR faculty development program structured primarily as an online course to serve CUNY faculty from across the disciplines. CUNY is the largest urban university system in the country, with more than 170,000 students.

While NICHE trains faculty in effective pedagogies for QR instruction, the ultimate goal has always been to improve the QR skills of students. QR instruction is especially important at The City University of New York, given the socioeconomic and educational disadvantages that so many CUNY students face. In particular, many enter college with weak quantitative skills and high levels of math phobia (Peskoff 2000; Wilder 2009, 2010). As shown in Table 1, students at the CUNY senior colleges tend to have SAT scores well below the median for all college-bound seniors. At some, such as John Jay College and York College, approximately 75% of students score below the national median (496 for critical reading and 514 for math) (Rowell 2013). Ensuring students' quantitative literacy remains a challenge at even the most selective CUNY schools (Collison et al. 2008). For this reason, all the CUNY institutions must work hard to ensure that students achieve satisfactory levels of QR competency.

Most full-time CUNY students attend college while working for pay and providing care for others. In many cases, the demands placed on these students are extraordinary. Moreover, CUNY students represent a significant and growing segment of the undergraduate population—students who are older, female, ethnically diverse, and likely to be working or raising a family. The CUNY colleges are typical of a particular kind of institution—public, urban, and nonresidential—that can be readily identified in community college and university systems throughout the United States.

Table 1: Sociodemographic Characteristics of CUNY Students, 2012

	Minor-ity[1]	Fe-male	Low inc.[2]	First gen.[3]	Prov. care[4]	Work 21+[5]	SAT rdng.[6]	SAT math[7]
Senior colleges	43	60	50	41	59	22	—	—
Baruch	25	49	46	41	53	18	570	640
Brooklyn	39	61	53	46	67	22	535	565
City	54	53	53	36	55	16	505	560
Hunter	31	69	43	35	60	19	570	580
John Jay	60	57	49	42	60	30	465	475
Lehman	78	69	52	49	63	22	500	510
Queens	26	60	44	36	55	23	535	570
York	69	66	57	48	67	26	438	465
Comp. colls.	56	54	53	42	57	23	—	—
M. Evers	96	73	65	59	71	25	—	—
NYC Tech.	66	45	60	45	50	19	—	—
Staten Island	26	57	38	35	58	27	490	515
Comm. colls.	67	57	65	51	58	20	—	—
Bronx	94	58	74	59	60	32	—	—
Hostos	93	67	80	55	62	19	—	—
Kingsboro.	50	55	61	44	61	18	—	—
LaGuardia	62	58	64	50	57	23	—	—
Manhattan	73	58	63	52	54	19	—	—
Guttman	81	52	—	—	—	—	—	—
Queensboro.	53	54	60	49	61	14	—	—
Total, CUNY	53	58	67	45	59	21	—	—

Sources: City University of New York (2013), Grove (2013).
[1] Includes American Indian, Alaska Native, Black (not of Hispanic origin), and Hispanic.
[2] Percentage with household incomes of less than $30,000.
[3] Percentage in the first generation of their family to attend college.
[4] Percentage providing care to another person; refers only to full-time students.
[5] Percentage working for pay 21 or more hours per week; refers only to full-time students.
[6] Estimated median SAT critical reading score. The SAT is required only of incoming first-year students. At some CUNY senior colleges, the majority of students are transfer students.
[7] Estimated median SAT math score.

2. Strategies for Effective QR Instruction

In her book *Powerful Learning: What we Know about Teaching for Understanding*, Darling-Hammond (2008: 5) argues that meaningful learning is accomplished through a number of key approaches including: "(1) creating ambitious and meaningful tasks, (2) engaging students in active learning, (3) drawing connections to students, (4) scaffolding the learning process, (5) assessing student learning continuously, (6) providing clear standards and constant feedback, and (7) encouraging strategic and metacognitive thinking." Likewise, successful instruction in QL requires *progressive pedagogy*: "connecting content to real-life situations, lighter coverage of topics, an emphasis on understanding concepts rather than facts, integrating content across disciplinary boundaries" (Cuban 2001: 89).

Research on effective pedagogy informs NICHE and provides a foundation for each unit of the course. Enrollees not only review the relevant literature, but engage in activities and prepare instructional materials that are anchored in these approaches. A comprehensive review of these strategies can be found on the NICHE website (see "Best Practices" at www.teachqr.com); a brief summary is presented below.

2.1 Real World Applications and Active Learning, including Discovery Methods

A famous Chinese proverb states, "What I hear, I forget; what I see, I remember; what I do, I understand." This proverb describes a fundamental principle of active learning. Extensive research has shown that students learn more rapidly, retain knowledge longer, and develop superior critical thinking skills when they are actively involved in the learning process. (See, e.g., Himes and Caffrey 2003, Kain 1999; Kenny 1998; King 1994; Twigg 2005.) Constructivist methods, which view learning as a form of understanding constructed by the learner and focus on ways in which the individual learner makes sense of the subject matter, are also important. (See, e.g., Brooks and Brooks 2001; Caine and Caine 1994; Cakin 2008; Hatano 1996; Killen 2006; Leonard 2002; Tout and Schmitt 2002; Switzer 2004.)

2.2 Pairing QR Instruction with Writing, Storytelling and Critical Reading

Pairing quantitative constructs with language can strengthen academic arguments; improve quantitative literacy/reasoning; improve public discourse; encourage quantitative reasoning across the curriculum; and prepare students for the workplace (Madison 2012). Placing QR within the context of writing programs has also been shown to improve writing instruction, challenge the notion that QR is merely remedial math, and provide a route for the incorporation of QR into the curriculum (Grawe and Rutz 2009). Stressing the importance of connecting writing and QR, Lutsky (2008: 63) argues that "quantitative information may be used to help articulate or clarify an argument, frame or draw attention to an argument, make a descriptive argument, or support, qualify, or evaluate an argument. Quantitative analysis may also influence how arguments are marshaled and how exchanges of arguments are conducted."

2.3 Using Technology, including Computers

Computer skills are also essential to QL/QR instruction (Collison et al. 2008; Jabon 2006; Steen 2004; Vacher and Lardner 2010; Wiest, Higgins and Frost 2007). Indeed, the use of computers can actively engage students in QR work, promote logical thinking, and help students master QL/QR skills that are central to the research process (Fuller 1998; Markham 1991; Persell 1992; Raymondo 1996). The use of spreadsheets has also been shown to promote QR engagement in a variety of fields (Vacher and Lardner 2000). Likewise, strategies that incorporate information and communication technologies have proven effective in primary school numeracy instruction (Moseley et al. 1999). Active learning with computers helps develop students' QR abilities (Jabon 2006; Wilder 2009), and computer literacy can itself be regarded as an important QR skill (Wilder 2010).

2.4 Collaborative Instruction and Group Work

Interdisciplinary and collaborative approaches, including group work, are effective methods of QR education. (See, e.g., Dingman and Madison 2010; Madison and Dingman 2010.) Caulfield and Hodges (2006: 52), describing their research on the use of

groups to teach social science reasoning and quantitative literacy, reported that "most of our students work harder and learn more while working in groups." Indeed, Grouws and Cebulla (2000: 20) argue that "teachers must encourage students to find their own solution methods and give them opportunities to share and compare their solution methods and answers. One way to organize such instruction to have students work in small groups initially and then share ideas and solutions in a whole-class discussion."

2.5 Pedagogy that is Sensitive to Differences in Culture and Learning Styles

A substantial body of research shows that women and minorities experience mathematical and quantitative disadvantages. However, teaching that is sensitive to the needs of minorities, women, and individuals of different cultural backgrounds can improve QR learning. Tout and Schmitt (2002: 171) note that in the U.S., considerable effort has been directed toward the success of females in mathematics; the most effective approaches include “working cooperatively, promoting discussion and idea sharing, and using hands-on materials.” Even within the classroom, teachers need to be sensitive to variations in students' abilities. (See, e.g., Stern 2004.) An ethnomathematical perspective that recognizes how different forms of mathematics arise in different cultures (e.g., Zaslavsky 1994) can also contribute to our understanding of how to best teach QR.

2.6 Scaffolding the Learning Process and Providing Rich Feedback and Opportunities for Revision

In effective QR instruction, the instructor is an active facilitator of learning. Killen (2006: 21) notes that the teacher's goal should be "to encourage students to be both investigators and critics of the subjects they are studying, while providing them with sufficient scaffolding for them to be successful in their learning." Scaffolding entails "providing a student with enough help to complete a task and then gradually decreasing the help as the student becomes able to work independently" (Killen 2006: 7). Throughout the learning process, faculty (or peers) should provide feedback to students and ensure that they have ample opportunities to master the material.

3. The Structure of NICHE

The objectives of NICHE are to provide instruction on best practices for teaching QR; to foster the development of instructional materials that make use of effective strategies for teaching QR; to infuse QR into a wide range of disciplines and CUNY colleges; to increase faculty interest and comfort in teaching QR, strengthening the faculty’s own QR skills, if necessary; and to establish a network of faculty who are committed to improving students’ QR skills.

In teaching faculty how to infuse QR into their courses, NICHE uses the same approaches that have proven effective in the teaching of college students: active learning, discovery methods, etc. The course includes a 2-day in-person introductory session as well as 8 online instructional units, each lasting one week. The units themselves are asynchronous, but there are deadlines for each unit. In addition, we require that faculty participants review and complete both welcome and wrap-up packets which include materials such as pre- and post-NICHE questionnaires and assessments. Our online instructional units, delivered through Blackboard, serve as a complement to the NICHE website (www.teachqr.com).

Each online unit can be completed in 6–8 hours. Faculty are compensated $1,500 for their participation in NICHE, with the option of receiving $300 in additional support for submitting their assessment data and a report describing a QR-infused course they have taught in the year following their NICHE participation.

While NICHE is chiefly an online course, the instruction begins with a 2-day in-person session in which faculty get acquainted with one another and discuss QR pedagogy. During the session, faculty score the Critical Thinking Assessment Tests (CATs) that they administered in their courses the previous semester. The CAT, a short answer, faculty-scored examination developed by researchers at Tennessee Technological University, is used as a tool for faculty development in NICHE. The CAT emphasizes numeracy, and the faculty's active engagement in scoring the test provides information about the abilities of CUNY students as well as insights into the assessment of QR skills. The in-person session also provides an overview of the meaning and relevance of QR, with special emphasis on the required reading, John Paulos' classic book *Innumeracy*.

The 8 online units of NICHE are (1) QR and Making Numbers Meaningful; (2) QR Learning Outcomes; (3) The Brain, Cognition and QR; (4) QR and Writing; (5) Discovery Methods; (6) Representations of Data; (7) QR Assessment; and (8) QR Stereotypes and Culture. Each unit includes a set of readings, videos, hands-on activities and interactive discussions. In addition, there are several key tasks that must be completed—activities/assignments in which faculty develop materials for their own courses. The key tasks are as follows:

1. Articulate a set of QR learning goals → Provide peer feedback on QR learning goals → Develop a revised set of QR learning goals in response to peer feedback.
2. Create/adapt a QR lesson plan/exercise → Provide peer feedback on a QR lesson plan/exercise → Develop a revised QR lesson plan/exercise in response to peer feedback.
3. Create/adapt a QR assessment plan/instrument → Provide peer feedback on QR assessment plan/instruments → Develop a revised QR assessment plan/instrument in response to peer feedback.

For each key task, we provide detailed instructions and guidelines for peer review, which we urge participants to use as they develop/adapt their own instructional materials.

4. Summer 2013 NICHE Results

The faculty enrollees in NICHE included the NICHE PI/co-PI team as well as the NICHE campus liaisons who had been selected by the PI prior to the funding of the project.[2] In addition, each liaison was charged with recruiting a faculty member for NICHE, and the PI reached out to several additional faculty who were involved in QR initiatives on their home campuses.

Twenty CUNY faculty from 4 community colleges and 7 senior/comprehensive colleges participated in the summer 2013 NICHE program. The 20 faculty represented 8 disciplines: African American studies (1); biology (4), economics (1), mathematics (7),

[2] NICHE was developed by Esther Wilder (PI), Elin Waring (NICHE Liaison), Frank Wang (co-PI), and Dene Hurley (co-PI). In the discussion of results, we have excluded our own responses from the quotations.

political science (1), psychology (2), public affairs (1), and sociology (3). Four external evaluators/reviewers were also actively involved in the project. They reviewed the NICHE course materials and provided feedback to the faculty enrollees on the instructional materials they had developed during the course.

4.1 Attitudes Toward QR Instruction

The NICHE faculty participants are a diverse group who bring many different perspectives and experiences to QR instruction. During the in-person session we conducted a survey using clickers, asking faculty about their backgrounds and their experience with QR. This survey revealed considerable variation among the participants. While most (63%) agreed that QR is highly valued at their home campuses, approximately one third neither agreed nor disagreed. Faculty at community colleges were considerably more likely to express agreement than the others. (See Table 2).

As noted earlier, faculty enrollees completed a questionnaire and a QR assessment prior to the start of the NICHE course . As shown in Table 3, our first NICHE cohort consists largely of faculty who are already making a concerted effort to infuse QR into their teaching. This is not surprising, since the majority were selected because they had been involved in QR initiatives on their home campuses. It is noteworthy that those who were recruited by the NICHE liaisons all gave scores of 3 or lower in response to this question (not shown), a reflection of the fact that we encouraged the liaisons to reach out to faculty who had not been directly involved in any QR initiative. Perhaps not surprisingly, faculty who are making a concerted effort to incorporate QR into their teaching are also more comfortable teaching QR. For instance, all the faculty enrollees who reported high levels of effort also exhibited high levels of comfort teaching QR. (See Table 3.)

4.2 NICHE Activities and Discussions

As mentioned earlier, the NICHE course includes a range of hands-on activities (approximately 3 in each unit) that promote self-reflection on QR pedagogy and/or allow participants to engage in effective strategies for teaching QR. For example, faculty enrollees undertake hands-on activities working with data and QR problems, review students' work, and evaluate assessment materials. They also participate in discussions about the activities, the course readings, and the videos.

Table 2: "Effective QR Instruction is Highly Valued at My College"

	Community College	Senior College	Total
Strongly Agree	57%	0%	21%
Somewhat Agree	43%	42%	42%
Neither agree nor disagree	0%	50%	32%
Somewhat Disagree	0%	8%	5%
Strongly Disagree	0%	0%	0%
N	7	12	19

Source: In-person NICHE survey using anonymous clickers, June 2013.

Table 3: Efforts to Infuse QR into Course Instruction, by Comfort in Teaching QR

	Effort to infuse QR[1]			
Scale of Comfort[2]	1–2	3–4	5–6	Total
1	57%	0%	21%	40%
2	43%	42%	42%	25%
3	0%	50%	32%	15%
4	0%	8%	5%	10%
5	0%	0%	0%	10%
N	12 (60%)	7 (35%)	1 (5%)	20

Source: Pre-NICHE online questionnaire, June 2013.
[1]Effort to Infuse QR question asked: *On a scale of 1 (very concerted effort) to 7 (no effort), how would you rate the extent of your effort(s) to infuse quantitative reasoning into your course instruction?*
[2]Scale of Comfort questioned asked: *On a scale of 1 (very comfortable) to 7 (very uncomfortable), how would you rate your comfort in teaching QR?*
Note: No scores were above 5 on the comfort scale and no scores were above 6 in the "Effort to Infuse QR" scale.

In an exercise designed to get faculty thinking about ways of blending QR and writing in their own instruction, participants were asked to graph a course they teach along a QR/writing continuum. The graph was made available through Google Documents and participants were given instructions on how to add a shape to the graph. The resulting graph can be seen in Figure 1.

After graphing their courses, faculty were asked to "go to the bottom of the graph and identify yourself, indicate the symbol you used, noting what course it represents and why you graphed it where you did."

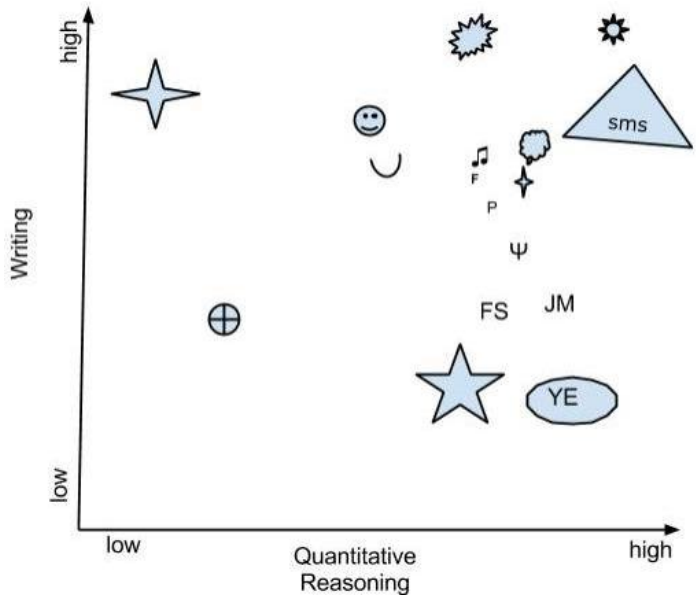


Figure 1: Faculty graph a course they teach on the "QR and Writing" spectrum.

A biology faculty member at Bronx Community College replied,

> My symbol is the circle with 4 quadrants, which I chose because Intro Biology 2 has 4 major topics: development, genetics, evolution, & ecology. It has a fair amount of writing, as each week students participate in either a discussion board or a wiki. . . . It's relatively low on the QR scale currently, as the only QR-heavy topic is genetics and only 3 lab require mathematical and QR skills. The same topics could be taught with a heavier emphasis on QR.

In another exercise, faculty examined the relationship between stories and graphing. They first watched a video by Kurt Vonnegut in which he discusses the "shapes of stories." Afterward, they watched a video of "The Three Little Pigs" and graphed the story using FlockDraw. Participants were asked to explain their drawing and to "reflect on whether you think graphing stories has any relevance to your discipline, and why." An example of such a graph is shown in Figure 2. In describing this graph, a psychology professor at Hunter College wrote:

> I chose a familiar line graph format and focused on the Emotional Experiences part of the story across time and across the 3 pigs. Of course the first two pigs are happy/carefree to begin and become frightened after the wolf comes and blows their house down (but they do recover some after reaching safety with pig 3). The third pig, of course, is more concerned/less carefree to start but gets more happy (positively gloating in the video) after his house holds up, they are safe, and he can use the "I told you so" line forever with his siblings. (Did you notice how he enjoyed making them duck back under the bed by knocking (sounded like a

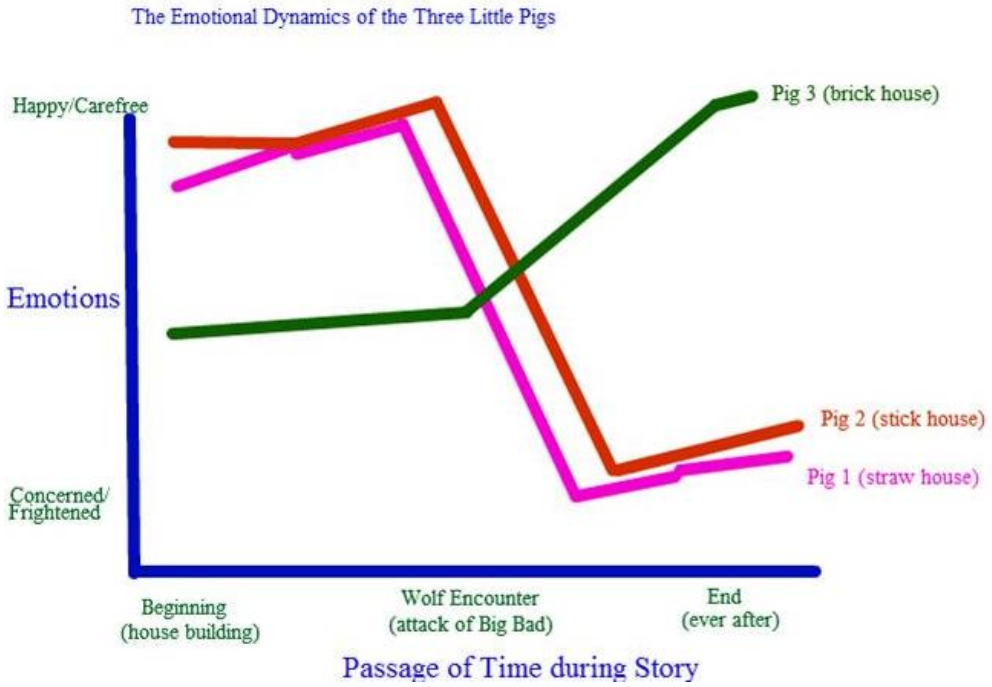


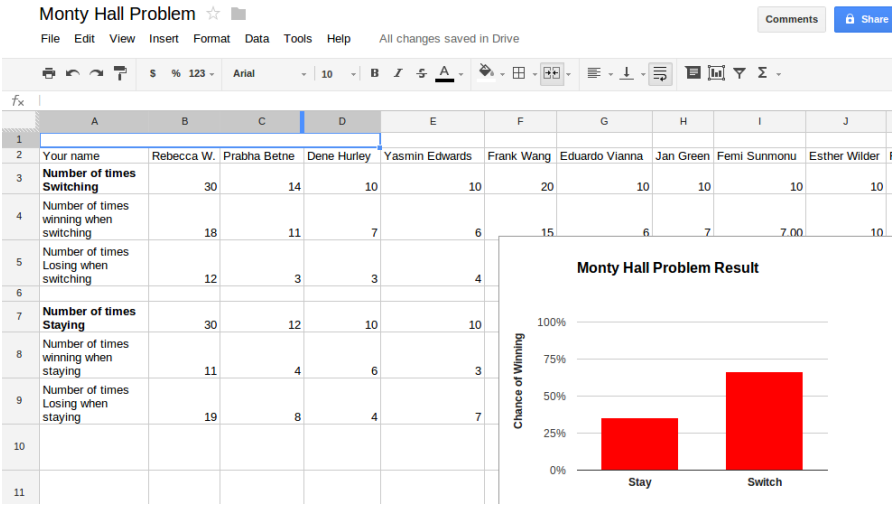
Figure 2: "The Three Little Pigs" as represented by a psychology faculty member.

> wooden door) on his brick piano?) I guess I could use something like this in class—minus the learning of a new drawing program. Students could talk in small groups about how they would represent the key dimensions of some story and draw a sketch by hand.

Participants' perspectives on the graphing activity varied by discipline. A faculty member in biology at Bronx Community College reported, "I would have a hard time finding a way to work graphing stories into biology. We would be better served graphing data – actual data rather than metaphor – in my classes." Meanwhile, a psychology professor at LaGuardia Community College wrote, "I thought this was a pretty clever exercise. This clearly bears relevance to my discipline, psychology, in that it demonstrates that qualitative data (e.g., narrative) can always be analyzed in terms of quantitative dimensions. I very much appreciate this movement back and forth between different forms of representation, which helps reveal some underlying patterns and help us focus on some key dimensions of phenomena."

In an exercise designed to show the advantages of discovery methods and group work, participants were asked to pick a partner and to undertake an empirical test of the Monty Hall exercise, the classic probability problem. They were instructed to undertake at least 20 trials, 10 with switching and 10 without switching. Afterwards, they posted their results on a shared Google spreadsheet, a portion of which is shown below (Figure 3). Finally, they were asked to reflect on the results of the exercise and on the ways in which discovery methods might be useful in teaching QR. A faculty member in mathematics at Guttman Community College wrote,

> The benefit of discovery methods is that students get to accept or refute their own assumptions based on evidence. A simple example that I have used is the probability of getting heads or tails in a coin toss. All the students will indicate that there is a 50% chance of getting heads or tails, but when they do the actual tosses they see that while this is the expected probability it may not be what is observed. They then have to explain why, and they are able to determine how sample size affects expected ratios.



	A	B	C	D	E	F	G	H	I	J
1										
2	Your name	Rebecca W.	Prabha Betne	Dene Hurley	Yasmin Edwards	Frank Wang	Eduardo Vianna	Jan Green	Femi Sunmonu	Esther Wilder
3	**Number of times Switching**	30	14	10	10	20	10	10	10	10
4	Number of times winning when switching	18	11	7	6	15	6	7	7.00	10
5	Number of times Losing when switching	12	3	3	4					
6										
7	**Number of times Staying**	30	12	10	10					
8	Number of times winning when staying	11	4	6	3					
9	Number of times Losing when staying	19	8	4	7					
10										
11										

Figure 3: Faculty input data for the Monty Hall Problem with the results shown in a graph (in NICHE the results were presented in a separate tab in the Google spreadsheet).

4.3 NICHE Tasks

As previously described, NICHE participants are required to submit 3 core instructional materials: their QR learning goals, a QR lesson, and their assessment instrument(s). In addition, faculty engage in a collaborative peer review process after submitting each of these materials. The NICHE website provides links to numerous repositories of QR instructional materials, and some of these are reviewed as component parts of NICHE.

Early in the course, faculty are asked to articulate 3 QR goals that they will address in the QR lesson they develop or adapt. Specifically, they are asked to articulate a goal in each of 3 domains: (1) knowledge and conceptual understanding; (2) thinking and other skills; and (3) attitudes, values, dispositions and habits of mind. After submitting their goals, faculty provide and receive peer feedback, then revise their goals accordingly.

Table 4 summarizes the QR goals that the faculty submitted. The columns of the table are based on the Quantitative Literacy Valid Assessment of Learning in Undergraduate Education (VALUE) rubric adopted by the Association of American Colleges and Universities (2010), which we introduce early in NICHE. As the table shows, many faculty structure their QR goals around basic mathematical and quantitative skills such as measures of central tendency, conditional probability, and working with data. While they want students to be able to undertake calculations, they place the strongest emphasis on applying, explaining, and making decisions based on quantitative information.

Table 4: NICHE Faculty QR Learning Goals

Foundational skill or skill set	Fields(s)	Data collect -ion	Tables and/or graphs	Calcu- lation	Expla- nation	Appli- cation	Infer. & deci- sion	Com- muni- cation	Ap- precia- tion
Absolute vs. relative #	math, soc			2	2	2	2		1
Area and volume	bio		1	1	1		1		
Bivariate analysis	soc		1		1		1		
Central tendency & dispersion	math, soc		1	2	2	2	2		
Conditional probability	math, econ		1	2	2	2	2	1	
Correlation	math			1	1	1	1		
Data analysis	Afr stud, bio, math	2	2	1	2	3	2	3	2
Graphical reps.	math, psych		2	1	2	2	2		
Location/ proximity	bio			1	1				
Percentages/ ratios	math, poli sci			2	2	1	2	1	
Research/ sampling	psych			1	1	1		1	
Total		2	8	14	17	14	15	6	3

Note: This table does not include information from 2 of the 3 faculty who ultimately withdrew from NICHE.

5. Concluding Thoughts

NICHE teaches faculty strategies for infusing QR throughout the curriculum. We engage faculty using a variety of hands-on exercises and discussions that encourage them to reflect on their teaching and to consider ways to integrate QR using best practices such as active learning, discovery methods, and the appropriate use of technology.

The program has led to a number of dynamic discussions about the readings, course materials and exercises. Indeed, many faculty have commented that NICHE has caused them to rethink their pedagogy. Participants have developed an array of high-quality instructional materials. Moreover, NICHE has led to a strong sense of community, with faculty working collaboratively to help one another.

As with any faculty development initiative, however, NICHE has faced some challenges. Because most of the course is taught online, technology-related issues are among the greatest obstacles. Although most participants have not experienced technical problems, others have had difficulty using Blackboard or working with the linked software programs such as Google Documents and FlockDraw. These problems cannot be traced to any single issue, but to a wide range of difficulties including technological inexperience, lack of attention to instructions, and the idiosyncrasies of the I.T. infrastructures in use throughout CUNY.

Another challenge is that many participants found it difficult to balance the workload and demands of NICHE with their other summer commitments and obligations. NICHE has been a high priority for some faculty but not for others. A few have lagged behind in meeting the course requirements or have submitted lower-quality instructional materials. Of the 20 faculty who started the program, 3 withdrew before its conclusion.[3] At the same time, most enrollees have demonstrated a strong commitment to NICHE. We have been impressed by the sustained engagement of the NICHE participants and by the quality of the discussions and instructional materials that have resulted from the program.

Acknowledgements

Support for the NICHE project has been provided by the National Science Foundation's (NSF) Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (STEM) (TUES) award #1121844. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily represent the views of the National Science Foundation. We are especially grateful to Steven Castellano who provided extensive help in the development of NICHE. Corrine Taylor, Stephen Sweet, Katherine Rowell, William Frey and Flora McMartin have also provided extremely helpful suggestions and feedback. We also thank Robert Whittaker for his ongoing support as well as Judy Duncker, Tzuhao (T) Huang, Hsien-Tseng (Elvin) Wang, Rebecca West, and Ruifang (Grace) Xu for their thoughtful comments on NICHE. William H. Walters provided helpful suggestions on a draft of this paper.

[3] One faculty member indicated that she plays to re-enroll in NICHE during the summer of 2014.

References

Association of American Colleges and Universities. 2010. *Quantitative Literacy VALUE Rubric*. Washington, DC: Association of American Colleges and Universities.

Bok, D. 2006. *Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why They Should be Learning More*. Princeton, NJ: Princeton University Press.

Bressoud, B. 2009. Establishing the quantitative thinking program at Macalester. *Numeracy* 2(1): Article 3.

Briggs, W.L. 2006. What mathematics should all college students know? Pp. 17–19 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Brooks, J.G. and M.G. Brooks. 2001. Becoming a constructivist teacher. Chapter 9 in *In Search of Understanding: The Case for Constructivist Classrooms*. Revised edition. New York: Prentice Hall.

Caine, R.N. and G. Caine. 1994. *Making Connections: Teaching and the Human Brain.* Menlo Park, CA: Addison Wesley.

Cakin, M. 2008. Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental and Science Education* 3(4): 193–206.

Caulfield, S.L. and C.H. Persell. 2006. Teaching social science reasoning and quantitative literacy: The role of collaborative groups. *Teaching Sociology* 34(1): 39–53.

City University of New York (CUNY). 2013a. *2012 Student Experience Survey*. Retrieved July 28, 2013 (http://cuny.edu/about/administration/offices/ira/ir/surveys/student/SES2012FinalReport.pdf).

_____. 2013b. *Current Student Data Book*. Retrieved July 28, 2013 (http://cuny.edu/about/administration/offices/ira/ir/data-book/current.html).

Collison, C., C. Good, S. Hazarika, M. Johnson, J. Jung, A. Mayo, W. Millhiser, D. Remler, and L. Beck. 2008. *Report of the Provost's Task Force on Quantitative Pedagogy*. Baruch College, The City University of New York. Retrieved July 28, 2013 (http://www.learningace.com/doc/1874377/446fa1ae680e08b398670bc87ae3147e/taskforceonquantitativeskills2008-09-05).

Cuban, L. 2001. Encouraging progressive pedagogy. Pp. 87–91 in *Mathematics and Democracy: the Case for Quantitative Literacy*, edited by L.A. Steen. Princeton, NJ: National Council on Education and the Disciplines.

Darling-Hammond, L., editor. 2008. *Powerful Learning: What we Know about Teaching for Understanding*. San Francisco: Jossey-Bass.

Diefenderfer, C., R. Doan, and C. Salowey. 2006. The quantitative reasoning program at Hollins University. Pp. 41–48 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Dingman, S.W. and B.L. Madison. 2010. Quantitative reasoning in the contemporary world, 1: The course and its challenges. *Numeracy* 3(2): Article 4.

Fink, J.B. and E.D. Nordmoe. 2006. A decade of quantitative reasoning at Kalamazoo College. Pp. 51–62 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Fuller, T.D. 1998. Using computer assignments to provide active learning in the undergraduate social problems course. *Teaching Sociology* 26(3): 215–21.

Ganter, S.L. 2006. Issues, politics and activities in the movement for quantitative literacy. Pp. 11–15 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Gordon, S. and J. Winn. 2006. Interconnected quantitative learning at Farmingdale State. Pp. 55–62 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Grawe, N.D. and C.A. Rutz. 2009. Integrating with writing programs: A strategy for quantitative reasoning program development. *Numeracy* 2(2): Article 2.

Grouws, D.A. and K.J. Cebulla. 2000. *Improving Student Achievement in Mathematics.* Geneva, Switzerland: International Academy of Education.

Grove, A. 2013. SAT scores for admission to the senior colleges of CUNY. *About.com*. Retrieved July 28, 2013 (http://collegeapps.about.com/od/sat/a/cuny-sat-scores.htm).

Haines, B. and J. Jordan. 2006. Quantitative reasoning across the curriculum. Pp. 63–68 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Hartzler, R. and D. Leoni. 2006. Mathematics across the curriculum. Pp. 69–74 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Hatano, G. 1996. A conception of knowledge acquisition and its implications for mathematics education. Pp. 197–217 in *Theories of Mathematical Learning*, edited by Leslie P. Steffe and Pearla Nesher. Mahwah, NJ: Erlbaum.

Hillyard, C., J. Korey, D. Leoni, and R. Hartzler. 2010. Math across the community college curriculum (MAC^3): A successful path to quantitative literacy. *MathAMATYC Educator* 1(2): 4–9.

Himes, C.L. and C. Caffrey. 2003. Linking social gerontology with quantitative skills: A class project using U.S. census data. *Teaching Sociology 31*(1): 85–94.

Jabon, D. 2006. Quantitative reasoning: An interdisciplinary, technology infused approach. Pp. 111–117 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Johnson, J. 2006. Math across the curriculum at UNR. Pp. 75–80 in *Current Practices in Quantitative Literacy*, edited by R. Gillman. Washington, DC: Mathematical Association of America.

Kain, E.L. 1999. Building the sociological imagination through a cumulative curriculum: Professional socialization in sociology. *Teaching Sociology* 27(1): 1–16.

Kenny, R.W. 1998. *The Boyer Commission on Educating Undergraduates in the Research University Reinventing Undergraduate Education: A Blueprint for America's Research Universities*. Retrieved July 28, 2013 (http://www.niu.edu/engagedlearning/research/pdfs/Boyer_Report.pdf).

Killen, R. 2006. *Effective Teaching Strategies: Lessons from Research and Practice*. 4th edition. South Melbourne, Australia: Cengage Learning.

King, K. M. 1994. Leading classroom discussions: Using computers for a new approach. *Teaching Sociology* 22(2): 174–82.

Leonard, D.C. 2002. *Learning Theories: A to Z*. Westport, CT: Greenwood.

Lutsky, N. 2008. Arguing with numbers: Teaching quantitative reasoning through argument and writing. Pp. 59–74 in *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education*, edited by B.L. Madison and L.A. Steen. Washington, DC: Mathematical Association of America.

Madison, B.L. 2012. If only math majors could write. *Numeracy* 5(1): Article 6.

Madison, B.L. and S.W. Dingman. 2010. Quantitative reasoning in the contemporary world, 2: Focus questions for the numeracy community. *Numeracy* 3(2): Article 5.

Markham, W.T. 1991. Research methods in the introductory course: To be or not to be? *Teaching Sociology* 19(4): 464–71.

Moseley, D., S. Higgins, R. Bramald, F. Hardman, J. Miller, M. Mroz, H. Tse, D. Newton, I. Thompson, J. Williamson, J. Halligan, S. Bramald, L. Newton, P. Tymms, B. Henderson, and J. Stout. 1999. *Ways Forward with ICT: Effective Pedagogy Using Information and Communications Technology for Literacy and Numeracy in Primary Schools*. London: Teacher Training Agency.

Persell, C.H. 1992. Bringing PCs into introductory sociology courses: First steps, missteps, and future prospects. *Teaching Sociology* 20(2): 91–103.

Peskoff, F. 2000. Mathematics anxiety and the adult student: An analysis of successful coping strategies. Pp. 34–38 in *Proceedings of the International Conference on Adults Learning Mathematics (July 6–8, 2000)*. Medford, MA: Adults Learning Mathematics.

Raymondo, J.C. 1996. Developing a computer laboratory for undergraduate sociology courses. *Teaching Sociology* 24(3): 305–09.

Rowell, K. 2013. What's a good SAT score? *About.com*. Retrieved July 28, 2013 (http://testprep.about.com/od/sat/f/SATFAQ_GoodSAT.htm).

Steen, L.A. 2004. Everything I needed to know about averages I learned in college. *Peer Review* 6(4): 4–8.

_____. 2008. Reflections on wingspread workshop. Pp. 11–23 in *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education*, edited by B.L. Madison and L.A. Steen. Washington, DC: Mathematical Association of America.

Stern, F. 2000. Choosing problems with entry points for all students. *Mathematics Teaching in the Middle Schools* 6(1): 8–11.

Switzer, J.S. 2004. Teaching computer-mediated visual communication to a large section: A constructivist approach. *Innovative Higher Education* 29(2): 89–101.

Taylor, C. 2006. Quantitative reasoning at Wellesley College. Pp. 141–146 in *Current Practices in Quantitative Literacy*, edited by Rick Gillman. Washington, DC: Mathematical Association of America.

Twigg, C.A. 2005. *Math lectures: An oxymoron? The National Center for Academic Transformation*. Retrieved July 28, 2013 (http://www.thencat.org/PlanRes/Math%20Lectures%20Editorial.htm).

Tout, D. and M.J. Schmitt. 2002. The inclusion of numeracy in adult basic education. *Annual Review of Adult Learning and Literacy* 3: Chapter 3. Boston, MA: National Center for the Study of Adult Learning and Literacy.

Vacher, H.L. and E. Lardner. 2010. Spreadsheets across the curriculum 1: The idea and the resource. *Numeracy* 3(2): Article 6.

Wiest, L.R., H.J. Higgins, and J.H. Frost. 2007. Quantitative literacy for social justice. *Equity & Excellence in Education* 40(1): 47–55.

Wilder, E.I. 2009. Responding to the quantitative literacy gap among students in sociology courses. *Teaching Sociology* 37(2): 151–70.

_____. 2010. A qualitative assessment of efforts to integrate data analysis throughout the sociology curriculum: feedback from students, faculty and alumni. *Teaching Sociology* 38(2): 226–246.

_____. 2012. Teaching quantitative literacy/quantitative reasoning (QL/QR skills): A numeracy infusion course for higher education. Pp. 2676–2690 in *Proceedings of the 2012 Joint Statistical Meetings*. Alexandria, Virginia: American Statistical Association.

Zaslavsky, C. 1994. "Africa counts" and ethnomathematics. *For the Learning of Mathematics* 14(2): 3–8.