

2012

Comparative Study of the Numeracy Education and Writing Across the Curriculum Movements: Ideas for Future Growth

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Recommended Citation

Hillyard, Cinnamon (2012) "Comparative Study of the Numeracy Education and Writing Across the Curriculum Movements: Ideas for Future Growth," *Numeracy*: Vol. 5 : Iss. 2 , Article 2.

DOI: <http://dx.doi.org/10.5038/1936-4660.5.2.2>

Available at: <http://scholarcommons.usf.edu/numeracy/vol5/iss2/art2>

Comparative Study of the Numeracy Education and Writing Across the Curriculum Movements: Ideas for Future Growth

Abstract

The percentage of American institutions with a Writing Across the Curriculum (WAC) program grew from 38% to 54% over the 20-year period from 1987 to 2008. Meanwhile the trajectory of the numeracy movement from publication of the popular book *Innumeracy* in 1988 to the appearance of *Numeracy* in 2008 was similar to the trajectory of the WAC movement from the publication of "Why Johnny Can't Read" (1975) to the appearance of the first WAC journal in 1994. Review of the WAC literature shows that the growth of WAC occurred despite numerous challenges: the need for institutional buy-in; assessment; orthodoxy of English departments; the notion that writing is a pre-college skill; recognition of WAC scholarship; the workload of grading; student resistance; and difficulties of getting external funding. Similar challenges face the numeracy movement today. The WAC literature reveals four major contributors to its successful growth: (1) a paradigm shift in thinking about writing pedagogy (exemplified by WTL, "writing to learn" rather than just "learning to write"; WID, writing in the disciplines; a rethinking of first-year writing courses; and writing across the curriculum); (2) campus-level faculty and student support for writing; (3) professional networks and scholarship around WAC; and (4) framing WAC within institutional movements. How can the numeracy movement apply these "lessons learned" from WAC? I conclude with five suggestions: (1) document that numeracy education increases students' critical thinking and decision-making skills; (2) compile electronic resources for faculty to integrate numeracy education into their disciplines; (3) expand our research methodologies and scholarly output so that numeracy education can be seen as its own field of study; (4) work with math departments and funding agencies to integrate numeracy more explicitly into high-volume, entry-level mathematics courses; and (5) support models of campus-wide programs that include a center for faculty and student support that is led by a numeracy education professional.

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Keywords

Writing Across the Curriculum, Quantitative Literacy Across the Curriculum, Comparative Study

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Cover Page Footnote

Cinnamon Hillyard, a mathematician, is an assistant professor in the School of Interdisciplinary Arts and Sciences at the University of Washington Bothell. She is a past Chair of the SIGMAA-QL and past Secretary-Treasurer of the NNN. She is currently working with the Carnegie Foundation for the Advancement of Teaching on the Quantway project. She teaches mathematics, statistics, and interdisciplinary research and writing courses. Her research focuses on the assessment of quantitative literacy and on how adults use quantitative literacy to make decisions.

Introduction

Over the past 20 years, the numeracy movement has grown in depth and breadth. Many calls for action around numeracy education have emphasized that “numeracy needs to be learned and used in multiple contexts” (Steen 2001, p. 6). Richardson and McCallum (2003, p. 102) further propose that numeracy education “at the college level also requires an across-the-curriculum approach, providing a variety of opportunities for practice.” A similar curricular movement, Writing Across the Curriculum (WAC), started about 15 years earlier and has changed the ways in which most college and university courses are designed and taught (McLeod and Maimon 2000). Because of its documented success, many numeracy education scholars have referenced the WAC movement when talking about advancing numeracy education and modeled their programs after strong WAC programs (e.g., AMATYC 2006; Steele and Kilic-Bahi 2008; Lutsky 2008; Madison 2009; Hillyard et al. 2010.) A closer examination of the WAC movement as a model for infusing numeracy into the undergraduate curriculum is warranted because both movements have cross-campus goals seeking to promote an essential literacy as part of a lifelong learning goal that enables citizens to participate in a democratic society.

A search of higher education literature reveals that there are several such “across-the-curriculum” movements (e.g., “information literacy across the curriculum,” “ethics across the curriculum,” “technology across the curriculum,” etc.). However, the WAC movement is the most prevalent and far-reaching. In 2008, 51% of all private and public universities and colleges across the United States had some sort of WAC program (Thais and Porter 2010). It is now considered best practice for any introductory writing course to move beyond a skills course to writing within the context of a theme and for courses across all disciplines to contain some writing component (McLeod and Maimom 2000). Parallel results are certainly worthwhile goals for those invested in numeracy education. It would be exciting, for example, if more than half of universities and colleges had campus-wide numeracy programs.

To make a comparison of WAC and the numeracy education movements, I reviewed two survey studies of WAC programs: one published by McLeod and Shirley in 1988 and a follow up study by Thais and Porter published in 2010. In addition, I analyzed content from the websites for the professional organizations around WAC and Writing Programs¹ and their related professional journals for further evidence to elaborate on the results of the studies. For numeracy

¹ The WAC Clearinghouse (<http://wac.colostate.edu/>) provides resources in conjunction with the *International Network of Writing Across the Curriculum* and the *Council of Writing Program Administrators* hosts a website at <http://wpacouncil.org/>. (These and the other links were last accessed April 19, 2012.)

education resources, I looked at the articles in this journal and other resources listed on the SIGMAA-QL and NNN websites.² Although evidence of writing and numeracy education can be found in a variety of publications (Vacher and Chavez 2008), *Numeracy* and the SIGMAA-QL and NNN websites are the face of collective current practices in both educational reform movements.

This article begins with a history of the WAC and numeracy education movements in order to provide context and insights on their historical similarities. Next, I review the challenges of the WAC movement and argue that similar challenges are also true for numeracy education. Then, I provide a theoretical framework to examine the strategies used by the WAC community to address these challenges. I use this framework to situate the work of numeracy education, including how the numeracy education community has used or could use these strategies to build numeracy education. In the conclusion, I use the evidence from the WAC movement to argue for next steps for numeracy education professionals to build on. Specifically, I propose that the numeracy education community can learn from the scholarship and best practices of the WAC movement.

Historical Comparison of Writing and Numeracy Education Movements

The evolution of the WAC movement is well documented (e.g., Russell 2002; Bazerman et al. 2005.) Writing, like numeracy, has always held some importance in the academy. Most scholars agree that the official Writing Across the Curriculum (WAC) movement began in the early 1970s with meetings of leaders in the National Association of English Teachers (NAET) and British scholars concerned about writing education. The work during the first few years consisted mostly of informal discussions. In 1978, the Council of Writing Program Administrators was founded, and more formal publications of WAC work began to appear in the early 1980s. However, much of this work was done mostly at smaller liberal arts schools such as Dartmouth and Carleton College. As evidence of growth in the movement, there was a seminal debate in 1988 at a NAET meeting where scholars argued whether writing centers should be in or outside the English department. In 1993, the first WAC conference was held, and in 1994 the first WAC journal, *Language and Learning Across the Disciplines*, appeared.

In those 35 years, the WAC movement has grown extensively. A 1987 survey (McLeod and Shirley 1988) reported that 38% of institutions have a WAC program, and in a follow-up survey, Thaiss and Porter (2010) provide a profile for

² The National Numeracy provides resources at: <http://serc.carleton.edu/nnn/index.html>. The Mathematical Association of America's Special Interest Group on Quantitative Literacy (SIGMAA-QL) has information at: <http://sigmaa.maa.org/ql/>.

2008 (Table 1). This marks an overall growth (from 38% to 51%) in WAC programs over the last 20 years. Although Thaiss and Porter caution that some of these programs may be in name only, the growth is still notable. Additionally, there is now a substantial professional network dedicated to the scholarship of WAC, and institutions that have WAC programs were “doing so largely on their own dime” (Thaiss and Porter 2010, 536).

Table 1.
Penetration of WAC Programs by Type of Institution

Type of institution	Count (percentage)
PhD-granting	131 (65%)
MA/MA-granting	128 (55%)
BA/BS-granting	191 (60%)
Community college	92 (33%)

As work around WAC evolved, many strands have emerged. Most notably are the “Writing to Learn” (WTL) and “Writing in the Disciplines” (WID) movements. Both make important distinctions in their agendas about the importance of writing in the college curriculum and will be discussed more fully below. Recently, other strands such as “Communication Across the Curriculum” have emerged to embrace writing, presentation, and other forms of communication in the pedagogies. Although there are important distinctions in these movements, my study includes them under the umbrella of WAC so that general comparisons of writing and numeracy education can be made.

Historical perspectives of the development of numeracy in undergraduate education have been provided by Sons (2006) and Madison and Steen (2008b). This education reform movement had beginnings with a plethora of persuasive publications and activities appearing in the late 1980’s including the release of policy reports such as *Everybody Counts* (National Research Council 1989), the publication of popular books such as *Innumeracy* (Paulos 1988), and the forming of a Quantitative Literacy Committee by the Mathematical Association of America. In 1994, the NSF awarded “Mathematical Sciences and their Applications Throughout the Curriculum” (MATC) grants. As work began on these grants, the movement gained strength with the publication of the seminal compendium, *Mathematics and Democracy* (Steen 2001). The professional organizations of the National Numeracy Network (NNN) and SIGMAA QL were founded in 2004, and *Numeracy*, the NNN’s professional journal to support scholarship in numeracy education, published its first volume in 2008.

It is worth noting that both the WAC and numeracy education movements began with local academic conversations and then gained initial growth with administrative and political support as part of public outcries for improved literacy education. The WAC movement received public attention after publication of “Why Johnny Can’t Write” (1975), while the numeracy movement gained strength from publication of *Everybody Counts* (National Research Council 1989). Although work towards developing these literacies existed before these publications, momentum for these movements has often been seen as a

response to social factors such as changing educational demographics, increased demand for and access to higher education, and test scores.

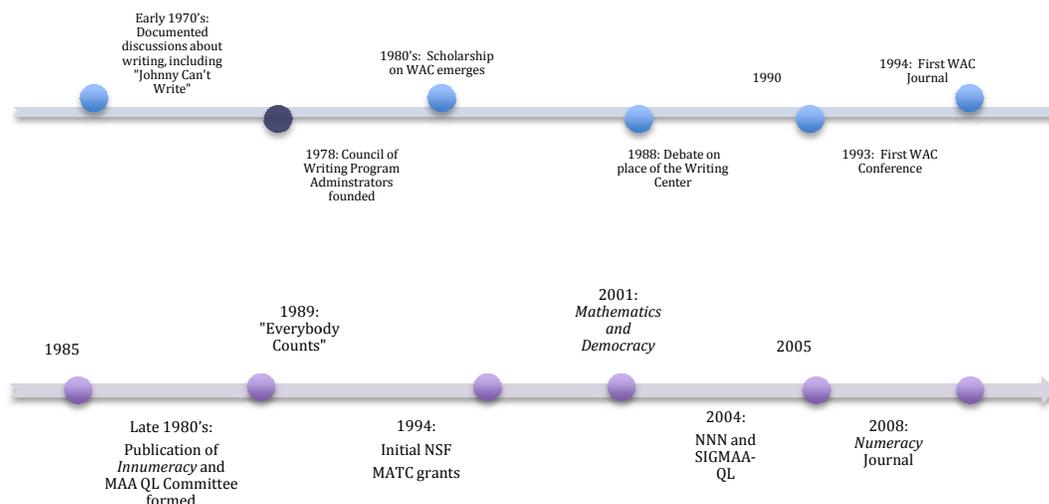


Figure 1. Brief timelines for WAC and numeracy education.

Timelines of the movements (Fig. 1) reveal how the nature and development of the two movements are similar. Both swell from cross-disciplinary and national concerns about higher education. Reviewing the timelines side-by-side makes it clear that both the WAC and numeracy education movements follow a similar trajectory moving from local conversations and seminal publications into professional organizations and scholarship opportunities. Strikingly, numeracy has maintained its 15-year lag time as noted from beginning documented publications to the emergence of a journal for scholarly work. Although the order of events between the beginning conversations and the journal vary, the important pieces such as development of professional organizations and significant seminal publications are evident in both timelines. This similarity provides further evidence of important aspects of literacy movements in general and, more specifically, that the numeracy education community can look to the WAC community for lessons learned.

Challenges of Across-the-Curriculum Movements

Many WAC Scholars have documented the challenges that WAC Programs have faced in their implementation (e.g., Fulwiler and Young 1990; McLeod and Maimon 2000; Townsend 2008; Walvoord 1996.) Below, I categorize their findings into the following challenges:

- *Institutional buy-in.* Across-the-curriculum movements can be expensive and hard to document in their effectiveness. These issues can make obtaining widespread institutional support difficult. But, without such support, the across-the-curriculum goals cannot be fully realized.
- *Assessment.* Assessing the impact of a writing program can be difficult as the results of such work are often found outside of the classroom, in other classrooms, or at some later time. Evaluation is complicated because of the complexity of such programs.
- *Orthodoxy of English departments.* Writing programs are often thought of as developing basic skills and literacy, something outside the role of the English department. English departments often do not want to be responsible for developing writing skills, especially in other disciplines.
- *Writing seen as a pre-college level skill.* Beyond the English department, other faculty members believe it is not their job to teach writing because college-ready students should already be equipped with these skills.
- *Recognition of scholarship.* Research on writing pedagogies is often not valued by traditional reward systems. If work in WAC scholarship does not count in promotion and tenure evaluations, it is difficult to convince faculty to do this valuable work.
- *Grading workload.* Providing adequate feedback to students on their writing is time consuming and unsustainable, especially with large class sizes.
- *Student resistance.* Writing is more work for the students, too. They often resist doing an “extra” writing assignment in lieu of a multiple-choice exam.
- *External Funding.* Writing programs are seen as institutionalized, often making it hard to obtain external funding for faculty development and writing-support centers.

Similar challenges are familiar to those involved with numeracy education at their institutions, and many are documented in the numeracy education literature. In this journal, for example, there are documented challenges with assessment (Taylor 2009), establishing a quantitative reasoning support center (Kaarali et al. 2010), building a scientific research base in quantitative literacy education (Scheaffer 2008), and changing faculty and student attitudes (Madison and Steen 2009).

Some of these challenges in both movements such as institutional buy-in, assessment, and grading workload reflect constraints on funding and faculty time. Other challenges such as student resistance, disciplinary orthodoxy, and pre-college level skills are based on cultural and academic norms. Some might argue that the cultural and academic norms around writing and mathematics are different. Both, however, are considered essential literacies. Furthermore, judging from my own experience, students resist doing extensive writing outside of English courses as much as they resist doing extensive quantitative reasoning

outside of mathematics courses. While there may be differences in how the norms are played out, I believe the underlying challenges remain the same in both literacy education movements.

Below I provide an analytical framework for the strategies the WAC community of scholars has used to address the above challenges. Then, in the following section, I will apply this framework in a parallel analysis of how the numeracy community has used these strategies or might consider applying these ideas to expand the pervasiveness of numeracy education programs.

Strategies for Growth and Sustainability of WAC

After reviewing the WAC literature, I identified four strategic areas that appear to have contributed to WAC's success in addressing challenges and continuing growth: (1) a paradigm shift in thinking about writing pedagogy; (2) a focus on campus-level faculty and student support structures and resources; (3) development of extensive, external professional support systems; and (4) thoughtful framing of writing curricula within social and political contexts. I contend that these provide a framework of analysis of the WAC movement that can then be used as a tool to analyze the numeracy education movement.

Paradigm Shift in Writing Pedagogy

The WAC literature cites at least four important shifts in thinking about writing pedagogy: understanding that writing is important to critical thinking; recognizing that writing varies across disciplines; redesigning entry-level composition courses; and insisting that writing must be done across the curriculum.

Writing to learn. One of the most important themes in the WAC literature is the idea of a curriculum moving from an essential *learning to write* goal to a more prominent *writing to learn* goal. As discussed above, the writing movement evolved from public outcries to address an essential literacy and was seen as a way to develop and strengthen writing skills. Those who purposefully integrated writing into their courses soon realized that these assignments deepened students' understanding of the material and critical thinking abilities as well. Bean (1996, p. 3) elaborates, "writing is both a process of doing critical thinking and a product communicating the results of critical thinking." Further, from Griffen's review of WAC programs (Griffen 1985, p. 401),

To write is to learn.... This concept... is the one that captures the imaginations of most of the faculty who attend our workshops. They enter skeptically, hoping that they will learn a little about how to improve their students' writing without having their own inadequacies demonstrated too blatantly. But before long, they discover that we are really talking about a new way of teaching and learning, in which students listen less and learn more ... exciting for participants is the *concept of writing as learning*. As they

themselves keep journals and practice their own assignments during workshops, teachers of art history, sociology, biology, and urban studies begin to realize that writing need not be an added burden to their teaching; rather, because it requires students to actively work with data and concepts, it may be the most valuable learning tool they have.

Similarly, Kuh et al. (2005, 185) corroborate faculty insight with student success: “Writing across the curriculum encourages interdisciplinary efforts and challenges students to think critically and holistically about their assignments.” The power of effective writing assignments has also been seen in mathematics courses. David Bressoud (2005) describes that “writing mathematics is one of the most effective tools I have found for forcing students to think about mathematics and for helping me to understand how they think about it.” So prevalent is this idea in the WAC literature that the “writing to learn” (WTL) effort is often seen as its own movement. As illustrated above, this framing of WAC as an opportunity for students to deepen their understandings of the course content is a successful strategy for getting faculty to participate in WAC programs.

Writing in the disciplines. As prevalent in the WAC literature as WTL, “Writing in the Disciplines” (or simply WID) emphasizes the importance of understanding that writing assignments vary across disciplines and courses. According to Townsend (2008, p. 54), “If there is one single principle that applies to all WAC teaching, it is that the writing assignments (whatever form they take) must reinforce course learning goals.” A WAC Clearinghouse resource guide³ further explains that students need “practice with the language conventions of a discipline as well as with specific formats typical of a given discipline. For example, the engineering lab report includes much different information in a quite different format from the annual business report.” Understanding these disciplinary contexts for writing can also help in faculty development.

Examples of both WTL and WID assignments can easily be found. Almost every discipline has a “Writing in XX” handbook available. For example, the Mathematical Association of America bookstore has at least four books dedicated to integrating writing assignments into undergraduate mathematics courses.⁴ In addition, the WAC community has published a number of general-purpose books for faculty in all disciplines in integrating writing assignments (e.g., Bean 1996; Segall and Smart 2005; Gottschalk and Hjortshoj 2004.) These handbooks speak to using writing as a way to engage students in the thinking about the subject matter. There appears to be ample materials provided by the WAC community for faculty to easily integrate engaging and successful writing assignments in their disciplinary courses that elicit critical thinking, and these tools further facilitate the role of faculty in participating and engaging with WAC programs.

³ <http://wac.colostate.edu/intro/pop2e.cfm>.

⁴ <https://www.maa.org/ebusppro/Bookstore/ProductListing/tabid/171/category/MW/Default.aspx>

First-year writing courses. Another important way in which the writing movement has contributed to a paradigm shift in writing pedagogy is in the way introductory composition courses, required of most students, are taught. McLeod and Maimon (2000, p. 581) write, “To have a coherent writing program for the student, WAC needs to begin at the beginning. First-year composition courses that introduce students to ‘academic discourse’ in its finest sense – the genre of writing that sets forth a thesis or hypothesis and marshals evidence to support it – are now familiar.” Sutton (1997) further argues that including authentic assignments in the first-year course are important not only for students’ future academic career but also for their professional life. He notes that many students who take the composition course may not complete college. So this course may be the most important course students take to improve their writing and critical thinking. Indeed, starting writing at the beginning facilitates students’ participation in WAC as they progress through their academic careers because this expectation is set early on.

Writing across the curriculum. The work done in the first writing course is not enough. An important step in the WAC movement has been communicating that writing *must* be across the curriculum. Former Harvard University president Derek Bok (2006, p. 98) reflects “good writing—like critical thinking—will never be a skill that students can achieve or retain through a single course ... sustained improvement will require repeated practice.” Griffin’s (1985) study on WAC programs confirmed that successful WAC programs were based on the premise that writing skills must be “practiced and reinforced throughout the curriculum.” This study goes on to confirm that such work is successfully accomplished when “the responsibility for the quality of student writing is university-wide” (Griffin 1985, p. 402-3). Often included in these models is the requirement of an upper-division writing-intensive course taught outside of the English department. Thaiss and Porter (2010) report that 58% of WAC programs have this requirement. Such an across-the-curriculum approach lessens the burden on individual faculty members because no one person is responsible for all writing instruction. Furthermore, student attitudes about writing can change when they see writing in multiple courses.

Campus-level Faculty and Student Support for Writing

As illustrated above, new curricula mean that faculty development is key to a successful WAC program. Faculty members need a safe place to develop assignments and try them out. In fact, WAC scholars agree that faculty development is the starting point to a successful WAC program (McLeod and Maimon 2000). Not only do faculty need assistance with developing assignments, but also with changing how they teach and evaluate new active-learning pedagogies. Faculty development can include seminars, individual meetings,

regular gatherings, in-house publications, and collaborative research projects. However, the “heart” of WAC faculty development is faculty workshops. In 2008, 78% of all WAC programs reported supporting faculty development through workshops (Thaiss and Porter 2010). The WAC literature is clear that such work “cannot be forced; faculty are independent agents with their own agendas. Faculty attend WAC workshops because they want to improve their teaching, because they want to help their students. ... They come voluntarily for practical guidance and help” (McLeod and Maimon 2000, p. 578).

To make this happen at the campus level, someone needs to be responsible for the WAC Program. Duties of the WAC campus leaders vary, but often include overseeing student support, working with administration on funding, and coordinating faculty development activities around WAC. So important is this position to many institutions, that 75% of WAC directors have tenure-line appointments, and more than half report directly to an academic vice president, dean, or college head (Thaiss and Porter 2010).

Successful WAC programs often collaborate with a student support center. McLeod and Maimon (2000, p. 581) explain: “A writing center is crucial. Students need audiences other than their peers in the classroom or their teacher to respond to their writing, and faculty need the assurance that when they assign writing in their classes, there will be a place on campus where knowledgeable tutors can respond to drafts of their students' writing.” Although not all WAC programs collaborate with the campus Writing Center, Thaiss and Porter’s (2010) study reports that 70% of WAC programs are connected to the university Writing Center in some way.

Successful WAC leaders are also cognizant of assessment. In addition to helping faculty assess writing assignments, they also conduct campus-wide assessment of student writing as well as assessment of the writing program itself. Thaiss and Porter (2010) found that 41% of WAC programs took part in ongoing formal assessment. As seems to be a recurring theme, WAC professionals write about their work and have provided multiple resources on writing assessment (e.g., Yancey and Huot 1997; 2009 special issue of the journal *Across the Disciplines*.)

Funding for WAC programs comes largely from internal resources. Only 7% of WAC programs report funding from an external foundation or private donor. Because WAC programs may be seen as less important than academic departments, budgets for these programs may be at risk in difficult economic times or with changes in leadership. Thaiss and Porter (2010) concluded their analysis of WAC programs by looking into the sustainability of such programs and note that the academic rank of the WAC program leader, effective faculty development workshops, presence of upper-division writing-intensive course in

the disciplines, and collaboration with other campus services are key features of long standing WAC programs.

Professional Networks and Scholarship Around WAC

The WAC community has an extensive professional network. There are at least two international professional organizations (Council of Writing Program Administrators and International WAC Network) and three journals dedicated to WAC.⁵ Not only do these mechanisms build a community of scholars to support each other in their work, but also “conference presentations and refereed publications by WAC personnel and WAC instructors can positively impact WAC program credibility, especially at research-oriented institutions. ... Administrators take note when WAC programs contribute new knowledge to the field” (Townsend 2008, p. 56). Currently, the WAC Clearinghouse reports that more than 2000 individuals have created accounts on their website.⁶

Clearly, WAC is considered a field of study within Rhetoric and Composition. There are at least 50 theses and dissertations related to WAC.⁷ Not only are graduate students getting degrees in WAC, but faculty members are increasingly recognized in tenure and promotion for their WAC scholarship. This scholarship utilizes a large variety of methodologies. My review of recent articles from the last five years of the WAC journals revealed myriad research methodologies including large-scale surveys of students and faculty, focus groups, interviews, discourse analysis, content analysis, and purposeful case studies that reviewed student work and followed students from one course to the next. Indeed, WAC efforts are being recognized as an important academic endeavor, and professional, interdisciplinary communities around this work have helped support and solidify this understanding.

Framing WAC within Institutional Movements

Walvoord (1996) emphasizes the importance of framing the WAC movement within other social movements and institutional priorities. She urges WAC programs to work with other organizations, define WAC’s relationship to institutional administration, identify WAC’s relationship to technology, reexamine the meaning of key terms, and deal with assessment. She highlights doing so as an important step because of “the power that [social] movements sometimes have to change individuals, to change a culture” (p. 74). Framing a WAC program around campus priorities can gain institutional and administrative support and ongoing funding for the program.

⁵ <http://wac.colostate.edu/journals/>

⁶ <http://wac.colostate.edu/about/history/cfm>

⁷ <http://wac.colostate.edu/theses/>

Growth and Sustainability of Numeracy Education

In this section, I will use the framework of WAC strategies outlined in the previous section to point out areas in which the numeracy education community has utilized or could apply these strategies for its future growth. Specifically, I will discuss four areas: (1) a paradigm shift in thinking about numeracy pedagogy; (2) a focus on campus-level faculty and student support structures and resources; (3) development of extensive, external professional support systems; and (4) thoughtful framing of numeracy curricula within social and political contexts.

Paradigm Shift in Numeracy Pedagogy

I investigated four important ideas in numeracy pedagogy that parallel those of the paradigm shift in writing pedagogy represented by WAC. They are: understanding that numeracy is important to critical thinking (in WAC: writing to learn); recognizing that numeracy education varies across disciplines (WAC: writing in the disciplines); redesigning entry-level mathematics courses (WAC: first-year writing courses); and insisting that numeracy must be done across the curriculum (WAC: writing across the curriculum).

Numeracy Leads to Critical Thinking. The final sentence of *Mathematics and Democracy* suggests the possibility of a parallel WTL shift for numeracy education: “Like writing, numeracy must permeate the curriculum. When it does, also like writing, it will enhance students’ understanding of all subjects and their capacity to lead informed lives” (Steen 2001, 115). However, this shift has not been fully examined in the literature around numeracy education. We need to make an explicit move to the idea that numeracy education “requires students to actively work with data and concepts” and thereby encourages deeper thinking about the subject matter.

It is exciting to note that there is growing documentation that, indeed, those with higher numeracy skills make better decisions (Lipkus and Peters 2009). We need to use this research to begin documenting whether and how students’ thinking, decision making, and disciplinary knowledge increase when numeracy learning experiences are effectively integrated into a college classroom. Making this shift from *learning to be quantitatively literate* to *quantitative literacy increases learning* would be helpful in convincing faculty and administrators of the importance of numeracy across the curriculum.

Numeracy is Context Dependent. Vacher and Lardner (2011) provide evidence that numeracy skills vary across disciplines. Further, examples of integrating numeracy assignments into college-level, discipline-specific

classrooms are growing. Websites such as Dartmouth's Electronic Bookshelf,⁸ Math Across the Community College Curriculum,⁹ Sensor,¹⁰ and SERC¹¹ have compiled collections of numeracy assignments. The QUIRK¹² program has compiled extensive resources on integrating numeracy into writing assignments, and this journal has at least four articles about specific numeracy assignments in non-math courses. However, the numeracy education resources lack general-purpose handbooks for all faculty members who want to use numeracy to increase thinking as well as more-specific disciplinary guides. Compiled resources that purposefully discuss numeracy tools, their uses across disciplines, and strategies for teaching and assessing numeracy in individual classrooms would be an invaluable guide to college faculty.

First-Year Math Courses. Madison and Steen (2009, p. 6) advocate for a change in introductory mathematics courses stating, "Much of school mathematics and introductory college mathematics is based on techniques and methods and algorithms. It should be based more on reasoning, problem solving, the kinds of processes that are very important in developing quantitative reasoning." There is a growing number of examples of integrating QR into introductory mathematics courses. *A Fresh Start for Collegiate Mathematics: Rethinking the Courses below Calculus* (Hastings 2006) and *Current Practices in Quantitative Literacy* (Gillman 2006) provide examples of precalculus and Quantitative Literacy Courses. Nevertheless, the practice of beginning numeracy at the beginning is not widespread. Efforts such as Carnegie's Quantway¹³ and Statway¹⁴ projects are making strides towards this by infusing numeracy into developmental mathematics courses at community colleges. However, other funded projects see reform in entry-level mathematics and statistics courses as ways to increase cost effectiveness and efficiency of such courses. The numeracy education community has not fully advocated that quantitative reasoning be part of all entry-level courses including quantitative literacy, developmental math courses, algebra, precalculus, first-year calculus, and introductory statistics courses. Practicing the quantitative reasoning "habit of mind" early on will be essential for continued growth of undergraduate numeracy education programs.

Numeracy Across the Curriculum. The numeracy education community has also recognized the need for this work to be outside of the mathematics department, and models of numeracy education across the curriculum have been

⁸ <http://www.math.dartmouth.edu/~mqed/index.php>

⁹ <http://www.mac3.amatyc.org/>

¹⁰ <http://www.sencer.net/>

¹¹ <http://serc.carleton.edu/index.html>

¹² <http://serc.carleton.edu/quirk/>

¹³ <http://www.carnegiefoundation.org/quantway>

¹⁴ <http://www.carnegiefoundation.org/statway>

built. In 1995, NSF MATC awards initiated substantial movement toward numeracy across the curriculum. One participating institution, Dartmouth College, created sixteen new courses, modified thirteen others and developed an extensive evaluation procedure to assess student attitudes toward and achievements in mathematics. Dartmouth's program continues to thrive, owing largely to its campus-wide advisory board (Korey 1999). Building on that work, Hollins University adopted an across-the-curriculum model by creating two requirements: the Basic Quantitative Reasoning Requirement (q) and the Applied Quantitative Reasoning Requirement (Q). The "small q" provides students with basic skills in and understanding of mathematics and statistics reasoning, while the "big Q" integrates QR into disciplinary courses outside mathematics and statistics and enables students to apply those skills (Diefenderfer et al. 2004). More examples of numeracy across the curriculum have been published in *Numeracy*. Lists have been published in Gillman's book (2006) and the introductory article by Madison and Steen (2008b). These lists could be updated and additional examples of numeracy programs should be documented.

Campus-level Faculty and Student Support for Numeracy Education

Faculty development is something the numeracy education professionals have done well. Campus programs such as those at Hollins University (Diefenderfer et al. 2004) and Dartmouth College (Korey 1999) as well as national programs such as "Math Across the Community College Curriculum" (Hillyard et al. 2010) and "Spreadsheets across the curriculum" (Vacher and Lardner 2010) provide evidence of the effectiveness of faculty workshops. Given this support, many faculty members have created and assessed numeracy curriculum. To date, most of these faculty development projects have been the result of external funding. Just as the WAC community found, successful professional development around numeracy education comes when faculty are given the time and skills to think through meaningful ways to infuse numeracy into their existing curriculum (Hillyard et al. 2010). The numeracy education community needs to document the good work done and support additional, on-going faculty development activities at the campus level.

Numeracy scholars have made significant headway on QL assessment. For example, in this journal, Taylor (2009) provides an overview of some of the well-developed measures for quantitative literacy assessment, and Sundre and Thelk (2010) discuss the technicalities and importance in aligning QR assessment with learning goals. These are just two of the many examples in QR assessment. Continued work in the area of numeracy assessment should be supported.

Evidence of campus-level numeracy program leaders and student support of numeracy education is rare. Although Shield's (2010) study cites that 68% of

colleges surveyed have a “quantitative support center,” there is little evidence that these centers are more than a math tutoring center and part of a campus-wide numeracy education plan. Wellesley, Trinity College, University of Washington Bothell, and Hollins have reported the importance of faculty leaders and support centers,¹⁵ and Karaali et al. (2010) discuss their process for building such quantitative reasoning support center at Pomona College. These accounts underscore the need for someone to be responsible for campus-wide quantitative reasoning goals as well as the need for solid peer-tutoring support for numeracy education. An examination of effective campus leaders and support centers would be a welcome addition to the numeracy education literature.

Professional Networks and Scholarship Around Numeracy

The numeracy education community has two national professional organizations, the National Numeracy Network (NNN) and the Mathematical Association of America’s Special Interest Group on Quantitative Literacy (SIGMAA-QL), and there is at least one regional organization, the Northeast Consortium on Quantitative Literacy (NEQL). We also have the *Numeracy* journal as a place to document our scholarship in this area. While important, these groups are still small. Further, our scholarship around numeracy education could include more diverse research methods. We can and should look to the WAC literature for examples of research studies and methodologies that could be adapted to our work.

Although Gaze discusses the creation of a Masters in Numeracy program, he laments, “the future of the program is in doubt” (2010, p. 2). Similarly, a recent query on the SIGMAA-QL listserv about the idea of a numeracy minor received responses such as “never thought of that” and “these are basic skills, why would we award a degree in QL?” Clearly, there are still voices from within the numeracy education community that do not recognize this work as a field of study. Yet, Vacher and Chavez (2008) found that the scholarship in numeracy is extensive. We should make an effort to compile reference lists of these key studies as well as a list of dissertations from research in numeracy education as a next step towards national recognition of this work as a field of study. While numeracy education as a field of study in mathematics education may be controversial, it is feasible to build a community of interdisciplinary scholars around numeracy education, using a variety of research methodologies to create knowledge of best practices in numeracy education.

Framing Numeracy within Institutional Movements

Framing numeracy education within institutional goals and priorities is an

¹⁵ For a slide presentation from the 2008 MathFest panel, The Role of Quantitative Literacy Centers in Supporting Students and Faculty, see <http://sigmaa.maa.org/ql/meetings.php>.

important need for the numeracy education community as well. The NNN has moved in this direction by holding meetings in conjunction with other professional societies. At the campus level, Grawe and Rutz (2009) note that part of the success of Carleton's QUIRK program came from aligning their efforts with the campus writing program. Kennedy (2001, p. 55) notes, "While the sciences, arts, and social studies slug it out, English and mathematics remain seemingly above the fray. ... These are the only subjects that most students take every year. Nobody, apparently, dares to suggest that the need for knowledge in either of these classic disciplines will decrease in the future." We need to use this advantage to promote our work locally and nationally. With similar historical trajectories and challenges, numeracy education has many of the same components of WAC. It may make sense conceptually and fiscally to collaborate with successful WAC programs already established on a campus whenever possible.

Conclusion

Lutsky (2008, p. 65) notes, "There are reasons why it has proven much more difficult to forge quantitative literacy across the curriculum initiatives than writing across the curriculum ones." However, the framework developed in this paper shows there are similarities in the numeracy education and writing across-the-curriculum movements. Given the prevalence of WAC and its 15-year lead, the numeracy education community can learn from the WAC experience. In particular, the comparisons outlined in this paper lead me to suggest the following for the numeracy education movement:

- Document that numeracy education increases students' critical thinking and decision-making skills. The change in thinking about the place of writing has been essential for WAC programs to engage faculty members. A similar paradigm shift about the role of numeracy education in helping people make better decisions would be an important step for future growth.
- Compile electronic or hard-copy handbooks for faculty that provide concrete ideas in integrating numeracy education including activities that work across and within disciplines.
- Expand our research methodologies and resulting research publications so that numeracy education can be seen as its own area of study. Recognizing and promoting WAC as an area of study with a community of scholars is essential for supporting that community. Similarly, the numeracy community needs to do the research and document its findings for long-term growth and sustainability of numeracy education.

- Work deliberately with math departments and funding agencies to integrate numeracy more explicitly in high-volume, entry-level mathematics courses. Just as with writing, we must start this habit of mind at the beginning. This can also lessen student resistance to numeracy when they find it integrated in coursework of other academic disciplines, as expectations are set early.
- Continue to support models of cross-campus programs that include a center for faculty and student support that is led by a numeracy education professional. Additionally, campus programs should link to other academic support programs and work within campus goals and priorities. A successful program will support faculty work across the curriculum as well as garner institutional buy-in.

If the numeracy community wants to duplicate the WAC trajectory and have more than half of the universities and colleges recognizing campus-wide programs in numeracy in 15 years, then we have more work to do. The WAC literature provides multiple insights on how to move our work forward. We should look to this work and collaborate with WAC scholars locally and nationally to find models that work for us.

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