More Complicated Than It Seems

A Review of Literature about Adult Numeracy Instruction

© Kate Nonesuch

Malaspina University-College
Cowichan Campus

December 2006

Acknowledgements

Thanks to members of RiPAL BC, especially to Suzanne Smythe for help with getting started and getting finished with this project.

Thanks to Bonnie Soroke, Evelyn Battell and Vicki Noonan for talking and reading with me.

I appreciate the financial support provided by the National Office of Literacy and Learning (NOLL), Human Resources and Social Development Canada.

Introduction

> I see teachers in one corner basing their decisions on what others in their programs have done and relying on trial and error to address basically the same questions I faced in the early 1970s. … And, in the researchers' world, it is more than obvious that few of the research-based publications from our "ivory towers" reach the hands of teachers or tutors. Even when they do, it often seems that researchers do not have the appropriate answers for the pressing and immediate questions of practitioners or governments (Quigley, p.3).

Although Allan Quigley says he is more optimistic now about the relationships between researchers, governments responsible for policy around literacy, and teachers and tutors, he paints a picture of recent history that I recognize, from a teacher's perspective. It was in the spirit of trying to connnect myself and other practioners with research that I began, in 2005, a project funded by the National Office of Literacy and Learning (NOLL), Human Resources and Social Development Canada. The question I attempted to answer through my work on this project was "How can ABE math instructors in BC apply research findings to their practice?" While the question was big, and each of its many parts was big, it came from a personal question: How can I apply research findings to my own teaching practice?

For more than 15 years, I have been teaching math as part of the Adult Basic Education (ABE) program at Malaspina University-College, at the Cowichan Campus in Duncan, BC. Mainly I have taught at the fundamentals level[1], with occasional forays into introductory algebra. During that time, and based on previous teaching experience, I tried many different methods and texts in my attempt to teach so that students would understand math and, I hoped, learn to like it. During that period, being too busy teaching, I didn't have time to search systematically for relevant research material, and it wasn't until the recent explosion of material online that searching from a remote location became at all feasible. Hence, when I received funding for this project, I welcomed the luxury of spending time away from the classroom, to read, think, talk, and write about teaching math.

This review is meant for adult numeracy practitioners, and, as such, will concentrate on topics related to instructional methods, and will not take up issues such as general educational policy or program administration, frameworks, and curriculum. While these latter issues have a huge impact on the work of the numeracy instructor, they are largely "givens" in the work and life of practitioners, and as such beyond the scope of this review.

By "numeracy instruction" I mean instruction in those areas of math covered by the Fundamentals and part of the Intermediate scale in the BC Articulation agreement, or,

---

[1] "Fundamental" and "Intermediate" are the names given to the first levels in Adult Basic Education programs in BC. In the area of math, they cover such topics as operations with whole numbers, fractions, decimals, per cents, and area, perimeter and volume of two- and three- dimensional shapes, and reading and constructing charts and graphs.

more generally, the math needed for daily life as a consumer or a worker: operations with whole numbers, fractions, decimals and per cents; measurement of time, length, area and volume; and reading charts and graphs.

Situating myself

My experiences both as a student and as a teacher of numeracy, as well as my teaching philosophy, have shaped the interpretations I bring to this review of approaches to numeracy instruction. I went to school for 12 years in a system that taught math concepts abstractly, with little connection to real life, where most students were expected to learn, by rote, algorithms that they didn't understand. Fortunately, I did understand the concepts, and the abstract approach suited my style. Indeed, I grew to love math for the beauty of number patterns and the elegance of mathematical reasoning. I did not, however, have any idea of the difficulties many of my fellow elementary and high school students faced until I began teaching math in ABE. There I met them, all grown up. I began to teach them, not by tying math to their own experience, but by trying to make the abstract more concrete, as I describe in an article on working with student resistance to using math manipulatives (Nonesuch, 2005b).

As an instructor of both numeracy and literacy, I believe that a mindfulness about the power relationship between teacher and student, a willingness to share power, and a sense that the locus of control of learning is best situated with the student, all combine to make a fruitful learning experience and a teaching experience that has more joy than frustration, and where both teaching and learning result in more satisfaction than guilt or resentment. My experience as an instructor has been nearly all in ABE programs in the community college system, rather than in the school district system, or in workplace education or in the not-for-profit sector.

After my experience with writing/refusing to write a literature review in a previous research project (Niks, Allen, Davies, McRae and Nonesuch, 2003), I came to writing this review with mixed feelings. I am not an academic (I have a BA [Hons English]), and the research literature was foreign territory to me. Some pieces I gave up on because I could not understand the language of post-structuralist analysis or psychological or sociological or statistical jargon. Because I was unfamiliar with the literature, I found it difficult to follow when one academic situated him/herself in the discussion by minute comparisons of definitions or philosophies of other academics, although as I read more and more, I came to have a nodding acquaintance with some of them. Nonetheless, I found the process of reading the literature interesting, especially research that was based on first-hand teaching experience, where I could use my own experience and my contact with other instructors as a touchstone, rather than having to rely on other things I had read.

However, it is with trepidation I offer this literature review to the world. I know I have been truthful here: I have not deliberately refused to consider anything I found, and I have been clear that I am using my knowledge and experience of some 20 years of teaching as a basis for my interpretations of what I read. Nonetheless, I am aware of my lack of formal training in doing research, in reading research, and my lack of familiarity with the research in the numeracy field; perhaps, like Samuel Johnson's dog that walked on his hind legs, the wonder is not that I do it badly, but that I do it at all.

My Reading

I found many studies to support the idea that the research on numeracy instruction for adults is so lacking or flawed that it is impossible to say what is effective practice; nonetheless, many academics and instructors have written extensively about principles and strategies and best practices, and I found substantial agreement that teaching for understanding rather than memory is the best approach, with many strategies for implementing that approach. My own experience, however, tells me that in BC, at least, math is not generally taught using such principles of effective practice, and indeed, I found some studies that echo my experience. When I consulted with about 100 practitioners in BC early this year (Nonesuch, forthcoming, Chapter 1) I found that nearly all of them had heard of most of the principles and strategies supported by the literature, so it was not a lack of knowledge that prevented them from applying the recommended procedures in their practice. I searched out some answers to this conundrum, what makes it difficult to apply recommended principles and strategies to numeracy instruction? What complications are behind those statements of best practice that seem so straightforward? What revolutions in thought and attitude would be necessary to implement strategies that seem as safe and as conservative as many of those put forth by established writers? The answers I found make up the bulk of this review.

Not enough research to identify effective numeracy practice

As a neophyte in reading the literature, I approached it in a haphazard way—many library and other database searches, reading things as I found them, or as they came in on interlibrary loan, and reading on much too broad a scale for my purposes; later, of course, I got a little more systematic. In those early days, I found much interesting material before I came upon my first literature review done by a professional researcher, Diana Coben (2003), for the United Kingdom's National Research and Development Centre for Adult Literacy and Numeracy. Coben says that "Adult numeracy is fast-developing but under-researched, under-theorized and under-developed," (p. 117) and that "Evidence on the impact of numeracy tuition is sparse and unreliable" (p. 118). She goes on to say that much of the research is qualitative, with a broad range of research methodologies.

In other countries, too, the research is scarce and often done with small groups of teachers and students, without control groups. Carole Torgerson, Jill Porthouse and Greg Brooks (2005) reviewed results of randomized controlled trials (RCT's) that evaluated teaching strategies and pedagogies in adult literacy and numeracy. They concluded that:

> There is a dearth of rigorous RCT's in the field of adult literacy and numeracy. The evidence is suggestive of a benefit of adult literacy and numeracy interventions; however, because of the heterogeneity of studies, the precise role of any intervention is uncertain and this finding may be undermined by the presence of substantial publication bias (executive summary).

John Benseman (2003) in New Zealand reviews the little research in adult literacy done there, and finds that numeracy is an area "largely ignored" by researchers (p.12). In Canada as well, a search for studies that measured the efficacy of particular strategies or pedagogies yielded nothing, although there were many reports of current practice, which I will discuss in the next section.

Effective practice identified

The call for RCT research by Torgerson *et al* (2005) notwithstanding, many practitioners and academics have written about effective numeracy instruction, and there are several organizations that have come together to study and improve numeracy instruction to adults, such as ALM (Adults Learning Mathematics) ANN (Adult Numeracy Network) and ALNARC (Adult Literacy and Numeracy Australian Research Consortium).

Nearly all the literature I read, written since 1990, shows evidence of sharing a constructivist philosophy, based on the premise that learning takes place when a student actively constructs meaning from experience and from previous personal knowledge; the teacher facilitates activities and problem solving through which the student can construct knowledge and understanding. Rita Smilkstein (2002) suggests that that a cycle of learning that encourages students to construct their own knowledge in real, meaningful situations while reducing reliance on drill and worksheets, using student-centred rather than teacher-centred instruction, follows a learning pattern common to all human beings.

Many people have written about the importance of a constructivist approach to teaching numeracy, and examples abound of instructors reflecting on their practice along these lines. I will mention a few here:

Pat Rogers (1991) reported that she successfully changed her teaching practice at the post secondary level. When she began teaching math, she taught as she had been taught, through lectures and assigned practice. However, she began to develop some participatory activities, such as "think-write-pair-share," class dialogue, board work, brainstorming, problem-posing, small group work, and proof generation. Later, as she describes in an article in *Women's Education des femmes*, she was able to do a comparison study in which she taught a section (approximately 60 students) using her participatory methods, while two other sections of the same class were taught by two different lecturers using traditional methods. All three sections took the same final exam. Rogers concludes:

> [S]tudents in my section obtained more A grades overall (27% compared with 22% and 19%) and only 15% of students in my section failed the examination, where 24% and 30% failed in the other two sections. Covering the course content presented no difficulty for me or, judging by their examination success, for the students. Over two-thirds of them participated actively in the course in one way or another and only one student complained of discomfort (p. 41).

John Dingwall (2000), in a discussion paper written for the National Roundtable on Numeracy at Queen's University (Dennery, 2000) discusses some success factors in adult numeracy programs in Canada: connecting math to real life experience, building on previous knowledge of students, and paying attention to math anxiety and other emotional factors. Other authors have similar lists of best practices, for example, Barbara Glass (2001) in *Numbers Talk: A Cross-sector Investigation of Best Practices in LBS Numeracy*, compiles responses about best practices from 32 programs in Ontario.

Respondents cited practices such as encouraging interaction between students, dealing with math anxiety, using manipulatives, relating math to real life experience, and encouraging discussion about math. Lisa Hagedorn, (2001) in *Best Practice and Innovations* from the Ontario Literacy Coalition, has a similar list: deal with math anxiety, ask students to write/talk about math learning, use manipulatives and real materials, and relate math to everyday life.

Iddo Gal has written extensively about adult numeracy and adult numeracy instruction, often with other authors. In a manual written for numeracy practitioners, *Adult Numeracy Instruction: A New Approach* (Gal, Ginsburg, Stoudt, Rethemeyer, & Ebby, 1994), I found a comprehensive and coherent statement of principles, which I used as a basis for further investigation. Although similar principles are found in articles by many authors, the clarity and conciseness of the format given by Gal *et al* bring the principles into sharp focus and allow us to see how any particular practice we might examine lines up with them. I will list their answers to the question "How should we teach math and develop numeracy skills?" which they summarize as an "adopt a 'whole math' approach"(p. 7):

1. Determine what learners already know about a topic before instruction.
2. Address and evaluate attitudes and beliefs regarding both learning math and using math.
3. Develop understanding by providing opportunities to explore mathematical ideas with concrete or visual representations and hands-on activities.
4. Encourage the development and practice of estimation skills.
5. Emphasize the use of "mental math" and the need to connect different mathematical skills and concepts.
6. View computation as a tool for problem solving, not an end in itself; encourage use of multiple solution strategies.
7. Develop learners' calculator skills and foster familiarity with computer technology.
8. Provide opportunities for group work.
9. Link numeracy and literacy instruction by providing opportunities for students to communicate about math.
10. Situate problem-solving tasks within familiar, meaningful, realistic contexts in order to facilitate transfer of learning.
11. Develop learners' skills in interpreting numerical or graphical information appearing within documents and text.
12. Assess a broad range of skills, reasoning processes and dispositions, using diverse methods (Gal *et al*., 1994, p. 2,ff).

Effective practice not implemented

Leo Hutchinson, a Vancouver ABE teacher, declares that most of his students "claim that one of the reasons they do not understand math is because their previous math teacher(s) did not pay attention to them and their need to understand math better"(2000, p.1). These thoughts are echoed by Tom Nesbit (1995) of Simon Fraser University, who says, "the primary contributor (to low mathematical ability in adults) appears to be the poor teaching in school mathematics classrooms" (p.3).

Nesbit made a study of three math classes at the introductory (grade 9) level in a community college in Vancouver, using surveys, interviews and classroom observation. Several key findings emerged:

> (1) Within the classroom, the teacher's role was paramount—almost all decisions about classroom activities were made by teachers, and the learners' influence was minimal; (2) the teacher and the textbooks adopted the role of supreme authorities of mathematical knowledge; (3) adult learners were assigned a passive role in their own education (Nesbit, 1995, abstract).

This kind of teaching is in direct opposition to arguments that talk of the futility of the "banking model" of education, to use the term coined by Paulo Freire (1970). In a report prepared for the Ontario College Sector Committee for Adult Upgrading, two "best practices" of primary importance are cited: "the development and reinforcement of the learner's control of his/her own learning" and "a shared power relationship in the classroom that contributes to self-esteem and self-confidence"("Best practices in managing the classroom to improve student commitment", no date, p.7).

Nesbit (1996) describes the factors that influence teachers to teach using the banking model: first, the pervasive view of math as a formal system unto itself, so that everyday math is not "real math," and real math is so abstract that it cannot be experienced; second, institutional emphasis on outcomes, competition and exams that make it clear to the student that these are the only valid criteria to measure learning, rather than some other, more personal or more relevant criteria.

Mary Jane Schmitt challenges the use of workbooks in adult numeracy instruction, although they are widely used in ABE programs. In BC, especially where small class sizes or continuous intake means that content is delivered in a self-paced model, often the workbook or textbook is the only method of instruction. Schmitt points out that the workbooks' focus on isolated instances of standard computations means that "success in the adult education math class is defined as the ability to follow successfully a sequence of rule-based instructions that can be matched to one-step or two-step word problems" (Schmitt, 2006, p. 1).

Judy Perry, from *Beat the Street*, a Toronto literacy program, was a participant in a workshop given by Tom Ciancone, Flora Hood, and Joy Lehmann, where she gained some insight into her assumptions about teaching math:

> One thing that struck me during the workshop was the way that I teach numeracy training to new tutors. When I teach them how to teach reading and writing, I emphasize the pre-, during, and post-reading/writing activities that we, as competent readers, do unconsciously. I emphasize all the things the learner brings to the text, how to teach the learner to interact with the text as they read. Yet, I don't think about that when I'm teaching

> numeracy! It's just math—I teach the formulae and the learner practices the skill ("Beyond worksheets: Making math meaningful", 2005, p.12).

Charles Brover, Denise Deagan, and Solange Farina (2000) discuss a similar finding amongst teachers taking part in the meetings of the New York City Math Enquiry Group (MEG). Teachers who taught English language literacy by taking into account learners' backgrounds, and who tried to provide meaningful opportunities to learn reading and writing, nonetheless taught math by "abstract and alienating computational drills" (p. 3). After participating in MEG's meetings and discussions, which focus on doing math problems and discussing the implications for math instruction, "one teacher wrote in her journal: … 'More and more I see that good teaching that applies in BE [Basic Education]'s reading and writing is also true for math'" (p.3).

The authors (Brover et al., 2000) state that that members of the New York City Math Exchange Group have been meeting since the early 90's to do math and to learn "to think about math education in a new way… [W]ithout alternative models of learning math, teachers tended to teach math the way it had been taught to them" (p. 2).

Barriers to implementation of effective practice

When I looked at the list of points by Gal *et al*, above, and others like it, I thought "There is nothing new here—I've been hearing similar things for the past 15 years." At first, I was relieved to find that the literature matched my thinking; I reflected that our problems with math instruction would be easily solved if everyone agreed on the solutions. Then I began to wonder why I had not changed my practice to bring it in line with these ideas, if I had known about them for so long, and why had others not changed their practice? Why didn't I know even one person who was successfully teaching numeracy using those principles? I thought about how hard it is to implement those ideas, and how many times I had tried and failed. Then I began to find some other research and reflection that shed some light on the complexity of those simply stated ideas, and I began to recognize some of the difficulties that get in my way. In preparation for writing my manual for instructors of adult numeracy (Nonesuch, forthcoming), I met with eight groups of practitioners, 90 people in total, and by and large their reactions were the same as mine—nearly all of them had heard of nearly all the strategies on the list, but they encountered many difficulties in putting them into practice.

Gal *et al* (1994) suggest the possibility that many numeracy instructors do not follow these principles, even though they may agree with them, because of a lack of professional development activities to learn how to implement them, which may lead them to fall back on memories of their own math education and follow that pattern semi-automatically, or because of student resistance to these new ideas. I began to ask myself what kind of professional development would make it possible for instructors to successfully adopt these principles. What is at play here? What complexities, what hidden reasons lie at the base of the difficulties instructors face when they try to change their numeracy teaching practice? I began to search for literature that would shed some light on what makes it so hard to implement these strategies, and I will discuss my findings for some of the strategies below, using the language in the points set out by Gal *et al*.

Determine what learners already know about a topic before instruction.
Lisa Hagedorn (2000) surveyed instructors in the Literacy and Basic Skills programs in Ottawa-Carleton school district, and found they recognized many strengths in their students, including estimation, mental calculations, fraction skills used in cooking, and other coping skills, yet students could not transfer these skills to doing calculations or word problems in class. We know that street math is not the same as school math, but both are valid maths. Why is it so difficult to use what students already know to make the connection to more formal math?

Lindenskov and Hansen (2000) may shed some light on students' reception of instructors' attempts to build on prior knowledge. They report that they found three groups in the adult numeracy classes they looked at: first, a group that had no methods for figuring out particular kinds of problems, and wanted the teacher to give them a method; a second group who had their own methods and who weren't interested in learning new ones; and a third group who had some methods of their own, but who were interested in other methods, and whose practice changed or expanded over the course of the class. If such diverse attitudes are found in other ABE classes, it is difficult to imagine what classroom practices would make it possible for all of them to make a connection between prior knowledge and new knowledge.

Lindenskov and Hansen have more to say about the process of students adopting new knowledge, and adapting their habitual ways of doing math. One of their students decided to continue to use a method learned in class for figuring percents after a better-educated colleague at work confirmed that her "new" method was commonly used at that workplace. "For us it is obvious that the social reaction to new methods from education is overwhelmingly influential, e.g., as to whether the adults will remember, appreciate, and use new methods and knowledge or not" (Lindenskov & Hansen, 2000, p.5). Although I did not find any other published support for this conclusion, one of my colleagues confirmed it by saying that her students were unlikely to adopt her (more efficient) methods for doing calculations if they were different from methods used by friends and family who helped with homework. "My Auntie does it this way," is a frequent reason her students give for sticking to the old ways. What implications does that conclusion have on classroom practice? Surely, it is a question of more than simply finding out what students know and building a bridge to more standard practice, or to more advanced concepts. Perhaps we need posters of singers and sports heroes announcing that they mentally divide by two instead of using a calculator to find 50% of something!

Address and evaluate attitudes and beliefs regarding both learning math and using math.
Math, far from being soulless, logical, and cold, is a subject fraught with emotions. The emotions do not come from the numbers, but from the people working with the numbers, and people coming back as adults to learn math are people who are often scared and angry, confused and humiliated, unconfident and passive, people, in fact, who hate and fear math. Many theorists say that people who are in the grip of negative emotions cannot deal with learning something new. One of the features of Thomas Gordon's *Teacher Effectiveness Training* (1974), for example, and of Saskatchewan NewStart Life Skills (*Core lessons for life skills programs*, 1994) is that the teacher/coach needs to help the student deal with the emotions, at least for the moment, so that learning can proceed.

Moreover, Rita Smilkstein (1991) says that hormones associated with positive emotions enhance learning while chemicals associated with negative emotions inhibit learning—quite a challenge for the numeracy instructor, not only to deal with the negative emotions, but also to replace them with positive feelings in order to promote learning.

The concept of math anxiety, and strategies for dealing with it, have been around for many years; sometimes it is dealt with in the counsellor's office, sometimes in the classroom, often not at all. Fred Peskoff (2000) reports on a study he did of adult students and their use and evaluation of strategies for dealing with math anxiety. Strategies were designated either as "approach" strategies, which met the problem head-on (such as don't fall behind in homework; ask the instructor; let the instructor know when you don't understand; find extra study/review time), or as avoidance strategies, which helped the student avoid the feelings of anxiety (such as relaxation techniques or leaving the room to alleviate stress). The approach strategies were viewed by all students as more useful than the avoidance strategies, and talking to a counsellor and working with a tutor were seen as least useful of all. However, the students most in need of help were the ones least likely to take effective measures to get it. Low anxiety students tended to use the approach strategies more than high-anxiety students, who more frequently used the approaches seen by all students as less useful. So simply teaching techniques is not enough, if anxiety is preventing students from using the most efficacious strategies for reducing anxiety. The author also suggests that using a tutor may be seen as not useful if the tutor uses different explanations or strategies than those taught by the instructor, and points to the need for tutors and instructors to collaborate.

Bonnie Fortini (2001) decided to use the theory of multiple intelligences to help students deal with math anxiety, and gave each student an MI assessment, talked in class about math anxiety and about MI, and worked with students to develop strategies to deal with anxiety based on their MI strengths. In the second and third semester, she had to cut back on the MI work, but, nonetheless, she reported favourably on the value of MI in helping students overcome math anxiety, and found that her own teaching also changed for the better as she grew more comfortable working with types of intelligences that were different from her own. It is not clear that the MI theory and practice in themselves reduced anxiety, or if simply gaining some control over their learning by understanding themselves more clearly led to a reduction in anxiety and a more positive attitude to learning math.

Develop understanding by providing opportunities to explore mathematical ideas with concrete or visual representations and hands-on activities.

The use of base ten blocks, Cuisenaire rods, and various other concrete models for operations with whole numbers, decimals and common fractions have long been available commercially, and instructors have been making and using their own as well, from beans and paper clips for counting, to playing cards to teach addition and subtraction, to more elaborate materials. Beth Marr (2001) observed that working with real objects (cans and bottles for measuring volume, for example) fostered discussion, made for a livelier classroom, allowed students to bring prior knowledge to engage in new experience, and seemed to activate memory. "The lasting memories appeared stronger than any that the words and diagrams traditionally used on worksheets had provoked, since student's speech in later tasks contained many direct references back to prior visual memories" (p. 218).

Yet the use of manipulatives, which on the surface seems so likely to lead to student success, brings with it unexpected difficulties. The instructor must bring a light touch, a sense of ease with manipulatives and with math concepts, and an ability to deal with students' feelings about using them. Lisa Hagedorn (2004) worked with classroom teachers to make learning materials to suit their students' needs, and to share the materials with other instructors. Their material, as well as a report on their activities, is available online. Hagedorn muses on the process of fitting such activities to a particular class:

> This diplomacy of teaching – when to direct, when to step back, what to control, what to leave alone, how much of a path through an activity to clear for the learner, and when to ask him/her to bushwhack, is fundamental and fascinating (2004, p.21).

In my own teaching, I have found that many students resist using manipulatives, thinking them "childish" or "not real math," and in some cases they refuse to use them. In any case, this resistance has to be taken into account before students can gain from using concrete materials. I have developed some ways to work with their resistance, including acknowledging their feelings, using trial runs of material, and including students on the team of decision makers (Nonesuch, 2005b). These tactics, however, are outside the bounds of what is considered "normal" classroom practice.

It seems likely that workplace programs would face the least resistance to using real objects to teach concepts, and indeed, in an interview with *Literacies*, Sue Grecki talks about her work with students in the trades who need help with math:

> So we'd work with plumbers using a piping system drawing, and figure out the elbow degree and the length of the travel. Then we'd go into the shop and start measuring and cutting pieces to see if they work. That's when they realize something worked or that they were looking at setting up the problem the wrong way ("Making math concrete (and iron, and plastic): Numeracy and construction trades", 2005, p.15).

Another way of overcoming student resistance to using hands-on strategies is to give them some knowledge of and control over the learning process. For example, Meg Constanzo (2000) says that students who had been taught about multiple intelligence theory and who had had a chance to find out their own strengths were more willing to use alternate strategies (such as drawing diagrams or using manipulatives) which were appropriate to their strengths, but which they had resisted previously.

Resistance to such methods comes also from instructors, who, with students, reckon on the need for drill and practice and worry about the perceived increase in time needed for "discovery methods." Kathy Safford writes of her own experience teaching basic math and on the "math wars" about the best way of teaching math to children; she has modified her initial zeal for a strictly constructivist approach for adult learners to include space for drill and practice: "If students have constructed and own the rules they are practicing, they can reconstruct them at some later time. Practice diminishes the need for such activity and releases their brains to engage in more constructive work" (Safford, 2000).

Encourage the development and practice of estimating skills.

Why is it difficult to develop students' skills in estimation? Although I did not find any writing on this topic, it seems to me if students can make reasonable estimates, and if they value the usefulness of the strategy, it is a testament to their understanding of mathematical concepts and the particular context of the problem they are working on. Is it possible to foster estimating skills without including in your practice many of the other principles in Gal's list?

Emphasize the use of "mental math" and the need to connect different mathematical skills and concepts.

Most instructors are aware that many students have their own methods of making computations mentally, although for the most part they view them as substandard and are slightly ashamed of them. (My students often hide their methods from me.) Writing in the newsletter of Adults Learning Mathematics, Janet Duffin (2002) suggests that we should encourage students to develop their own methods and to share them with the group as a way of having their own methods respected and of learning from other methods, thus improving competence and confidence. Even so, she recognizes the temptation to intervene when students are working out their own method, because "our instinct is to weigh in and help them" (p. 7). Sandra Wilson and Alison Tomlin (1999), numeracy student and researcher, reported on a piece of research they undertook together, to interview other people to discover what method they used to do sums. Doing formal research goes further than Duffin (and many others) suggest. Such activities again put students in control (they are the researchers) and give them opportunities to see in real life the variety of approaches and strategies people use. Students reach a better understanding through collecting, organizing and understanding their data, and practice is embedded in a real research process instead of in worksheet drills. However, the idea of doing such a research project, especially the act of writing it up and publishing the results, would be considered outrageous by most instructors I know, wasteful of time and of dubious value in light of the perceived rigidity of program content in most ABE programs.

Develop learners' calculator skills and foster familiarity with computer technology.

Catherine Cantrell (2000) finds putting students in front of computers to use math educational software "boring and potentially pointless" (p. 1) because students are isolated from other students and from teachers, and there is often no relevant context in which they can use skills as they learn them. In this article she tells how she uses everyday software such as spread sheets and graphs, the internet, PowerPoint, web page creation, etc. to teach math while providing students with a group experience, as suggested by the next principle.

Provide opportunities for group work.

Beth Marr (2001) writes about the many benefits of group work. She observed that when students were given a collaborative task they started on a more equal footing and explored meaning together, rather than one being more expert than another. The many tasks necessary for a group to function (keeping time, maintaining relationships, bringing in outside knowledge) means that people with lower math skills can make a positive contribution to the group while learning from others. Furthermore, she says, “I believe that for many adult students there is an unspoken social need that is integral to their return to study. Leaving the isolation of the home and mixing with others seems an important part of the new learning experience”(Marr, 2001, p.217).

An interesting discussion with my colleagues at Malaspina University-College led to an illuminating discovery about students’ reactions to doing group work. Some teachers were talking about how hard it was to get students to do group work: they drag their feet, complain, and say they’d rather work on their own in their books. Iris Strong, who teaches ABE at the Nanaimo Campus of MUC, speculated that her students thought working in groups was inefficient and time-consuming. She thought that they wanted to work by themselves in order to make faster progress. The following week, she led discussions in two different classes, and reported that her hypothesis was wrong:

> Then I asked them to describe what happens inside their heads and hearts when they’re asked to participate in an activity that doesn’t feel natural to them, or one that they simply do not LIKE doing.
>
> Well, I was wrong about thinking it was a time issue! At least for the students who responded in these two classes, the common denominator was that taking part in some of these activities involves interaction, and during interaction, others can see that they are dumb, stupid, and not as smart. Fear of exposing ignorance seems to be the motivator for these folks to want to do their own individual work. The cool thing is that they were all quite comfortable sharing that, and laughed about acknowledging it to each other. We’ve had a couple of wonderful sharing times on this topic in each class!! (E-mail, February 23, 2006).

What are other difficulties in using group work in ABE math classrooms? The instructor must teach more than simply math. In their introduction to a collection of several adult numeracy programs in Australia, Penny Halliday, and Beth Marr state, “Adult students in particular need to be taught how to work cooperatively in an enjoyable, non-competitive and supportive environment” (1995, p.9). Facilitating groups is a skill that does not necessarily come with every math teacher; as we have seen, literacy instructors often do not bring their skills in doing “whole language” to their work as numeracy instructors. Some instructors do not themselves know how to work co-operatively, or how to foster a non-competitive environment in their own workplaces, so can hardly be expected to teach it or encourage it in their students. Moreover, professional development for ABE/Literacy teachers does not often take the form of increasing their group facilitation skills, or applying methods to teach students to work co-operatively.

Link numeracy and literacy instruction by providing opportunities for students to communicate about math.

Beth Marr (2000) found that students needed "opportunity to speak" and "means to speak" (understanding of concepts and ability to use math terminology), and that the usual methods based on preparing students to complete worksheets provided neither. She used strategies to increase opportunity to speak such as group and pair work using manipulatives, discussion and sometimes writing about math thinking, and rehearsal for a report to larger group; participation in these activities increased students interest in acquiring appropriate language to express their ideas. Many of these activities that encourage students to talk about math, however, involve working in a group, and the instructor must deal with the difficulties outlined in the previous section if students are to have the opportunities Marr suggests are useful in learning math.

Situate problem-solving tasks within familiar, meaningful, realistic contexts in order to facilitate transfer of learning.

The crux of the matter seems to be in determining what is a realistic context for students. In practice, it often means that instructors pick topics that they think are realistic, such as budgeting or shopping. However, Alison Tomlin, in her article "Real Life in Everyday and Academic Maths" challenges the idea that instructors should determine the topics to be covered, and challenges especially the idea that instructors can take real life situations and turn them into math problems that relate to students' lives. She gave an example of paying an electricity bill in England, which has no relevance in the Canadian context. However, a comparable situation from my own teaching will serve to make the same point.

When I first began teaching numeracy to adults, I often ran across texts with shopping "problems" for students that required them to figure out which of two or three options was the best buy—the best buy always being the cheapest. Yet, as I got to know my students, they told me that, if you have only $5.00 to spend, it is irrelevant to figure out whether it is cheaper to buy 500 grams of something for $4.00 or a kilogram for $6.98. How to make your money or your food stretch to the end of the month is not a math problem if you live with a drunk who takes all the money to buy booze, or who brings his buddies home to eat up the food you were hoping to serve the kids the next day. Tomlin says:

> In talking as though we ([instructors] and policy-makers) know or can predict students' everyday lives and maths problems, we risk being profoundly patronising. What is real, everyday or relevant, or has meaning, depends on things far more complicated than [we] can know (Tomlin, 2002, p. 12).

Johnston, Baynham, Kelly, Barlow and Marks (1997) echo this caution in their report on a study of young students in Australia, many of whom have their own reasons for choosing not to budget their money. "If we are not careful, we will interpret this choice as lack of knowledge or even moral inadequacy" (p. 113). The authors suggest we need to ground ourselves in the real uses students make of money—selling/buying drugs, making bets, making things, protecting themselves from being cheated.

> "…(Numeracy instructors) themselves need to be truly at home with the mathematics their students need…. they need to be able to understand something about the structural constraints of society and the possibility of agency, about how students make their own mathematical lives, even though it may not be in circumstances of their own choosing" (p.131).

As a final note on this subject, Tom Ciancone (1988), discounting the importance of realistic contexts in teaching math, says that getting help with everyday problems is only one of four possible motivations of adult students, and that "success in mathematics is as great a motivating factor for learning as relevance" (p. 2).

Assess a broad range of skills, reasoning processes and dispositions, using diverse methods.

It is a truism in educational circles that you teach what you test for; if you want to change classroom practice, you have to change the way learning is tested and measured. Yet in programs such as Tom Nesbit (1995) studied, the text was of paramount importance, and nearly every math text comes with a battery of pre- and post tests, chapter tests, mid-term and final tests. So long as programs and instructors are tied to a text and its tests, it will be impossible to implement the constructivist strategies under discussion here. Members of a discussion group at the National Roundtable on Numeracy (Dennery, 2000) listed some of the problems with testing and accountability from their experience in the Canadian context. They stated that assessment should be based on "actual performance of authentic materials and tasks" (p. 4), but recognized the difficulty this raises in reporting to funding agencies, for example. They wondered if authentic assessments could be set up and reported so as to meet the requirements of external accountability.

Barbara Glass cites one method of assessment recently developed by the Literacy and Basic Skills Program in Ontario, a "demonstration." "These cumulative activities are intended to involve learners in real-life tasks that incorporate the skills and knowledge of several modules or units of study" (Glass, 2001, p. 60). More than 100 demonstrations are available online at the AlphaPlus website (http://demonstrations.alphaplus.ca). Their use requires more teacher time and preparation than a paper-and-pencil test, and the results are less easily understood by someone outside of the process.

M. Elaine Harvey (1991) goes a step further in rejecting traditional assessment practices:

> Evaluating students through testing, assigning marks, and ranking, is a patriarchal approach. In feminist teaching, marks are generally not determined by one do-or-die exam. Marks for work during the term have become increasingly important. But let's not even assume that marks are necessary. We could use grades or even assign complete/incomplete status. Why do we even labour under the assumption that evaluation is essential to education? It is not essential to learning. In fact, it may even be detrimental (p.14).

An emphasis on "authentic assessment" or on self-evaluation of process runs counter to the current climate in adult basic education, where government departments and other funders demand more and more detailed and standardized outcomes evaluation.

Who is in charge here?

Many of the strategies reviewed above include an element of student control of their learning, or of shared power between teacher and student, although neither was evident in the study by Tom Nesbit (1995) referred to earlier. There, teachers maintained control over nearly every aspect of the class, and the students were reduced to passivity in the face of the authority given to teacher and text. In a series on improving student retention, a report prepared for the College Sector Committee for Adult Upgrading, a committee of the Association of Colleges of Applied Arts and Technology of Ontario, states explicitly:

> The management of learning should lead to the development and reinforcement of the learner's control of his/her own learning;

> and,
>
> The management of learning should strive to build a shared power relationship in the classroom that contributes to self-esteem and self-confidence ("Best practices in managing the classroom to improve student commitment", no date, p. 7).

Thinking about learners being in charge, I was stunned when I ran across this introductory phrase in an article by Lindenskov and Hansen (2000): “According to Danish legal provision, the learners participate in the ongoing planning of the course. In Eigil’s class, two themes were democratically chosen” (p.5). It is impossible (but tempting) to imagine all the shifts that would take place if such a law were enacted in British Columbia.

Nicol and Anderson (2000), in a study with mildly learning-disabled adults, found that two groups of students who had teacher-led instruction and teacher-plus-computer-software instruction, respectively, improved more than the control group. The authors suggest that the improvement in the group that used computer-assisted instruction with the teacher may be influenced by a change in teacher-student relationship (more collaborative and less confrontational) as much as by the actual software (p. 191).

Haacke, van Duin, and de Laat (1997) describe an individualized math program in the Netherlands, where many students are on individual paths, yet they do not follow blindly modules set out for them by instructors, and which integrates many aspects of group work, mental math, and practical problems. Instructors face a difficult challenge in this setting: “For us educators our way of thinking has to be reversed. Instead of suppliers who offer what they think is necessary, they had to become educators who listen to the demand so the education can be adapted to what is needed” (p. 3). Moreover, in the Canadian context, they would have to overcome years of conditioning that encourages students to take a passive, rather than an active, role in their education.

Mike Baynham (1996) investigated the role language plays in the adult classroom, particularly how humour may produce a more egalitarian relationship between teachers and students. A shared power structure may be the hardest to implement of all the principles of adult numeracy instruction under discussion here. It is hard for instructors to give up control. It is hard for students to accept control and hard for them to believe that the teacher is willing to give up control. The transition from the status quo to some new way of being may be the hardest of all. I have reflected on my own practice in this area in an article published in the RaPAL journal (Nonesuch, 2005a).

Summary

Although some academic researchers say that little statistically valid research has been done about adult numeracy instruction, many instructors and others in the field have reflected on their practice and on their observations, to come up with a consensus about what “best practice” looks like. There is general agreement on many of the ideas about best practice, although still some controversy on some of the details.

Yet, even with this general agreement in principle, ABE/literacy math classes are still taught in the old-fashioned way, with power centered in the teacher, and the text and the test governing the content and method. A little closer look at the principles shows some barriers to implementation by teachers. Many of them ask both teachers and students to step out of their usual roles, and change is always difficult. Some of them ask teachers to make themselves vulnerable, to deal with emotions and respect their students' knowledge of things the teacher does not and possibly cannot know. Some of them ask students to be open about their lack of knowledge and skills, lacks they have been hiding for years. Some of them are in conflict with the needs and assumptions of administration and funding bodies, which want to count completions and register grades. I have tried to elaborate the complexities of some of them, to try to see what is there that prevents them from being easily and widely adopted. All in all, making change in adult numeracy instruction is much more complicated than it seems on the surface.

Conclusion

My intention here has been to push the edges a little of the principles elaborated by Gal *et al*, and other writers, but not to deny their validity, because I think they are valid. I want to incorporate them all into my practice, and I'm curious about what makes it so difficult. I think that we have to name the problems of implementation more clearly before we can adopt these suggestions, before we can change our practice to bring it into line with research and theory.

Resistance to change, both from instructors and students, and the difficulty of moving the locus of control from instructor to student are barriers to changing our practice. They seem to be circular; which comes first? A remark from the National Roundtable on Numeracy seems to focus the dog-chasing-its tail aspect of this difficulty:

> While focus on a grade mark equates learning achievements with external approval, the authentic assessment encourages the learner to look within and take satisfaction in personal accomplishments and skills-building (Dennery, 2000, p.4).

If the learner is to look within and take satisfaction from what s/he finds there, instructors must find a way to put into practice those principles and strategies I have been discussing here. If students are to learn to construct meaning from their math classes, instructors must learn to facilitate activities that will foster such a construction of meaning. Further, someone must find a way to encourage and teach instructors to undertake this task. And somehow, ABE/numeracy students must come to expect and demand control over their learning.

How to implement best practices; how to get instructors enthusiastic; how to get students involved—these are the difficulties we have yet to overcome. It is clear that simply saying "do this, do that" will not enable instructors to improve their practice; there is a need for investigation into the specific context of adult numeracy instruction to figure out what gets in the way of implementing such best practices. Investigators, however, must be revolutionaries in their approach, for a revolution in practice is necessary. Investigators must be willing to look at the factors that make instructors resistant to change. They must be willing to look at why instructors and administrators are unwilling to have the messiness of real numeracy education come into their classrooms. Finally, they must be willing to work with students to find out what invitations to participate need to be sent, how bridges can be built, what it will take for students to believe that we are willing to change, and that the change will be beneficial.

References

Baynham, M. (1996). Humour as an interpersonal resource in adult numeracy classes. *Language and Education, Volume 10* (Number 2), 187-200.

Benseman, J. (2003). Literature review of New Zealand adult literacy research. Retrieved Dec. 3, 2006 from http://www.nald.ca/library/research/benseman/litreview/cover.htm.

Best practices in managing the classroom to improve student commitment. (no date). *Retention Through Redirection.* College Sector Committee for Adult Upgrading, a committee of the Association of Colleges of Applied Arts and Technology of Ontario. Retrieved Dec. 3, 2006 from http://www.collegeupgradingon.ca/projrprt/RthruR/bestprac/cover.htm.

Beyond worksheets: Making math meaningful. (2005). *Literacies* (5), 12-13. Retrieved Dec. 3, 2006 from http://www.literacyjournal.ca/Forumpages/forum4_s05readings.htm.

Brover, C., Deagan, D., & Farina, S. (2000). The New York City math exchange group: Helping teachers change the way they teach mathematics. *Focus on Basics, 4*(B), Retrieved Dec. 3, 2006 from http://www.ncsall.net/?id=317.

Cantrell, C. (2000). Using software applications to teach math. *Focus on Basics, 4*(B), Retrieved Dec. 3, 2006 from http://www.ncsall.net/?id=313.

Ciancone, T. (1988). Adult numeracy: Taking mathematics from the real world into the classroom and back. Retrieved Dec. 3, 2006 from http://www.nald.ca/library/research/numeracy/num1/cover.htm.

Coben, D. (2003). *Adult numeracy: Review of research and related literature*. London: National Research and Development Centre for Adult Literacy and Numeracy.

Constanzo, M. R. (2000). *Adult multiple intelligences and math.* Paper presented at the ALM-7 Conference, Medford, Massachusetts. Access ERIC ED478894.

Core lessons for life skills programs. (1994). Victoria BC: BC Ministry of Education, Skills and Training.

Dennery, D. (2000). National roundtable on numeracy at Queen's University: Summary of proceedings. *National Roundtable on Numeracy*. Retrieved Dec. 3, 2006 from http://www.nald.ca/FULLTEXT/nls/inpub/numeracy/summary/cover.htm

Dingwall, J. (2000). Improving numeracy in Canada. *National Roundtable on Numeracy.* Retrieved Dec. 3, 2006 from http://www.nald.ca/fulltext/nls/inpub/numeracy/improve/cover.htm.

Duffin, J. (2002). Personal mental methods. *ALM Newsletter* (No. 15), 7-8. Retrieved Dec. 3, 2006 from http://www.alm-online.org/

Fortini, B. (2001). In S. Kallenbach & J. Viens (Eds.), *Multiple intelligences in practice: Teacher research reports from the adult multiple intelligences study*: National Center for the Study of Adult Learning and Literacy (NCSALL). Access ERIC ED453 386.

Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.

Gal, I., Ginsburg, L., Stoudt, A., Rethemeyer, K., & Ebby, C. B. (1994). *Adult numeracy instruction: A new approach*. Philadelphia: The National Centre on Adult Literacy. Access ERIC ED 397 232.

Glass, B. (2001). Numbers talk: A cross-sector investigation of best practices in LBS numeracy. Retrieved Dec. 3, 2006 from http://www.collegeupgradingon.ca/projrprt/numtalk/numtalk.pdf .

Gordon, T. (1974). *T.E.T., teacher effectiveness training*. New York: P. H. Wyden.

Haacke, F., van Duin, S., & de Laat, M. (1997). Independent learning: Numeracy developments in ABE practice. Access ERIC: Full text (141 Reports--Descriptive). Netherlands.

Hagedorn, L. (2000). Compiled responses of LBS teachers in Ottawa to a questionnaire about their numeracy teaching practices and needs. Ottawa: Ottawa-Carleton District School Board. Retrieved Dec. 3, 2006 from http://www.nald.ca/fulltext/ottawa/response/response.pdf.

Hagedorn, L. (2001). Numeracy. *Best Practice and Innovations*. Retrieved Dec. 3, 2006 from http://www.on.literacy.ca/pubs/best/numeracy/cover.htm.

Hagedorn, L. (2004). *An exploration of collaborative materials development in adult numeracy teaching: Improving numeracy instruction in the LBS program - phase ii*. Ottawa: Ottawa-Carleton District School Board. Retrieved Dec. 3, 2006 from http://www.nald.ca/library/research/cmdreport/cover.htm.

Halliday, P., & Marr, B. (Eds.). (1995). Not one right answer--mathematics within the certificates of general education for adults. Melbourne: Adult, Community, and Further Education Board. Access ERIC ED384709.

Harvey, M. E. (1991). Math is a (wo) man's subject. *Women's Education des femmes, 9*(1). Retrieved Dec. 3, 2006 from

http://www.nald.ca/litweb/other/cclow/newslet/1991/Sumer_v9/13.htm

Hutchinson, L. (2000). Teaching mathematics to adult students. *Groundwork, 25*(2), 10. Retrieved Dec. 3, 2006 from http://www.abeabc.ca/groundw/teaching.htm.

Johnston, B., Baynham, M., Kelly, S., Barlow, K., & Marks, G. (1997). Numeracy in practice: Effective pedagogy in numeracy for unemployed young people. *Research report.* Australian National Training Authority, Brisbane. Access ERIC ED 433457.

Lindenskov, L., & Hansen, E. P. (2000). Two dilemmas in communicating mathematics in adult basic courses: "How to support pre-knowledge of adult learners" and "how to support democratic classroom decisions." *ALM Newsletter* 12. Retrieved Dec. 3, 2006 from http://www.alm-online.org/Newsletters/News12.pdf.

Making math concrete (and iron, and plastic): Numeracy and construction trades. (2005). *Literacies*(5), 14-16. Retrieved Dec. 3, 2006 from http://www.literacyjournal.ca/Forumpages/forum4_s05readings.htm.

Marr, B. (2000). How can they belong if they cannot speak the language? Enhancing students' language use in the adult mathematics classroom. *Literacy and Numeracy Studies,* 10 (1 & 2), 55-69. ERIC ED474045.

Marr, B. (2001). Connecting students, sense and symbols: A workshop of practical activities from personal experience, and informed by research. ERIC: ED 48c 011.

Nesbit, T. (1995). *Teaching mathematics to adults.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco. Access ERIC ED392603.

Nicol, M. M., & Anderson, A. (2000). Computer-assisted vs. Teacher-directed teaching of numeracy in adults. *Journal of Computer Assisted Learning, Vol 16*(3), 184-192.

Niks, M., Allen, D., Davies, P., McRae, D., & Nonesuch, K. (2003). *Dancing in the dark: How do adults with little formal education learn? How do literacy practitioners do collaborative research?* Malaspina University-College Nanaimo, BC. Retrieved Dec. 3, 2006 from http://www.nald.ca/library/research/dark/cover.htm.

Nonesuch, K. (2005a). Putting learners in charge of making decisions. *RaPAL Journal (Research and Practice in Adult Literacy, Lancaster University*), Spring 2005.

Nonesuch, K. (2005b). Working with student resistance to math tools. *Literacies*(5), 4-8. Retrieved Dec. 3, 2006 from http://www.literacyjournal.ca/Forumpages/forum4_s05readings.htm.

Nonesuch, K. (forthcoming). *Changing the way we teach math: A manual for teaching basic math to adults*. Duncan, BC: Malaspina University-College. To be available on-line at http://www.nald.ca/.

Peskoff, F. (2000). Mathematics anxiety and the adult student: An analysis of successful coping strategies. Access ERIC ED 474042.

Quigley, B. Allan. (2006). The World of Literacy education is shaped like a trinagle,but we are starting to change it. Retrieved December 11, 2006, from http://www.nald.ca/library/research/triangle/cover.html

Rogers, P. (1991). Transforming mathematics pedagogy. *Women's Education des femmes, 9*(2). Retrieved Dec. 3, 2006 from http://www.nald.ca/litweb/other/cclow/newslet/1991/Fall_v9/40.htm.

Safford, K. (2000). Making peace in the math wars. *Focus on Basics*, 4(B), Retrieved Dec. 3, 2006 from http://www.ncsall.net/?id=318.

Schmitt, M. J. (2006). Developing adults' numerate thinking: Getting out from under the workbooks. NCSALL. Retrieved Dec. 3, 2006 from http://www.ncsall.net/?id=319.

Smilkstein, R. (1991). A natural teaching method based on learning theory. *Gamut*, 12. Access ERIC ED 382 237.

Smilkstein, R. (2002). How the brain learns: Research, theory, and classroom application. *Learning Assistance Review*, Spring 2002.

Tomlin, A. (2002). Real life in everyday and academic maths. Paper given at Mathematics, Education and Society Conference (MES3), Helsingor, Denmark. Retrieved Dec. 3, 2006 from http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED473855.

Torgerson, C., Porthouse, J., & Brooks, G. (2005). A systematic review of controlled trials evaluating interventions in adult literacy and numeracy. *Journal of Research in Reading, 28*(2), 87-107.

Wilson, S., & Tomlin, A. (1999). How do you do maths? *ALM Newsletter* Number 8. Retrieved Dec. 3, 2006 from http://www.alm-online.org/.