

Adult Numeracy via New Learning Technologies: An Evaluative Framework

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Abstract

Adult numeracy is an essential part of literacies spanning personal, community, economic, and workplace domains. Increasingly there is a tendency for materials to be delivered or supported by technological means (e.g., online, CD-ROMs, etc.). Also, the technological tools themselves, when used as mathematical teaching devices (e.g., calculators, computer software packages), are themselves far from transparent.

This workshop reports on and extends a work-in-progress now reaching the final stages of an ARC-funded post-doctoral fellowship. This research has been aimed at assisting developers in the design of materials to support the learning of adult numeracy via new learning technologies. It has also sought to assist potential users, such as practitioners and individual learners, in the evaluation of these products. In this workshop we will discuss and critique aspects of an evaluative framework in its most recent version.

Introduction

Adult numeracy is an essential part of literacies spanning personal, community, economic, and workplace domains. When adults return to study numeracy they face a range of challenges and may have multiple yet contradictory reasons for their decision. In the personal domain, from a psychological point of view, there are the underlying memories of the last time that they studied mathematics. These include how they felt about the discipline of mathematics, how they felt about the pedagogical practices of their various teachers over the period of formal education, whether they chose freely to discontinue their studies of mathematics or faced some form of compulsion or coercion, and what were the reasons. They now have to face (again?) the possibility of losing face in front of strangers, as well as possible derision by significant others in the realms of family and friends. In the economic sphere they are facing opportunity costs of time and/or money which could have been otherwise allocated; even possible cessation of social welfare support. From the workplace perspective they may be studying to maintain or improve their current job/s, or be contemplating changing jobs or further education which requires more mathematics and/or technology. They may have community responsibilities which demand mathematics (especially financial literacy); they may have a desire to improve their understanding of civic issues which draw on logical and statistical arguments.

For all of the above reasons, and more, it is essential that adults returning to study numeracy have the best quality curriculum and pedagogy to support the kinds of investment outlined above. At the macro- or bureaucratic level, the curriculum needs to be as broad and flexible as possible in order to meet the various needs and interests of adult learners. This means for the curricular content of numeracy should extend far beyond the so-called basic skills of numbers and simple measurement to encompass the range of activities in which adults might participate, yet not necessarily be restricted to *functional mathematics* in which the prime focus is the needs of the labour market as articulated by big business and industry. Accordingly, aesthetics and creativity should also be taken into consideration.

Once the learner has enrolled in a program of study, it is the numeracy teacher/tutor who then has the responsibility of juggling official requirements of government and/or employer in order to accommodate the needs of the learner: to enable them to achieve the credential and to develop the mathematical skills and knowledges to which they might aspire. In recent years there has been a trend towards supporting and even delivering learning through technological means (e.g., online, CD-ROMs, etc.). One well accepted reason is that funding bodies assume that there will be some kind of saving on teacher costs — even though this is quite debatable. Another reason is to offer the learner increased access through reducing the restrictions on time and location of study. Of course there are still hidden costs to the learner in purchasing or hiring computers and in doing their own printing. Not all learners willingly choose distance education modes for their numeracy studies, and may face the additional challenges associated with accessing the technology itself, with or without a reliable technical

support service. In any case, the technological tools themselves, when used as mathematical teaching devices (e.g., calculators, computer software packages), are themselves often far from transparent. Given all of these contingencies, it is essential that adult numeracy courses delivered and/or supported by information and communication technologies [ICTs] in the form of new learning technologies [NLTs] are of the highest quality, and grounded in research.

Research into Adult Numeracy via New Learning Technologies

The research I have carried out over the last three years has been aimed at assisting developers in the design of materials to support the learning of adult numeracy via new learning technologies. It has also sought to assist potential users, such as practitioners and individual learners, in the evaluation of these products. This work-in-progress is towards an evaluative framework with three major dimensions of numeracy, pedagogy, and technology.

Questions may be asked as the WHY adults choose (if they are in fact given a choice) to take on learning mathematics/numeracy supported and delivered wholly or in part by new learning technologies. There may be multiple reasons, often in tension with one another or even contradictory.

- 1 What are their motives?
 - 1.1 Is it to achieve a credential?
 - 1.2 Is it to achieve develop new and/or deeper understandings?
 - 1.3 Is it to prove something to one's self?
 - 1.4 Is it to be able to help significant others to learn mathematics?
 - 1.5 Is it to support their own or their family's business/financial interests?
 - 1.6 Is it to learn more about technology?
 - 1.7 Is it to learn more through technology?
 - 1.8 ...

Adult Numeracy. What is considered adult numeracy continues to be hotly debated internationally: Even the label itself is contested by those who favour other descriptors such as functional mathematics, mathematical literacy, statistical literacy, and so forth. As is the case with any education in the public domain, and even the private domain in the case of in-house workplace education, the issues are political. This means that what counts as adult numeracy varies according to the stakeholders concerned, with the most powerful voices holding sway. But it is important to ask serious questions such as: who are the learners, why are they learning, and how do they learn best. When materials are pre-packaged, and unable to be modified to meet the needs of particular learners, it is essential that research is carried out by developers and practitioners working together to identify as many likely characteristics of learners as possible [i.e., the WHO question] and to address these explicitly wherever possible. An excellent example of this is the CD-ROM produced at the University of Southern Queensland (USQ, 2000) for adults returning to study in preparation for undergraduate mathematics. There are five content topics: numbers, calculations, negative numbers, order of calculations, and fractions. Each of these is accompanied by a range of options: video story, group discussion, learn more about ..., examples, and self-test. The producers make considerable effort to address the affective domain through the modelling of different behaviours and expression of feelings by a range of actors reflecting the different cultural and social backgrounds of typical students. The program encourages the co-operation and dialogue which many adults lacked in their previous mathematics education experiences. There is also a focus on keeping a personal diary to record both mathematical notes and personal reflections. These characteristics are particularly important for women returning to study, in my experience.

At the same time, the mathematical content needs to be appropriate to the particular learners [i.e., the WHAT question]. This means reading recent research (or even conducting research where feasible) into the kinds of activities in which the adult learners are likely to be engaged, or may wish to be in future. This research is critical in order to avoid the patronising kinds of materials which take early school mathematics topics and simply re-present them in more 'grown-up' contexts. Adults are quite capable of seeing through these, and the sense of humiliation deepens. On the other hand, adults do not return to study mathematics in order to improve their shopping habits or to undertake even more hypothetical home renovations.

They probably already feel quite capable in these domains, and don't deserve to be demeaned further by such disrespect. However, contextualisation is an essential factor in much adult learning. When educators and researchers take the time to go deeply into the relevant context (e.g., the workplace) the outcome can be powerful for all concerned (see, e.g., FitzSimons, 2000). Learning becomes a truly shared experience and all stakeholders are likely to benefit. Not all program developers have such luxury, and reviews such as the one posted on a European Union-funded numeracy website — the EMMA Portal may be of benefit (see, e.g., FitzSimons, 2004).

Pedagogy. Considering the HOW question leads to a discussion of pedagogy. Pedagogical practice in pre-packaged materials clearly has more constraints than in face-to-face teaching where the teacher/tutor can react immediately to feedback from students and make adjustments to pace, revisit earlier content, and so forth. The kinds of questions which might be asked include the following:

- 2 Following Taylor (2001):
 - 2.1 How accessible is the content for all students, in terms of appropriate language use (terminology, right level)? Does it accommodate the needs of second (or other) language speakers?
 - 2.2 Are text materials written in informal language with little mathematical jargon to make them more accessible to novice learners?
 - 2.3 Is formal mathematical language introduced at a slow pace for novices with links to glossaries or other nested explanations?
 - 2.4 Are content and activities grouped in small bursts to allow novice learners to experience early success and to build confidence, knowledge, and skills gradually?
 - 2.5 Do all closed activities have fully worked solutions with problem-solving prompts to guide learners through the steps?
 - 2.6 Do some activities, or parts of activities, allow for diversity and originality of possible solutions?
- 3 Following Ginsburg & Gal (2000): Does the activity:
 - 3.1 Encourage the development and practice of estimation skills?
 - 3.2 Emphasise the use of "mental mathematics" as a legitimate alternative computational strategy and encourage development of mental mathematics skill by making connections between different mathematical procedures and concepts?
 - 3.3 View computation as a tool for problem solving, not as an end in itself?
 - 3.4 Encourage the use of multiple solution strategies?
 - 3.5 Develop learners' calculator skills and foster familiarity with computer technology?
 - 3.6 Link numeracy and literacy instruction by providing opportunities for learners to communicate about mathematical issues?
 - 3.7 Situate problem-solving tasks within meaningful, realistic contexts in order to facilitate transfer of learning?
 - 3.8 Develop learners' skills in interpreting numerical or graphical information appearing within documents and text?
- 4 On a broader scale, some of the issues to be addressed could include:
 - 4.1 Teaching with Technology: Does the activity model the use of appropriate technology in the teaching of mathematics so that learners can benefit from the opportunities it presents as a medium of instruction?
 - 4.2 Interactive and Collaborative Learning: Does the activity foster interactive learning through student writing, reading, speaking, and collaborative activities so that learners can learn to work effectively in groups and communicate about mathematics both orally and in writing?
 - 4.3 Connecting with Other Experiences: Does the activity actively involve learners in meaningful mathematics problems that build upon their experiences, focus on broad mathematical themes, and build connections within branches of mathematics and between mathematics and other disciplines so that learners will view mathematics as a connected whole relevant to their lives?

- 4.4 Multiple Approaches: Does the activity model the use of multiple approaches—numerical, graphical, symbolic, and verbal—to help learners to learn a variety of techniques for solving problems?
- 4.5 Experiencing Mathematics: Does the activity provide learning activities, including projects and apprenticeships, that promote independent thinking and require sustained effort and time so that learners will have the confidence to access and use needed mathematics and other technical information independently, to form conjectures from an array of specific examples, and to draw conclusions from general principles?

Drawn from Cohen (1995)

However, isolated mathematical skills on their own do not ensure numerate behaviour. Learning mathematics and using numeracy are two different activities, serving very different purposes. Numeracy in practice requires the creative transformation of mathematical knowledges and skills to address problems that are contextually situated in cultural, social, and historic terms, and which generally require a practicable solution under real constraints of time and/or money. Ideally the persons involved have developed a repertoire of strategies, and understand the practical limits or tolerances allowable within the particular situation, but are never allowed to intentionally make mistakes (unlike most learning situations). Communication between stakeholders is of the essence. The following questions extend the parameters for evaluation in this direction.

- 5 Are the learning tasks authentic?
 - 5.1 Do learners investigate issues that are of current importance to the world?
 - 5.2 Do learners use real-world data to understand current events?
 - 5.3 Do learners have access to the arguments presented to government and to current discussions between expert authorities?
 - 5.4 Do the learning activities involve tasks that reflect the way in which the knowledge will be used in real life contexts?
 - 5.5 Are the learning tasks based on authentic or simulated workplace activities?
 - 5.6 Do the learners have to accept responsibility for their solutions in any real tangible way?
 - 5.7 Are there any real consequences to the learners' calculations?
 - 5.8 Are there realistic materials available for learners to explore and reflect on strategies for use?

Technology. When using new learning technologies, questions need to be raised as to the purpose of the activity. Following Kuutti (1996): Is it just to reinforce skills and procedures already learned? Is it to learn more about the technology itself or to gain a deeper understanding of the conceptual processes of the mathematics? In other words, to support sense-making. Or, is it to enhance communication between participants, possibly across time and space? To automate a new routine or to construct a new tool? To support reflection on the activity itself? For adults to develop the capacity for numerate behaviour there needs to be a balance of all three levels: automating routines, developing understanding, and fostering communication/creativity. The following questions, drawn from Slavit and Yeidel (1999) relate to utilising web-based resources.

- 6 Are connections made between classroom practice and the ideas in web-based activities?
 - 6.1 Is there an integration between lectures, web-based resources, practical exercises, field trips and assessment tasks?
 - 6.2 Are web-based activities visually appealing, technologically transparent, interactive, contextually-based, enjoyable, connected to course content, and conceptual in nature?
 - 6.3 When teaching with web based resources, are there a range of teaching strategies aligned to the pedagogical perspectives for both labs and theory to ensure learners' success?
 - 6.4 When teaching with web based resources, what pedagogical adaptations are there to meet the diverse cultural expectations of learners?

Following Engelbrecht and Harding (2005):

- 6.5 Communication, interaction and collaboration: Is there synchronous or asynchronous communication through tools for co-construction of knowledge and sharing of ideas? [Synchronous could include voice and video conferencing, shared whiteboards and live presentation tools (e.g., tablet or electronic writing pad), application sharing, live assessment, chat rooms, web safari, and breakout rooms for smaller groups. Asynchronous, could include group project activity, assessments, surveys, votes. These may be completely open-ended or constrained. Ideally, course should be structured to necessitate communication.]

Conclusion

In this paper I have drawn on an evolving evaluative framework which addresses the major dimensions of numeracy, pedagogy, and technology in relation to adults learning numeracy. I have considered these from four perspectives of who are learning, why are they learning, what are they learning, and how are they learning. I have argued that learning mathematics and developing numerate behaviour are two different activities with different purposes, with different pedagogical implications. Finally, I have recommended that where new learning technologies are utilised, they need to accommodate a range of activity levels, ranging from embedding routines, though supporting transformative and manipulative actions oriented towards understanding, to enhancing communication and creativity. It is not sufficient to focus solely on the first level.

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