



## **Adults Learning Mathematics**

An International Journal

**Chief Editor  
Janet Taylor**

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## Objectives

### **Adults Learning Mathematics – an International Research Forum**

has been established since 1994 (see [www.alm-online.net](http://www.alm-online.net)), with an annual conference and newsletters for members. ALM is an international research forum bringing together researchers and practitioners in adult mathematics/ numeracy teaching and learning in order to promote the learning of mathematics by adults. Since 2000, ALM has been a Company Limited by Guarantee (No.3901346) and a National and Overseas Worldwide Charity under English and Welsh Law (No.1079462). Through the annual ALM conference proceedings and the work of individual members an enormous contribution has been made to making available theoretical and practical research in a field which remains under-researched and under-theorised. Since 2005 ALM also provides an international journal.

### **Adults Learning Mathematics – an International Journal**

is an international refereed journal that aims to provide a forum for the online publication of high quality research on the teaching and learning, knowledge and uses of numeracy/mathematics to adults at all levels in a variety of educational sectors. Submitted papers should normally be of interest to an international readership. Contributions focus on issues in the following areas:

- Research and theoretical perspectives in the area of adults learning mathematics/numeracy
- Debate on special issues in the area of adults learning mathematics/numeracy
- Practice: critical analysis of course materials and tasks, policy developments in curriculum and assessment, or data from large-scale tests, nationally and internationally.

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**Adults Learning Mathematics** – An International Journal

**In this Volume 4(1)**

<b>Editorial</b> Janet Taylor	<b>4</b>
<b>Specific quality criteria for research on adults learning mathematics?</b> Tine Wedege	<b>6</b>
<b>A willing suspension of disbelief? ‘Contexts’ and recontextualization in adult numeracy classrooms</b> Helen Oughton	<b>16</b>
<b>A Trickle down mathematics: Adult pre-service elementary teachers gain confidence in mathematics – enough to pass it along?</b> Mary Ashun & John Reinink	<b>33</b>

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## Editorial

**Janet Taylor**

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Welcome to the first issue of ALM-IJ for 2009. In this issue we again present a truly international format with papers from Sweden, United Kingdom and Canada. The issue also well represents the diversity of the ALM-IJ readership with papers on research in general, teacher education and adults in numeracy classes.

In the first paper Tine Wedege reflects on the debate around the identity of the research field of adults learning mathematics. She raises the concept of *problematique* saying that any research paper has to explain and present its own *problematique* explicitly, i.e. define the problem field and the theoretical/methodological/philosophical approach of the study. She argues that in addition to general research criteria authors in the adults learning mathematics domain should also consider (1) What is adult mathematical knowledge (or adult numeracy)? (2) How do adults learn mathematics? (3) Why teach mathematics to adults?

In the second paper from the United Kingdom, Helen Oughton investigates the context and recontextualisation in the adult numeracy classroom focusing on the concept of funds of knowledge. She has used the study of linguistics interaction to argue that mathematical word problems do not draw on the students' funds of knowledge and practice, and require that learners develop a 'willing suspicion of disbelief' to effectively to develop numeracy skills. I note that embedded within the methodology of this article is the little gem of using students' own mobile phones to record tutorial conversations – a positive use of the mobile phone in the classroom.

In the final paper Mary Ashton and John Reinink from Canada focus our thoughts on adults learners in pre-service teacher education programs. In this study they compare adult and non-adult learners discussing aspects of the program that worked to effect change in belief, confidence and mathematical competency of adults learning in pre-service teaching studies.

This will probably be my last editorial for the journal as a new team will take over in mid-2009. I have enjoyed my time as Chief Editor immensely and have learnt a lot from all involved; readers, writers and editors. I want to take this opportunity to thank in particular all of the co-editors and reviewers I have worked with over the last 3 years or so. The journal cannot be successful without all of us helping out in this collegial manner. I look forward to reading over the next year more interesting and challenging research articles in ALM-IJ - so keep those papers coming in.

Prof. Janet A. Taylor  
Chief Editor



## Specific quality criteria for research papers on adults learning mathematics?

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### Abstract

Since 1997, the identity of the research field of adults learning mathematics has been debated; the research field has grown in quantity and quality; and the research forum Adults Learning Mathematics (ALM) has established an international journal. In practice, the researchers answer the question about identity and quality of research papers in committees, in editorial teams or as referees in journals. The purpose of this article is to create a starting point for a debate, based on quality criteria in the field of mathematics education research, on specific criteria to locate quality of research papers on practice-related educational research in the field of adults learning mathematics. Following general criteria in mathematics education any research paper has to explain and present its own *problematique* explicitly i.e. define the problem field and the theoretical/methodological/philosophical approach of the study reported. Additional criteria specific to the field of adults learning mathematics are suggested, namely, the author should position themselves by answering the following three questions: (1) What is adult mathematical knowledge (or adult numeracy)? (2) How do adults learn mathematics? (3) Why teach mathematics to adults?

Keywords: research papers, quality criteria, identity, adults learning mathematics

### A search for identity and quality

For the last 15 years a new international research field has been cultivated in the borderland between mathematics education and adult education. Conceptual frameworks and theoretical approaches are imported from the two neighbouring fields and restructured within the new community of practice and research (Wedege, 2001). The international research forum Adults Learning Mathematics (ALM) was created in 1994 and need was felt for an identity debate within this new research area. Thus, the following question was formulated at the Fourth International Conference on Adults Learning Mathematics, ALM4, in 1997: “Could there be a specific *problematique* for research in adult mathematics education?” (Wedege, 1998). The debate continued at the following conferences and it was reported in the proceedings (e.g. Wedege, Benn & Maasz, 1999). Coben (2000) presented the identity debate in the introduction, “Perspectives on research on adults learning mathematics”, of the first international anthology from the field, and FitzSimons, Coben and O’Donoghue (2003) examined the current state of research in adult mathematics in the chapter “Lifelong mathematics education” of the Second International Handbook on Mathematics Education. In a review of research on adult numeracy, Coben (2003) also presented the debate on adult mathematics education as a research domain.

In this debate, the focus is on common characteristics in the construction of the area of investigation (adult numeracy and mathematics) and in the need for multi- and inter-disciplinary inquiry (pedagogy, psychology, sociology, anthropology etc.). Mertens (2005) presents the *paradigm* in educational research as “a way of looking at the world [...] composed of certain

philosophical assumptions that guide and direct thinking and action” (p. 7). According to her analysis, the central issues in a debate on identity of a specific “paradigm” in education research are ontological, epistemological and methodological. Where ontological issues deal with the nature of reality, epistemological issues with the nature of knowledge and with the relation between knower and would-be-known, and methodological issues deal with the approach to systematic enquiry. This notion of paradigm is consistent with an epistemological framework which I construed and called the concept of *problematique* in mathematics education with inspiration in French epistemology. *Problematique* covers a systematically linked problem – and practice – field within mathematics education research. Researchers working within a given *problematique* have a specific theoretical and/or methodological approach to the subject area (e.g. adults learning mathematics), and their approach is defined by ontological, epistemological and methodological choices (see Wedege, 1998, 2001, 2006). In the following section, I shall further present the terminology of *problematique*.

Within the research field of adult mathematics education, we may find different *problematiques*. Even incommensurable *problematiques* occur, like the one found in the International Adult Literacy Survey (OECD, 1995) – presuming that it is meaningful to measure people’s quantitative literacy with the same tool across different countries and cultures – versus investigations from an ethnomathematical perspective, which emphasizes the local and the culturally specific (Rogoff, 1984). In both cases, the subject area is people’s mathematical everyday competences, but the subject field is construed differently because of different research interests and questions, theories and methodologies. However, I have claimed that the *problematiques* represented within the international research forum of ALM have a series of common and specific traits. Among these are the following three characteristics (Wedege, 2001).

1. *Subject area: The learner is in focus, and their “numeracy” is understood as mathematical knowledge.*

Adult numeracy is the main construct in the subject field. In English speaking countries, the term “numeracy” is used for certain basic skills and understandings in mathematics which people need in various situations in their daily life. Numeracy is a key word in basic adult mathematics education. As a concept, however, numeracy is deeply contested in politics, education and research. Nevertheless, as an analytical concept, adult numeracy may be considered as mathematical activity in its cultural and historical context. For a review of international research and related literature on adult numeracy, see Coben (2003).

2. *Two approaches: The duality between the objective and subjective perspective is implicit, or explicit, in all studies.*

Two different lines of approach are possible and intertwined in the research: *the objective approach*, starting either with societal and labour market requirements with regard to adults’ mathematics-containing competences or with demands from the academic discipline (transformed into “school mathematics”), versus *the subjective approach* starting with adults’ need for mathematics-containing competences and their beliefs and attitudes towards mathematics (Wedege, 2001).

3. *Justification: The general aim of education and of research is “empowerment” of adults learning mathematics.*

This statement was concluded in the debate of “Adults Learning Mathematics as a community of practice and research” (Wedege, Benn & Maasz, 1999). Later Johansen

(2006) has drawn the same conclusion based on her study of the justification problem from a discourse analytical perspective.

At the Thirteenth International Conference of Adults Learning Mathematics, in 2006, I formulated this question: “Could there be specific criteria for quality of research papers in the field of adults learning mathematics?” It was obvious for me that this debate was needed as a next step in the search for identity. And indeed, at the conference the quality debate was welcomed by the participants. My purpose was to create a starting point for a debate on specific quality criteria within our field on the basis of general criteria for educational research and more specific criteria in the field of mathematics education.

### ***Problematiques in mathematics education***

In educational sciences and mathematics education research literature dealing with general issues of identity and quality, the term “paradigm” is used often with a broad meaning like in Mertens (2005), Furlong and Oancea (2005) and Dörfler (1993). According to Dörfler (1993), there exist different, even mutual exclusive paradigms, in the community of classical research in mathematics education. One of them for instance is the strong orientation to mathematical content, another is the social-constructivist paradigm. However, in mathematics education, the term “paradigm” has also been connected with Kuhn’s concept of paradigm defined as a system of common interests and presumptions characterising “normal science” in a specific historical period, a so-called “disciplinary matrix” (Kuhn, 1962). In this sense it is used to state that mathematics education research is weak in paradigms (see, for example, Niss, 2007). However, paradigms in the sense that Kuhn used them in sciences (mainly physics) do not exist in humanities or social sciences where several competing and incommensurable theories legitimately exist side by side at any time.

Like paradigm, the French term “*problématique*” is also used in a broad sense e.g. in Dörfler (1993) and in Sierpenska and Kilpatrick (1998). I have argued that the meaning of “*problématique*” in mathematics education is “problem field within which the coherence is defined by a science (psychology, sociology, anthropology etc.) and/or a theory” (Wedege, 2006, p. 321). In order to reconnoitre the complex scientific landscape of the borderland between mathematics education and adult education, I have used an epistemological terminology with the key terms: subject area, subject field, problem field and *problématique* as analytical tools (Wedege, 1998, 2001, 2006).

In any research process the *subject area* (the area to be investigated), is decided upon and a simple structure is formulated. Subjects within the area of adults learning mathematics might be, for example, the following phenomena:

- mathematics in adult vocational training;
- basic mathematics in the Brazilian adult education;
- adults’ views of mathematics; or
- learning mathematics as part of lifelong learning.

Taking the point of departure in a specific position, the researcher then adopts a certain view of the subject and identifies a *problem field* concerning the subject area by formulating problem complexes. In this way, the subject area is further structured into a *subject field*, the field which is actually investigated. Problem complexes might be, for example:

- the tension between the constraints and the needs felt by adults to learn mathematics;
- the neglect of developing adults’ statistical literacy in adult education; or
- the identification of adults’ mathematical understandings with common sense.

Within the community of ALM and other communities of research, problem complexes are formulated in the form of research questions and answers about the subject field on the basis of a specific theoretical and/or methodological approach, and a systematically linked problem field a

*problematique* is constructed. The subject field is opened and closed at the same time during this process. New questions, which could not be posed before the conceptualization, are formulated and as the complexity of the problem field is reduced other questions cannot be formulated. For example, questions concerning possible contributions from mathematics education to the development of adults' technological competences in the workplace presume a technology concept (Wedegé, 2000). The Danish proverb, "Som man råber i skoven får man svar" (generally translated to: "You get what you're asking for") represents one of the basic ideas in this concept of *problematique*. Another epistemological presumption is that problems formulated as research questions are the driving force of the research (Bachelard, 1949).

### Why do we need quality criteria?

The existence of criteria, no matter how provisional or incomplete, allows researchers to assess the quality of their work or the work of others, and it allows the field to see what progress, if any, is being made. [...] the criteria are lenses through which the research landscape can be viewed. (Kilpatrick, 1993, p. 31)

Any scientific discipline has its specific quality criteria. Hence, quality was naturally one of the dimensions to be debated in the search for identity of mathematics education as a research domain, at the ICMI study conference in 1994 (Sierpinska & Kilpatrick, 1998). The question discussed in the working group was: "What criteria should be used to evaluate the results of research in mathematics education?" The result of the discussion was a framework for examining criteria for the quality of research in mathematics education, and a series of questions for continuing the debate was formulated. One question was, "Could the relation of mathematics education to classroom practice generate criteria for quality in research in mathematics education?" Three of the papers presented at the conference dealt with quality (Hanna, 1998; Hart, 1998; Lester & Lambdin, 1998).

The issue of quality has not been on the agenda explicitly during the ALM conference sessions. In practice, the researchers answer the question about identity and quality of research papers in committees, in editorial teams or as referees in journals. According to the former chief editor, FitzSimons (2006) of *Adults Learning Mathematics – an International Journal (ALMIJ)*, the "refereed electronic journal has now been established to further develop the high quality work in this field" (p. 246). She presented and discussed the technical and conceptual requirements for the preparation of articles for the refereed journal, at the ALM12 conference in 2005. Instead of the timid question "could there be specific criteria for quality in the field of adults learning mathematics" the question might be formulated as: "What are the specific criteria ...?"

### Structuring and restricting the debate

As the issue of this article is specific quality criteria for research papers in the field of ALM, I have to clarify the meaning of the two terms "research" and "specific".

In clarifying research I follow Zan (2004) in her conception of *research* as "disciplined inquiry", meaning that in order to be "research" a study in mathematics education has to possess some characteristics, for example that:

- the study must be intentional enquiry, aimed to face a specific problem;
- the study must be connected with theory;
- the study must be connected with mathematics educational practice;
- the study must be public and verifiable; and

- the research procedures ought to be checkable.

This tentative answer to the question “What is research?” leads to the question “What is good research?”. Zan (2004) has proposed a list of quality criteria: objectivity, validity, generality, relevance, utility, ethics, originality, replicability etc. But a central point in her paper is that there is no agreement among researchers about these criteria and that the researchers’ epistemological choices play an important role in the choice of quality criteria.

In clarifying “specific” we need to consider – specific in relation to what? In my work, I lean on the debate within educational research and within mathematics education. As mentioned above, any scientific discipline has its own quality criteria. There exist general criteria for educational sciences. There are quality criteria specific to mathematics education. Furthermore, there are criteria for specific forms of theoretical and empirical research in education, for example fundamental research and action research. In order to assess quality in applied and practice-based educational research, Furlong and Oancea (2005) propose four dimensions and sub-dimensions of quality as presented in Table 1. I have chosen this example to illustrate the complexity of the quality debate in educational sciences, which also encompasses economic, technological and political issues.

*Table 1.* Dimensions of quality in applied and practice-based educational research (Furlong and Oancea, 2005, p. 15)

<i>Epistemic:</i> Methodological and theoretical robustness	<i>Technological</i>	<i>Capacity development and value for people</i>	<i>Economic</i>
Trustworthiness	Purposivity	Plausibility	Marketability and competitiveness
Builds on what is known + contribution to knowledge	Saliency/ timeliness	Partnership, collaboration and engagement	Cost-effectiveness
Explicitness	Specificity and accessibility	Reflexivity, deliberation and criticism	Auditability
Propriety	Concern for enabling impact	Receptiveness	Feasibility
Paradigm-dependent criteria	Flexibility and operationalisability	Transformation and personal growth	Originality
<i>Scientific robustness</i>	<i>Social &amp; economic robustness</i>		

The four dimensions of quality, in the analysis of Furlong and Oancea (2005), are the epistemic dimension, the technological dimension, the capacity development dimension and the economic dimension. In this paper, I restrict the discussion to epistemic questions concerning “methodological and theoretical robustness”. The five sub-dimensions of the epistemic dimension are trustworthiness; builds on what is known plus contribution to knowledge; explicitness; propriety; and paradigm dependent criteria. By *paradigm* they mean “a complex of epistemological/philosophical and methodological traditions, shared practices etc. used within a particular “epistemic community” (Furlong & Oancea, 2005, p.12), and they state that criteria may well vary depending on the particular paradigm used. With this broad meaning of the term “paradigm” – also compatible with the concept of *problematique* – I claim with reference to my analysis of the field (Wedege, 2001) that the core of the international research on adults learning

mathematics is dominated by a specific paradigm – or type of *problematique* – and thus are to be evaluated by similar quality criteria.

### **Research versus report**

When a referee comments on a research paper it is always necessary to assess both the research behind the paper AND the paper as a research report. The research being satisfactory is a necessary but not sufficient condition for a research report to be accepted. In terms of the report, there are particular criteria, e.g. location and discussion of the author's contribution to the research field and epistemological and methodological consciousness and reflection that need to be considered. Such criteria concern the quality of the conducted research. In order to structure the quality debate I suggest to distinguish analytically between:

- quality of the conducted research; and
- quality of the paper as a report of the research and its results.

In the literature on quality in mathematics education, we find this distinction in that some of the articles concern the research (Hart, 1997; Kilpatrick, 1993; Vital & Valero, 2003; Zan, 2004), some the research papers (reports or dissertations) (Dörfler, 1993; Hanna, 1998, FitzSimons, 2006) and some both (Lester & Lambdin, 1998).

The focus of this article is the report – not the conducted research – and I shall reduce the complexity of the quality debate further. The research field of ALM is situated in the borderland between mathematics and adult education (Wedge, 2001) and as such it is opened and closed by the two large fields. However, in my discussion, I further restrict the problem of quality criteria in two ways: (a) I look at research papers through quality criteria formulated within mathematics education research, and (b) I look for criteria for papers dealing with practice-related educational research – meaning that the research behind the report addresses a specific problem in the practice of adult mathematics education and not an epistemological, methodological or a purely theoretical problem.

### **General quality criteria for research papers in mathematics education**

At a symposium in Denmark on criteria for scientific quality and relevance in the didactics of mathematics, Dörfler (1993), former editor of *Journal für Mathematikdidaktik* and of *Educational Studies in Mathematics*, presented a list of requirements or demands, which he used to obtain a rather formal assessment of a research paper. By virtue of Dörfler's position in the field, these criteria might be considered as representing the first step towards what I seek: a checklist for any author of scientific articles in mathematics education. Here follows my summary of the list:

1. There should be an explicitly formulated rationale for the presented research: What are the goals? What is the motivation? The central research questions?
2. The research paradigm, the background philosophy should be made explicit and recognizable.
3. The employed research method and research design must be clearly stated and described -- especially when it is about empirical research.
4. In the case of theoretical papers or sections, assertions, statements and theses must be argued and made plausible within the assumed premises and framework.
5. In empirical research a clear and orderly presentation of the results is essential and the results must be strictly separated from their interpretation.

6. A general requirement is for a reasonable embeddedness in existing research and literature. Research is a social process and this should be reflected in every single paper to a certain extent.
7. The author must make plausible to the reader the relevance of the research to mathematics education. Not that the results could necessarily be applied in the classroom the next day, but in some way the paper should be concerned with teaching/learning mathematics.
8. Almost trivial are requirements like: clear and well structured, well defined or explicated terms and concepts, relatedness of the various parts of a paper, systematic referencing etc. (from Dörfler, 1993, pp. 85-87).

These criteria are relevant to all kind of mathematics education research, not only practice related research. However, all the points 1-8 concern the epistemic dimension of Table 1, and only one of the requirements (7), is specific to mathematics teaching and learning. But the criteria have been developed and formulated in the practice of two prominent journals in mathematics education research and, according to Dörfler (1993), “the specificity of mathematics education research derives from the range of human experience it studies and organizes” (p.79).

In (1) Dörfler claims the importance of making the research interest and questions visible, and in (2) he talks about the “research paradigm” (or “background” philosophy) which also has to be explicit. In (7), he states that the problems and the results have to be relevant to mathematics education. The three central criteria together are consistent with the concept of *problematique* where the meaning of the problem in mathematics education is seen as the driving and defining force in research (Wedege, 2001). Thus, it is possible in my work on specific quality criteria in ALM at the same time to use the terminology of *problematique* and to build on the general criteria formulated by Dörfler.

### **Specific quality criteria within the field of adults learning mathematics?**

In FitzSimons’s (2006) presentation at ALM12, the question of quality of an article for *Adults Learning Mathematics – an International Journal (ALMIJ)* was discussed in general terms; e.g. Does it make an original contribution to mathematics education for adults? And does it provide a well founded and cogently argued analysis?. But she also put forward a specific requirement: “Articles must be relevant to adult mathematics/ numeracy education (...)”. Here the criteria of relevance is defined in relation to research and theoretical perspectives; to debate; and to practice in the area of adults learning mathematics/ numeracy (FitzSimons, 2006 p. 246). Another specific criterion from the referee report of ALMIJ is that the submitted article should clearly be a study in the mathematics education of adults. FitzSimons presents the criterion like this:

... it is important to make the links to adults learning mathematics explicit. One of the problems faced by adult educators, internationally, is the definition of ‘adult’. Accordingly, it may be useful for the author/s to define the kinds of learners for whom the article is intended to be of relevance (e.g., early school leavers, older workers needing retraining, parents wishing to help their children, or new immigrants and others wishing to return to study/employment). Another ongoing debate is over the definition of terms such as ‘mathematics’ versus ‘numeracy’ or ‘mathematical literacy’, and so forth. Authors could briefly clarify their choice of terminology, explaining why they have chosen the particular term/s and what might be included as content or learning outcomes  
(Op cit p. 247).

In other words, the author must position themselves in the research field of adults learning mathematics. Given that we have a long series of international journals in mathematics

education it is important that any author submitting an article to ALMIJ makes explicit their reasons for this particular choice of journal. At a first glance the journal will publish articles concerned with “all aspects of adult mathematics/numeracy education”. A second glance shows that the conception of adult mathematics education is – and has to be – open to discussion and negotiation.

In the organising team of Topic Study Group 6 (TSG6), *Adult and lifelong mathematics education*, at the 10<sup>th</sup> International Congress on Mathematics Education (ICME) in 2004, we decided the following limitation – and opening – of the subject area of adult mathematics education in our call for papers:

By *adults* we mean people with the identity of citizens, workers, parents, un-employed, engineers etc. The term *lifelong* indicates that education takes place in all facets and spheres of life. By *mathematics* we mean multiple activities and knowledge, including academic mathematics, vocational mathematics, ethnomathematics, folk mathematics and adult numeracy. Regarding *education* we have adopted the terminology of UNESCO (2000) as a point of departure” with a distinction between informal, formal and non-formal education

(from “Aims and focus”, TSG6, ICME-10, 2004).

In TSG6 discussions, the issues were restricted to those following.

- Adult numeracy as a competence, building a bridge between school and personal, civic and working life.
- Adults’ beliefs, attitudes and emotions to mathematics, including their resistance and motivation to learn mathematics.
- The role of technology in adult lifelong mathematics education (informal, formal and non-formal).
- Global aspects, such as the role of large-scale studies of adults’ mathematical “needs”.

And the TSG6 concluded that: “Adult and lifelong mathematics education has multiple dimensions and we have to approach this subject area from psychological, sociological, anthropological, linguistic, philosophical, economic and political perspectives. The studies and experiences are likely to be linked with issues of class, gender and race” (from “Aims and focus”, TSG6, 2004).

Thus, it seems like the specificity of criteria for research papers and articles in ALM so far concerns the definition/limitation of the subject area in the study reported (what are the phenomena being investigated) and the opening of a problem field, for example the bridging of school and every day life, and adults’ resistance to learn mathematics. I propose that the next step in the quality work is a demand for clarification of the *problematique* within which the study is undertaken. The paper should explain and present its own *problematique* -- i.e. answer the following questions:

- What is the problem in the practice of adults learning mathematics and what are the central research questions of the study?
- Why is the problem being investigated – what is the purpose of the study?
- What is the theoretical/philosophical framework of the study?
- What is the methodological approach?

When the author gives an answer to these questions about the background, goals, framework and approach, at the same time he/she should respond to the following three questions, implicitly or explicitly:

1. What is adult mathematical knowledge (numeracy)?
2. How do adults learn mathematics?

### 3. Why teach mathematics to adults?

In this way, the reader will have information about the author's conception of and construction of the subject field (1), about the learning theory behind the study (2), and about the author's answer to the justification problem, which is closely related to the "what" and the "how" questions in mathematics education (3). Like this the author will present her/his position in research based on certain interest and values.

### Provisional conclusion

The purpose of this article is to present and discuss quality criteria for papers dealing with practice-related educational research on adults learning mathematics; i.e. where the underlying research addresses a specific problem in the practice of adult mathematics education and not an epistemological, methodological or a purely theoretical problem. As we have seen, in mathematics education it is a general demand that any research paper should explain and present its own *problematique*, i.e. background, purpose, research questions, theoretical framework and methodology. On this basis, I suggest that the specific quality criteria for papers dealing with practice-related educational research in adults learning mathematics as formulated in the last section, be taken as the conclusion of this paper and, hopefully, the beginning of the further debate in the international research community of adults learning mathematics.

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## **A willing suspension of disbelief? 'Contexts' and recontextualisation in adult numeracy classrooms**

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### **Abstract**

While a substantial body of research suggests that adult numeracy and literacy learners possess funds of knowledge and informal practices, it is not always clear to what extent these might be used in teaching and learning. In this study of linguistic interaction in adult numeracy classrooms, analysis of naturally-occurring student-student collaborative discourse is used to argue that mathematical word problems, even when designed for adults, do not draw on these funds of knowledge and out-of-classroom practices, and instead require a 'willing suspension of disbelief' by learners. Nonetheless, the adult students show a sophisticated level of metacognition and skill in handling the word-problem genre which might indeed be acknowledged as part of their funds of knowledge.

Key words: adult numeracy, word problems, funds of knowledge, peer-peer discourse, discourse analysis

### **Introduction**

A semblance of truth sufficient to procure for these shadows of imagination that willing suspension of disbelief for the moment (Coleridge, 1817, p. 442)

Mathematical word problems, based on everyday contexts such as the workplace, the home and the community, are the basis of assessment materials for nationally-recognised adult numeracy qualifications in England. This reflects policy discourses which suggest that adult numeracy learning should be functional and lead to increased employability and economic effectiveness (DfES 2001; DIUS 2007; DIUS, 2008). In one strand of my research into peer-peer discourse in adult numeracy classrooms, I was interested in whether the contexts used in such word problems were meaningful to adult learners and what affordances students were given to draw on their own out-of-classroom practices.

My approach involves the audio-recording of naturally-occurring student-student discourse generated during collaborative group work. Analysis of this discourse provides fresh insights into the students' experience of learning, and into the knowledge and practices they bring to the classroom and share with other students.

In this article I draw on two short episodes of talk during which students work together on word problems, and I critically analyse the text of one of these word problems. I use these analyses to consider: the relevance of the word problem genre to adult numeracy students; the extent to which the 'contexts' provided by such word problems may be regarded as meaningful to students; and the metacognitive and interpersonal practices which the students bring to bear on finding a solution.

## Background

### Skills for life in England

My discussion is located within the context of current policy for adult numeracy education in England; the *Skills for Life* agenda (*Department for Education and Skills [DfES]*, 2001) and the new impetus given to it by the recent *World Class Skills and Numeracy for Employability* strategies (*Department for Innovation, Universities and Skills [DIUS]*, 2007; 2008). Central to these strategies have been core curricula for adult literacy, language and numeracy, and a system of standards and nationally-recognised qualifications (Basic Skills Agency [BSA], 2001; Qualifications and Curriculum Authority [QCA], 2000). Funding is dependent on learners' achievement of these qualifications, and there is a strong focus on skills for employment.

While measures which raise the profile of, and funding for, adult literacy and numeracy provision, are to be welcomed, the strategies have been critiqued for their neo-liberal emphasis on economic effectiveness and workforce development; the deficit view presented of adult learners; and the prioritisation of funding for adults who are close to gaining accreditation rather than those with the greatest need (for example Papen, 2005; *National Institute of Adult Continuing Education [NIACE]*, 2007; 2008).

One of the underlying assumptions made by current policy is that numeracy (and literacy) for adults should be functional and relevant to real-life. This is expressed through the core curriculum, with its repeated references to terms such as 'straightforward', 'everyday', 'familiar' and 'practical' to distinguish adult numeracy from more esoteric and higher-status forms of mathematics (Oughton, 2007). It is also reflected – and this is what concerns us here – in many of the learning and assessment materials available to adult learners. Such materials rely greatly on mathematical word problems in supposedly 'real-life' contexts: from the home; from the workplace; and from commerce.

In a strong critique of artificial contexts in adult numeracy classrooms, Evans and Tsatsaroni (2000) warn of the dangers of 'an overly simplified notion of context as a "thin veneer" of applicability, that only *seemed* to make "word problems" in the classroom different from abstract calculations.' (p. 56, emphasis in original).

A student doing a calculation in shopping, has different purposes and constraints than when they are doing it in the mathematics classroom. The calculations have to be more accurate in the classroom, because that is what is required, or what it takes to keep the teacher happy, and because this is what is a valid answer in school assessment practices (Evans & Tsatsaroni, 2000, p. 59)

The characteristics of mathematical word problems have been extensively critiqued elsewhere (for example: Cooper & Harries 2002; Wyndhamn & Saljo, 1997; Verschaffel, De Corte, & Lasure, 2000). According to Gerofsky (1996; 1999), word problems generally have a three-part structure consisting of a 'set-up' to establish a scenario or minimal story-line, a number of items of information, and one or more question(s). Recurrent features of the genre include an anomalous use of tense, and arbitrary scenarios which have only a general bearing on the information components of the problem.

Dowling (1998) critically analyses a two-tier school mathematics textbook scheme, in which the books intended for higher-achieving pupils invite those pupils into the exclusive, 'esoteric domain' of academic mathematics. By contrast, the books intended for lower-achieving pupils position those pupils as interested in (and presumably destined for) manual, practical, functional numeracy tasks (the 'public domain'). Despite many adult learners' interest in mathematics for its own sake (Swain, Baker, Holder, Newmarch & Coben, 2005; Tomlin, 2002; Oughton, 2008), adult numeracy learners in England seem similarly to be positioned in

the functional domain by the curriculum, standards, and qualifications (BSA, 2001; QCA, 2000).

Over the last two decades, research in many countries has demonstrated that adult learners, including those often positioned as being in 'deficit' by policy-makers, have access to informal numeracy and literacy practices which are not legitimated by academic qualifications (Street, 1984; Gee, 1996; Barton & Hamilton, 1998; Lave, 1988; Saxe, 1988; Nunes, Schliemann & Carraher, 1993; Civil, 2003; Baker & Rhodes, 2007). Official discourse now encourages adult numeracy teachers to 'build on the knowledge learners already have' (Swain, Newmarch & Gormley, 2007, p. 7). A useful framework is Moll, Amanti, Neff, & González 's (1992) concept of 'funds of knowledge', developed in studies of Mexican families in Arizona. Moll et al. (1992, p.134) suggest that the concept provides a 'positive...and realistic view of households as containing ample cultural and cognitive resources with great, potential utility for classroom instruction'. Civil (2003) and Baker and Rhodes (2007) have further explored how a funds of knowledge approach could be used in adult numeracy teaching.

The term has been widened since its original inception, to include interpersonal and metacognitive skills, for example, in Hensley's (2005) categorisation of communication skills as funds of knowledge. It is suggested that metacognitive skills increase during early adulthood to peak in mature adulthood (Bakracevic Vukman, 2005), and this is reflected in Baker and Rhodes' proposal for a broader conception of funds of knowledge for adult numeracy learners, one that I find useful here:

the learners' knowledge and skills; their histories, identities, dispositions, personal attributes and beliefs; their expectations, motivations, aspirations, and experiences; their relationships to education, learning and to mathematics practices (Baker & Rhodes 2007, p. 2).

Collaborative group work is another development which is gradually gaining acceptance in adult numeracy classrooms. Proponents welcome the opportunity to break with the tradition of teacher-led IRE (initiation-response-evaluation) activity (Mehan, 1979, Swan, 2000, Swain & Swan, 2007). Collaborative approaches are becoming accepted as 'good practice', a view legitimised by the Office for Standards in Education (Ofsted ) in England, whose evaluation of mathematics provision for 14-19 year olds found that significant factors in high achievement included:

teaching that focuses on developing students' understanding of mathematical concepts and enhances their critical thinking and reasoning, together with a spirit of collaborative enquiry that promotes mathematical discussion and debate. (Ofsted, 2006, p. 5)

### **Classroom discourse as data**

The argument that the facts of greatest value for the study of education are those constituted in classroom interaction, and that they are most readily displayed in classroom talk, provides a persuasive reason for regarding classroom research as 'basic' research and recorded language as its vital evidence. (Edwards & Westgate, 1994, p. 55)

One of the difficulties in researching the numeracy practices of adults is the invisibility of many informal practices, such as calculating in one's head (Coben, 2006). In this study, I have recorded and analysed student-student discourse between adult numeracy learners working collaboratively in small groups to solve mathematical problems. The recordings provide privileged insights into the students' own experiences of learning which would not be available by observing teacher-led interaction.

Nonetheless we need to remember that the language used by students has passed through many filters, such as the vocabulary available to them to express their ideas; and the

social and cultural constraints which affect how they choose to share meaning with others – and this is before taking into account the interpretation of the researcher. Mehan (1984, p. 181) argues that:

By treating language as a mediating force in people's lives, sociolinguists have pointed out the importance of looking *at* the window of language and not just through it... acts of speaking and listening enable people to make sense of the world. That is, language transforms the world, changing nature into culture (my emphasis).

Traditionally, recording and analysis of classroom data has tended to focus on teacher-led discourse. This reflects not only the predominance, at least until recently, of teacher-led pedagogies, but also the methodological difficulties of obtaining naturalistic student-student discourse (Edwards & Westgate, 1994).

Recording and analysis of official and unofficial peer-peer discourse in secondary schools has been used powerfully in research by, for example, Maybin (2005) and Rampton (2006). Mercer and Sams (2006) investigate the discourse of collaborative mathematical group work in primary schools. However, peer-peer discourse in adult numeracy classrooms has rarely been examined, not least because collaborative group work has been, until recently, a relatively rare approach in such classrooms.

### **Methodology**

I draw on a set of methods and epistemologies which have in recent years been increasingly classified as linguistic ethnography. Linguistic ethnography involves the recording and analysis of naturally-occurring talk (and other interaction) in order to learn about the social settings and structures within which that talk takes place, and the ways in which these structures shape, and are shaped by, discourse. The traditional ethnographer's question: 'What is happening here?' is replaced by a slightly different one: 'What does the participants' language-in-use tell us about what is happening here?'

I also draw on critical discourse analysis of learning materials. Critical discourse analysis relates a 'fine-grained' analysis of written and spoken discourse to wider social structures, and is particularly concerned with exposing inequities and disrupting dominant discourses. There are overlaps and parallels between linguistic ethnography and critical discourse analysis, and the two methodologies may draw on and complement each other (Rampton et al., 2004).

The two episodes described here occurred as part of a larger study of peer-peer discourse in numeracy classrooms in adult community education centres in the north of England. I was particularly interested in what such discourse might reveal about the funds of knowledge brought to classrooms by the students, but also in other themes which might arise from linguistic and content analysis of the data.

The aim was to obtain discourse which was as naturalistic as possible, so the primary data collection method was unobtrusive audio recording (with the students' permission), supported by field observation. Interviewing and focus groups were occasionally used to clarify issues arising from initial analysis of the recordings, but these were kept to a minimum to avoid making subsequent talk less natural. Photographs were also taken of learning resources such as card activities.

Mobile phones were used as recording devices, placed unobtrusively on the classroom tables used for collaborative group work. Since the students also tend to place their own mobile phones on table-tops during classes, they have become 'part of the furniture' in these classrooms and participants tended to ignore them. Labov (1972) also suggests that speakers'

discourse tends to become more natural when they are intensely engaged in the subject under discussion, as the students were in their mathematical problem-solving. Students seemed quickly to forget that they were being recorded, and the data appears to be as naturalistic as can reasonably be expected.

The audio recordings were then transcribed for analysis, using field notes to enrich the transcription, where relevant, with information about students' movements and gestures and the resources used.

Themes emerging from the analysis include: differing roles taken by students within the group during discussion; linguistic devices used to negotiate ideas and express degrees of certainty; use of self-deprecation and humour (there is a lot of laughter in the recordings); the recurring metaphor of mathematical problem solving as a journey; relationships between the students' own learning and that of their children; and the out-of-classroom practices drawn upon by the students. The episodes below have been selected as illustrations of a theme which occurred throughout the study; that students rarely seemed to relate context-based mathematical word problems to life outside the classroom. The first involves mixing drinks in a given ratio; the second involves calculating a percentage using data about industrial fatalities.

All names used in this article are pseudonyms, and ethical approval for the research was obtained from the University of Sheffield, UK.

### **The classroom, the teacher and the students**

The episodes described below occurred during adult numeracy classes in two of the participating centres. All literacy and numeracy classes at these centres are funded by the Learning and Skills Council (LSC), so students are required to work towards a recognised numeracy qualification. This renders a supposedly negotiable curriculum compulsory, as learners must be taught the numeracy skills needed to gain the qualification. Enrolment for these classes is flexible, allowing students to join at any time during the year, and to continue until they have achieved the qualification they need (typically the National Certificate in Adult Numeracy). Opportunities to sit tests for this qualification are offered throughout the year.

The participating teacher, Elizabeth, is the most experienced of the numeracy teachers at these centres and (as a teacher-educator) I consider her to be an exceptionally good teacher. She has a strong subject knowledge, including a first degree in mathematics, and a commitment to a variety of participatory approaches to teaching and learning. I worked with Elizabeth to select those of her classes in which the students had responded well to collaborative group work. The classes chosen were all 'discrete' numeracy classes, in that numeracy learning was not embedded within another subject such as a vocational course.

The students in the classes were predominantly women, white-British and aged between 23 and 50 years old. Although classes are also open to men, the predominance of women is not unusual at these centres, where many of the learners are women 'returners', hoping to gain qualifications in order to return to work or further study as their children grow older. The ethnic homogeneity of the groups is representative of the semi-rural towns in which the adult education centres are based.

I cannot claim that my findings here are generalisable, and indeed the classes were selected as ones likely to generate discourse. The events must therefore be regarded as 'telling' cases, which serve to illuminate our understanding (Mitchell, 1984). As a teacher-educator who has observed many numeracy classrooms, I would suggest that while the students, the learning materials, and the community setting were 'typical'; the teacher – and the emphasis she placed on collaborative learning – were not.

### Episode one: Diluting drinks

This episode occurred in a class three weeks before most members of the group were due to sit tests for the National Certificate in Adult Numeracy at Level 1 and Level 2 (Level 2 being the target level for completion of compulsory schooling at age 16 in England). The previous week, Elizabeth had asked the students what they would like to work on next, and the students had chosen 'ratio' as a topic which many of them found difficult.

Six students attended the session, all of whom had attended before. Elizabeth introduced the topic by asking the students how ratio might be used in everyday life. They responded with examples such as: cooking; mixing squash (diluting concentrated drinks); mixing weedkiller; calculating betting odds; and the ratio of boys to girls in classrooms. This was followed by a short but challenging abstract activity in which students practiced expressing ratios in their simplest terms.

Elizabeth then gave out copies of a worksheet with word problems set in a 'real-life' context of diluting concentrated drinks – a situated practice already mentioned by the students in their introductory discussion. An extract from this worksheet, and two of the students' discussion as they attempted to solve a word problem together, are presented and analysed below.

#### Diluting drinks: Learning materials

The worksheet given out by Elizabeth is from the *Skillsheet* series of books (Henry, 2005), which contain photocopiable numeracy worksheets written for adults and older teenage learners. The worksheet is taken from the *Ratio* book and is themed around dilution instructions for concentrated juice drinks. The page begins with a discussion and explanation of the dilution instructions:

**INSTRUCTIONS**

**Dilute one part orange**

**with 4 parts water**

(Henry, 2005, p. 1)

The author of the sheet appears has attempted to make the context meaningful to adult learners. The dilution instructions are presented as though they are a label on a juice bottle; there is a simplified explanation of what the instructions mean, allowing self-study; and there is a section at the bottom of the page which discusses a weaker dilution for toddlers.

However, the problems on the sheet (discussed by the students in the transcript below) conform to the word problem genre commonly found in school classrooms. The first problem is as follows:

Question 1

Selina is making **diluted** juice in a large jug.

She pours two cups of orange into the jug.

How many cups of water does she need to put in ? \_\_\_\_\_

(Henry 2005, p. 1, emphasis in original)

This conforms to many of the characteristics of mathematical problems critiqued in the literature reviewed above, including the anomalous use of tense; the three-part structure of set-up, numerical information and question; and the arbitrary nature of the context.

We can further apply the principles of critical discourse analysis (Fairclough, 1989) to relate texts within this genre to wider power structures in adult numeracy education, and to the underlying assumptions about adult numeracy learners which feed into, and are maintained by, such texts. Fairclough suggests that power in written texts is one-sided, and the producers of texts address an 'ideal subject'. Readers must negotiate a relationship with the ideal subject, and will often feel that they should 'fall in' with this subject position, rather than oppose it. The *Skillsheets* promotional website claims that the worksheets 'teach basic maths in a straightforward and understandable way'; that 'topics are presented clearly and methodically with small steps of progression', and that 'where possible familiar contexts are used in sensible real-life situations' (Henry, 2008). The series thus complies with the expectations of policy by positioning adult learners, as the 'ideal reader', firmly in the functional (or 'public') domain.

### **Diluting drinks: Student talk**

The following transcript shows how two students, Jackie and Dawn, worked together to solve the word problem in Question 1 (reproduced above) of the *Diluting Drinks* worksheet.

Note on transcript conventions, which I have kept to a minimum.

(...) indicates indistinct words

[ indicates overlapping talk.

1. Dawn (reading from worksheet) "Selina is making dilute juice (...) she pours two cups of (...) into the jug. How many cups of water does she need to put in?"
2. Oh, right so it's ... four parts ...
3. Jackie Just a minute ... (reading from worksheet indistinctly)
4. Sorry, I'm a bit slower than you
5. Dawn How many cups of water does she need to put in?
6. Right, so...
7. So it'd be four cups, wouldn't it?
8. Oh no, no, it's eight of water...
9. (reading) "She pours two cups of orange into the jug..."
10. Right, so that, that's just for one part...
11. Jackie Shall we work it out, on some paper or something...?
12. Dawn (...) Here, right, what you got here, it's four, four for one, yeah? That's water.
13. Jackie Yeah
14. Dawn Yeah, and that's orange
15. Jackie Orange is [one
16. Dawn [yeah
17. Right, but she, she puts...
18. Jackie Two [cups...
19. Dawn [Two
20. Jackie Two cups of orange, so that's [eight parts
21. Dawn [yeah
22. Jackie eight parts water...
23. Dawn (encouraging) Yeah?

24. Jackie Is that right there?  
25. Dawn Yeah, eight parts water ... to two [parts  
26. Jackie [to two [parts of orange  
27. Dawn [Right  
28. So, how many cups of water does she need to put in, so it'd be eight  
29. Jackie Yeah  
30. Dawn (quietly, checking answer sheet) I think its eight, is it eight?  
31. (more loudly) Oh no, she's put twelve, oh no, it is eight  
32. Jackie Did she?  
33. Dawn Yeah, it's eight.

While transcripts such as these give us tantalising glimpses into many aspects of work, relationships and structures within adult numeracy classrooms, here I focus on Dawn and Jackie's approach to solving the word problem, and the extent to which they related the problem to out-of-classroom practices.

Dawn and Jackie's talk shows their acceptance and familiarity with the word problem genre. They did not refer to any occasion on which they have diluted drinks for themselves or others, nor did they question whether exact measurement is the only satisfactory way to mix the drink. They did not ask each other who 'Selina' might be, nor did they question the anomalous use of the present indicative tense, but continued its use in their own discourse. Their discussion demonstrated their understanding that they are expected to extract numerical information from the arbitrary referents in the problem (which they did in line 12), and to perform a calculation which, if done correctly, will result in the 'right' answer (which they successfully completed in line 20).

On obtaining an answer, Dawn and Jackie's discourse does not reveal any attempt to make sense of their answer, for example by considering whether the resulting total of ten cups might be expected to fit in the 'large jug' referred to in the original question. In fact, they did not talk of having made ten cups worth of diluted drink. Their talk focussed on the 'eight' which they believed to be the 'right' answer, but which they accepted only when they checked it on the answer sheet (line 31).

Dawn and Jackie's acceptance of this word problem interested me, because I suspected that most adults do not measure ratios accurately when diluting drinks. Later I asked students from the same class what methods they used to dilute drinks, particularly when mixing large quantities of drink. Between them, the students listed a wide range of methods, few of which bore any similarity to the one used by 'Selina' on the worksheet. The most commonly mentioned was approximating a quarter by eye or by markers on the squash bottle, but other methods included looking at the colour of the mixed drink, listening to the sound of the liquid filling an (opaque) container, and tasting the drink. All the students denied ever measuring accurately. As one of the students, Charlotte, said: 'I've more important things to do.'

Many of the students mentioned additional social dimensions to diluting drinks. Charlotte acknowledged that she might be more precise if she was 'counting calories'. Denise described the personal taste preferences of her children, and her young daughter's growing independence in choosing to mix squash for herself. Dawn explained how she 'goes mad' at her son because he pours in too much concentrate. Christine referred to a childhood in which money and other resources were scarce:

I'm thinking back to what my Mum did, because I come from five sisters, and my mum used to keep an eye on everything. So she'd say: Oi, you've had too much and there's not enough for everyone else. So it's like sharing as well.

As they solved the diluting drinks word problem, Dawn and Jackie did not appear to draw on any of these real-life practices or considerations. However, they did appear to draw on broader funds of knowledge in their understanding of what is expected of them when working with word problems of this genre. Although the word problem is presented as 'realistic', they appeared to understand that they must not allow it to become too real. For example, they are not expected to consider whether the people who will be drinking 'Selina's' juice are dieting, or have preferences for stronger or weaker drinks, or concerns about additives and artificial sweeteners. I suggest that this may be regarded as a 'willing suspension of disbelief'.

### Episode two: Construction industry fatalities

The second of the two events occurred in the same class two weeks later in the term. Again, six students attended, of whom five participating students, Charlotte, Dawn, Gemma, Jackie and Ruth, were working collaboratively on a sheet of percentages word problems. The session had been intensive, with the students carrying out a range of teacher-led and small group activities involving equivalences between fractions, decimals and percentages.

Elizabeth had also demonstrated methods of calculating percentages without calculators. This was very much focussed on the coming examinations, in which the candidates are not allowed to use calculators. All the students had found these topics very challenging. This extract is taken from near the end of the session; the part of the transcript immediately preceding this episode indicates that the students are getting tired.

#### Construction industry fatalities: Learning materials

The percentages worksheet used for this activity was chosen by the tutor, Elizabeth, from the *Skillsworkshop* website (2008). It contains ten 'Level 2' percentages word problems, requiring students to find given percentages of amounts, and to find one amount as a percentage of another. The contexts for the word problems are predominantly financial, for example discounts on purchases, but there are also a few other contexts, including the one discussed here:

#### Question 4

Over 2004 there were 220 fatal accidents in the Construction Industry.

55 of them were on building sites.

**What percentage of the total fatal accidents was on building sites?**

(Skillsworkshop, 2007, emphasis in original)

All resources on the *Skillsworkshop* website are contributed and maintained by volunteers. I do not intend to critique this worksheet, but to comment on the students' reactions to it.

The worksheet does not actually specify whether the figures used in the problem are supposed to be for the United Kingdom (UK) or for a different country, but according to the UK's Health and Safety Executive (HSE, 2005), there were 220 fatalities across **all** occupational sectors, and just 72 in the construction industry in the year 2004/5. Thus the figures on the worksheet are around three times higher than the UK figures (and have presumably been chosen to result in a familiar percentage). The same HSE press release reminds us that "behind these figures are enormous personal tragedies involving the unexpected loss of family and friends." (HSE, 2005).

### Construction industry fatalities: Student talk

The transcript begins from the point at which the students move on from the previous problem; no other discussion of this problem has taken place.

1. Ruth Right, (paraphrasing from worksheet) two hundred and twenty fatal accidents, fifty-five of 'em building sites.
2. (reading) ["What percentage of the total fatal accidents...?"]
3. Dawn [right, so you've got two hundred and twenty
4. Over... fifty-five
5. No, no, it's the other way round isn't it?
6. Gemma Is it the other way round
7. Dawn I don't [know
8. Ruth ["What percentage of the total fatal accidents...?"]
9. Dawn Yeah, it's – I think it's that way
10. Jackie Which way?
11. Gemma Is it the other way round, yeah?
12. Dawn I think so
13. Ruth Fifty-five, yeah, over two hundred and twenty
14. Dawn Yeah, so you've got to cancel that down
15. Ruth And how d'you do that then
16. Dawn Five'll go in to it, won't it?  
Five, ten, fifteen, twenty (whispered)
17. Ruth (...) is eleven
18. Dawn Yeah. How many fives into two hundred and [twenty?
19. Ruth [Well fifty's ten, a hundred is twenty
20. (laughing) One hundred and fifty is what, thirty?
21. Forty, forty-four
22. Forty-four?
23. Charlotte Yes
24. Ruth So it's eleven forty-fourths? (laughs)
25. Jackie Oh, no
26. Ruth We surely can get lower than that
27. Dawn Yeah
28. Charlotte Because [eleven
29. Dawn [Yes, eleven'll go into forty-four  
So it'll go in one, and four, so it's a quarter
30. Charlotte Yeah
31. Ruth Hang on a minute, whoa, whoa, whoa
32. Now you've got me now
33. Gemma Do you know your eleven times table?
34. Ruth Eleven, twenty-two, thirty-three, forty-four.
35. Charlotte Yeah
36. Dawn So eleven'll go in -
37. Ruth [Hang on, hang on
38. How do we suddenly -
39. Because I would have been thinking, what does that, and that, go into?
40. What goes into both of them?
41. Dawn Yeah, [yeah

42. Gemma [Eleven  
43. Jackie So it'll just be one, won't it? Because only one eleven goes into eleven.  
44. Ruth Yeah, I'm with you, I'm with you  
45. The bottom is [forty  
46. Dawn [Eleven'll go into itself once  
47. And it'll go into the bottom (...)  
48. It's a quarter  
49. Ruth Yeah I'm with you  
50. (...)  
51. Charlotte So that's 25%

The students then move on to the next problem on the sheet.

I have purposely included the students' entire discussion on this problem from their first reading of the question through to their obtaining the answer as a percentage, in order again to illustrate a pattern which recurs throughout the data I collected; that the students extract numerical information from the word problem and carry out their calculations, without responding in any way to the context in which this problem is set. We can usefully divide this episode of talk into two parts: lines 1-13 and lines 14-51.

Lines 1-13 are concerned with extracting the relevant numerical data and mathematical relationships from the problem. Although Ruth reads out the emotive word 'fatalities' three times during the episode (lines 1, 2 and 8), the students focus on the numbers, grappling only with the difficulties of which number is the denominator. Although Ruth's paraphrasing of the question in line 1 suggests her understanding of the structure of the problem, she does not reflect aloud on the significance of the context. It seems that the students disregard the context of the word problem here completely, even when the context makes statements that one might expect to provoke concern, shock, or at least a query as to their validity.

From line 14 onwards, the students react to the problem merely as an instruction to find 55 as a percentage of 220. Once Gemma has made her case that 220 should be the denominator rather than the numerator, the students' discussion is solely of arithmetic from line 14 through to the correct solution at line 51, centring largely on the identification of eleven as a common factor. Again the students have 'suspended disbelief' and concentrate on getting the 'right' answer.

Nonetheless, the students' talk again indicates that they draw upon metacognitive and interpersonal funds of knowledge. As before, the students demonstrate their familiarity with the word-problem genre and its conventions of simplified numerical relationships. For example, Ruth recognises (line 26) that  $11/44$  is an unlikely answer, even though she has not yet spotted the equivalence to a quarter.

Ruth's ready admission that she has not understood how the others have cancelled down the fraction (lines 31, 32 and 37) is typical of these students' willingness to share doubts and uncertainty, and clearly reflects the supportive nature of the group. This is also reflected as the students show patience and a variety of explanatory approaches in ensuring that Ruth eventually comes to understand (lines 33-48). For example, lines 43 and 46 show Jackie and Dawn's alternative attempts to explain the same idea to her.

### Discussion: Contexts or recontextualisation?

The word 'context' need not apply only to scenarios in word problems. A wider definition will embrace any site or setting in which numeracy takes place. Bernstein (1996) uses the term *recontextualisation* to describe the way a field is changed as it is transferred from its original site to pedagogical practice. (For example, woodwork as it is taught in school bears little resemblance to the work of a carpenter or joiner). The classification and framing of 'ratio' and 'percentages' as autonomous mathematical topics is a typical example of recontextualisation in classroom mathematics. At higher levels of mathematics, the concepts are merely different ways of describe the quotient of two numbers and would not be regarded as 'topics'.

Recontextualisation, whether of academic mathematics or of situated numeracy practices, opens up a space in which ideology inevitably plays a role in selecting what is to be learnt from the total knowable. In both the episodes I describe, the learning and assessment materials have recontextualised mathematical knowledge into an easily-recognised discourse with which learners can become familiar through intertextuality. Features of the discourse include the emphasis on functional numeracy, the familiar structure of word problems and the expectation of a simplified version of 'real-life'.

Street's (1984) distinction between ideological and autonomous models of literacy may usefully be applied here to numeracy. An ideological approach would take into account students' beliefs, goals and attitudes, and the power structures within which learning takes place. The relevance of mathematical topics to students' lives might be critically reviewed, and contexts which are related to social concerns (such as industrial health and safety figures), might be questioned and discussed. Similar approaches, such as a critical analysis of time and motion study data, are advocated by Frankenstein (1998).

Instead of being given opportunities to draw on their funds of knowledge and out-of-classroom practices, students were required to willingly suspend disbelief where the narratives of word problems did not reflect the real world, and to recognise that, despite the superficial appearance of a 'realistic' context, they were not expected to take realism too far.

Nonetheless I contend that, in solving these word problems, the students do use the broader interpersonal and metacognitive funds of knowledge described by Rhodes and Baker (2007). For example, they draw on funds of knowledge about the discourse of mathematical word problems and how to focus efficiently on finding the required solution. When working together, they admit doubt, challenge each other's responses, and support each other in group activities using a variety of approaches to explain and clarify. Even their use of humour, prevalent throughout the recordings, may be regarded as a resource (Baynham, 1996). Other parts of the data show how the students share and pool metacognitive strategies such as eliminating easy possibilities first, and using different forms of visualisation. As Dawn remarked in an earlier session: "We all play teacher".

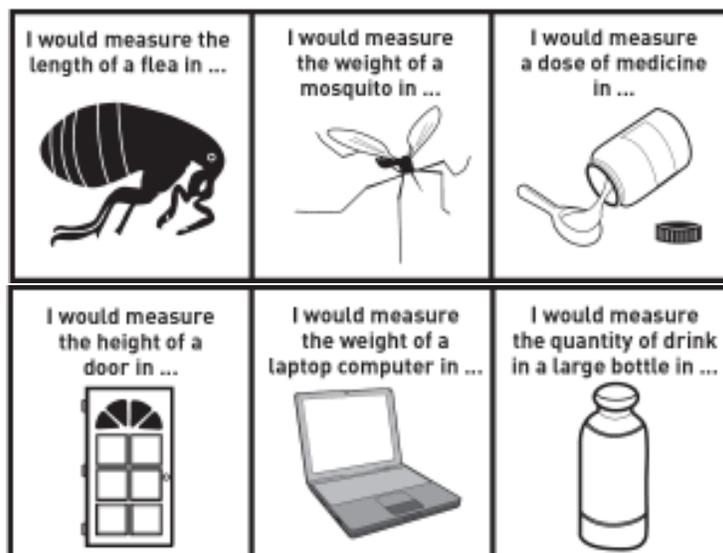
Ultimately, for students needing a numeracy qualification to fulfil career goals, these classroom numeracy skills may be a more valuable type of knowledge for their purposes than out-of-classroom practices, particularly where assessment for qualifications is based on word-problems. Our broader conception of 'context' is useful here in considering the needs of adults whose purpose in doing mathematics is to gain a qualification:

Context... refers to the framing of those occasions when numeracy is done and the purposes for that use of mathematics. These purposes and contexts depend on the individuals engaged in their numeracy practices. An appropriate context and purpose for one person may not be so for another. (Street et al., 2005, p. 22)

### Possible alternatives: A closer match between purpose and context

Not all learning materials and approaches rely on the 'thin veneer' of context. One example is the *Thinking Through Mathematics* project which uses a wide variety of abstract mathematical problem-solving activities to engage and motivate learners (Swain & Swan, 2007). The project does also include activities related to out-of-classroom numeracy practices, but these do not use the fictional narrative devices used by traditional word problems.

For example, the sample below shows six cards from an activity in which learners are required to match 24 such cards to appropriate units of measurement. The text uses the conditional mood to relate the activity directly to the learners' own practices.



(DfES, 2007)

The following extracts are taken from recordings of students working with these cards in another of the adult numeracy groups in my study. Rather than passively accepting contexts for word problems, as in the majority of discussions I recorded, here the students are playfully critical of contexts they don't consider relevant to them. Note how the conditional mood is maintained.

1. Judith (reading) "I would measure the weight of a mosquito in..."
2. Sally I wouldn't
3. (extended laughter from group)
4. Abigail (grim tone) Depends how much blood he's had
5. (more laughter)

The same card activity also resulted in some of the very few discussions recorded during my study in which students spontaneously drew on their out-of-classroom funds of knowledge to scaffold their formal learning. The following is one example; other practices discussed during this activity included filling cars with fuel and mixing concrete.

6. Donna I tell you what I always struggle with
7. You know, like **litres**
8. How many millilitres are there (...) Is it a thousand?
9. Abigail Mmm

10. Donna I get confused, because you think like 'mil' is a million
11. Abigail (showing her water bottle which is on the desk)
12. Yeah, well, if you think, one of them is five hundred millilitres
13. So two of them is a litre
14. Donna A litre
15. Abigail So, like, obviously if you do it in CL it's like, um
16. Donna Centilitres... A hundred? No
17. Is it a cent – centilitre. A hundred, isn't it?
18. Judith Forgotten
19. (laughter)
20. Abigail Some of them do have 'CL' on them, most of them have millilitres on
21. Donna Wine bottle have centilitre on them, don't they?
22. (...) centilitres (...)
23. Judith A hundred centilitres is a litre, so it's right
24. Donna Oh, right. So a thousand millilitres is one litre
25. Abigail With water, sometimes you can buy it and it says five hundred mil
26. Sometimes you buy it and it says centilitres
27. I think it depends if it's foreign water, or different places measure it in different ways, don't they, like -
28. Donna Oh yeah. So, half a litre is fifty centilitres.

While it is not possible to draw generalisable comparisons from a single activity, the difference between the above extract and much of the other data I recorded is so marked as to suggest that this is worth further investigation.

However, given the nature of current formal assessment materials, which in England are based on traditional word problems, such approaches would not prepare students to succeed in gaining numeracy qualifications, even if the activities do help them to develop the numeracy practices they might genuinely need once they progress from the classroom.

If adult learners can develop the metacognitive funds of knowledge required to gain qualifications, does it really matter if the word problems they are expected to solve bear little relation to real life? Clearly it is useful for learners to be competent in the discourses needed for success in their qualifications. However, it seems a sad reflection of assumptions about mathematical learning for adults that they are obliged to be so. If numeracy examinations assess nothing more than the ability of adults to pass those examinations, then we must ask what the point is in such qualifications.

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## **Trickle down mathematics: Adult pre-service elementary teachers gain confidence in mathematics – enough to pass it along?**

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### **Abstract**

Much research (Ma, 1999; Cohen & Leung, 2004; English, 2003) has been done on mathematics education and pre-service teachers with special emphasis on how the mathematics is taught and the psychology of the pre-service teachers. While there is concern among North American mathematicians that mathematics instruction in K-12 grades needs to be improved (Ma, 1999), how that can be achieved is an ongoing debate. This study, while recognizing the need for significant changes to the preparation of our elementary teachers seeks to look at a subgroup of pre-service teacher candidates – adult learners who are coming to the profession after accumulating several years of life experiences. Are their experiences similar to non-adults preparing for the same vocation? In what areas are they lacking? In what areas are they more superior? How should a teacher education program be designed to prepare these adult learners to teach mathematics effectively? In this study, we will compare these adult learners to non adult learners in the same class and discuss aspects of the pre-service program that succeeded in affecting their beliefs, confidence and mathematical competency.

Key words: mathematics; pre-service; adult; teach; practicum; teacher

### **Introduction**

Teachers in Ontario can be certified in two main ways: by obtaining a Bachelor of Education (B.Ed.) in a concurrent program that normally takes five years, or by completing a degree in any specialty and then continuing on to a one or two year consecutive B.Ed. degree through a faculty of education. As a requirement of certification, students must choose a division: Primary-Junior (PJ) refers to those who are generalists teaching from Kindergarten to grade 6, Junior-Intermediate (JI) refers to those with one teachable subject (for which they have satisfied a certain number of hours of coursework in their undergraduate degree) who will teach grades 4 - 10 and Intermediate-Senior (IS) refers to those who have two teachable areas and can teach from grades 7 – 12 in a secondary school. After receiving initial certification, teachers are able to augment their credentials by enrolling in Additional Basic Qualifications which will allow them to move from one division to another. There are currently 18 faculties of education in Ontario with most of them offering one degree leading to PJ, JI and IS certification by the Ontario College of Teachers.

For the purposes of this paper, adult learners are defined as those who have had extensive life experiences or other training prior to enrolling in the bachelor of education program. Casual

conversations with these adults reveal that many do not fondly recall learning mathematics when they were younger. Many of these adults are now choosing to start second careers as elementary teachers who must, by virtue of the Ontario classroom system, teach mathematics as part of their core curriculum. Whereas faculties of education the world over recognize the need to demand some mathematical competency prior to admission into a teaching program (Burton, 1987), the reality is that the need for teachers in many rural and inner city schools requires that Education faculties recruit the teachers first and then bring them up to an acceptable level of mathematics competency while they are in the pre-service program. This acceptable level of mathematics competency has been cause for concern in the past decade and Liping Ma's comparative work on math education of pre-service teachers in the USA and China highlighted in no uncertain terms that something major was lacking in how North American teachers are trained to teach elementary mathematics (Ma, 1999). In June 1998, the Californian Conference Board of the Mathematical Sciences appointed a steering committee for the purposes of addressing the problem of teachers who were teaching mathematics without proper training. A conservative estimate of 50% middle school and high school teachers teaching mathematics without even a minor in mathematics was enough of a reason to convene such a meeting. The tension in today's mathematics classroom is testament to the fact that the teaching of mathematics, having already gone through much change in the past century is due for another overhaul (Wu, 2006). How we motivate our students to appreciate, enjoy, study and understand mathematics is now one of concern in the wake of results in the latest 'Trends In Mathematics and Science Studies' (Gonzales, Guzmán, Partelow & Pahlke, et al., 2004). Since there is no fundamental reason to think that today's students are incapable of comprehending mathematics compared to students a couple of decades ago, one must look to those who teach these students to try to understand the issue of below average mathematics performance. Who are these teachers, how are they being taught and most importantly, what is being done to support them to enable them to teach a cohort that learns differently, lives differently, thinks differently and tends to apply concepts differently from those teaching them? For, while adult pre-service teachers are very motivated in their newly chosen profession, there is no doubt that their inability to block out previously held (and inherently erroneous) beliefs in mathematics education is a contradiction in terms (Wedeg, 1999) since these learners bring a wealth of experience and common sense competence from their everyday lives. One of our adult students observed:

'Some types of math have always been a struggle; however, I am strong in business math. I have a business minor - after I completed my first degree in English and Psychology, I began working on my business diploma, so there are some aspects of math I really enjoy. Our math text notes that education received before 1988 is considered "traditional" math. I graduated from high school in 1988 so all of my math experience is traditional. It was quite a struggle trying to get my mind wrapped around the constructivist theory, after have a rote education in math'

### **Format of study**

Participants in this study all came from one pre-service class, in one Education faculty and were all female. They were also all students in the final year of a B.Ed program as either consecutive or concurrent students. A number of these pre-service teachers began the B.Ed program after having held full time positions in other areas such as nursing, social work & hospitality. These students were those classified as adult students. Of the 30 students in the class, 22 were under non-adults (73%) and 8 were adult (27%).

The primary author was the instructor for the course on *Teaching Mathematics in Elementary School (EDU441 PJ)*, a semester course designed to be delivered face to face for 8 weeks (twice weekly; 90 minutes each session) with a 6 week practicum component. The

underlying purpose of this course, is to develop awareness and understanding of classroom theory and practice in mathematics. Education 441 PJ supports the learning expectations outlined in the Ontario Ministry of Education curriculum policy documents and the departmental mission statement of Redeemer University College. Students in the course are expected to:

- develop a strong foundation and understanding of the vision and underlying philosophy related to mathematics in the primary and junior divisions;
- explore topics and issues of relevance to the teaching of mathematics within the framework of the expectations set forth in the Ministry of Education curriculum policies and guidelines;
- gain an appreciation of the structures of creation, the intrigue and excitement of the mathematical relationships, the cultural changes in the approach to the role of mathematics, commitments to students and student learning;
- acquire knowledge of the mathematics curriculum; and
- become aware of the components of a positive learning environment for mathematics.

The course includes the exploration of:

- the current trends in the standards of school mathematics;
- how children learn mathematics with understanding;
- the role of the teacher in mathematics, planning and assessment;
- a study of the fundamentals of the five major strands of the primary/junior and junior/intermediate mathematics curriculum; and
- new approaches to mathematics, strategies for lesson planning, active learning, assessment and evaluation, the use and role of technology, and resources for teaching mathematics.

The theoretical perspective of the study was therefore based on the five key elements of the Ontario College of Teachers Standards of Practice for the Teaching Profession and provides the focus for the teaching of mathematics while the Ethical Standards for the Teaching Profession, also from the College of Teachers, provide the framework for student learning about the development of principles of the teaching profession. Education 441 PJ is part of the Redeemer University College program of teacher education that seeks to foster an attitude of continuing professional development so that the teaching of mathematics is not a static set of practices, but a commitment to personal and professional growth.

The course was delivered through five broad areas of (i) teaching methodologies, (ii) 6-week practicum in an Ontario classroom, (iii) one-on-one tutoring component with a student struggling in mathematics (iv) a series of reflections & papers looking at the history of mathematics, famous mathematicians and the relevance of mathematics in our lives and (v) whole class mathematics competency tutorials. The practicum and one-on-one tutoring were carried out during the same 6 week block of time for convenience. Most students reported that this arrangement worked well.

A pre-study survey (survey 1) was carried out in the first week of the course to establish answers to questions related to:

- age & mathematics background of participants [This was always asked in subsequent surveys];
- beliefs about who and what makes a good mathematics teacher;
- teacher's confidence in her own mathematical ability; and
- basic Mathematical competency of teachers.

A second survey was carried out midway through the course, when all students had passed the required competency test, worked on reflections and had experienced 4 weeks of methodologies. The main focus of that survey was to see if there were any changes in:

- beliefs about who and what makes a good mathematics teacher; and
- teacher’s confidence in her own mathematics ability.

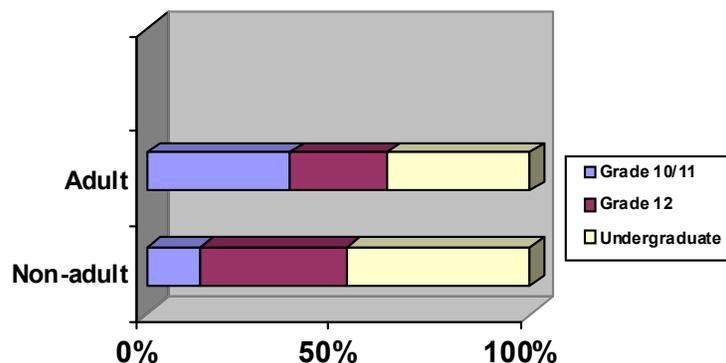
The third survey was carried out at the end of the 14 week course, asking questions about:

- beliefs about who and what makes a good mathematics teacher;
- the teacher’s confidence in her own mathematical ability;
- whether the practicum changed the pre-service teacher’s perception about beliefs and confidence in mathematics; and
- whether various activities (e.g. tutoring a student) during the practicum changed teacher perception of beliefs and confidence?

The authors recognize that there are obvious limitations to this type of study: using only one faculty of education, a study involving the author’s own class, one-gender participant pool and a small statistical sample. However, the one-gender participant pool helped clarify some of our results and through this study, the authors hope to shed light on the emerging trend of adult students and hopefully glean some insight into the various components of an elementary mathematics education program that will best help them to be most effective in their future classrooms.

### Survey results

The response rate for survey one was 100%, survey two was 81% and the third was also 81% with approximately 6 weeks between each survey. Analysis of the sample population showed that the education level differed by age. Only 62% of the adult learners completed upper level high school mathematics courses (Grade 12 or higher) while over 85% of the rest completed that same level of mathematics education. Further, we noticed that only 38% of adult learners completed some university-level mathematics courses while nearly 50% of non-adult learners completed the same. It is evident therefore that adult learners in this sample size have had less tuition in mathematics than non-adult learners in the class.



*Figure 1.* This figure is an expression of the highest level of mathematics education the students completed. A much larger percentage of students under 25 years (non-adult) completed post-secondary studies in mathematics than the adult learners.

When we asked respondents at the time of the first survey, to agree or disagree (i.e. is the statement true or false?) with the statement: ‘You’re either good in mathematics or you are not’ (i.e. is it an innate ability?), 37.5% of adult learners agreed with the statement, while 27.3% of non-adults agreed. By the second survey, the adult learners who agreed were still at 37.5%, and the non-adults who agreed with this statement had dropped to 11.8%. By the third survey, at which time the practicum was over, we observed that 42.9% of the adults agreed with this statement while 5.6% of non-adults agreed. Although the entire class believed overwhelmingly that mathematical ability was not innate, our results indicate that proportionately more adult learners agreed with this statement.

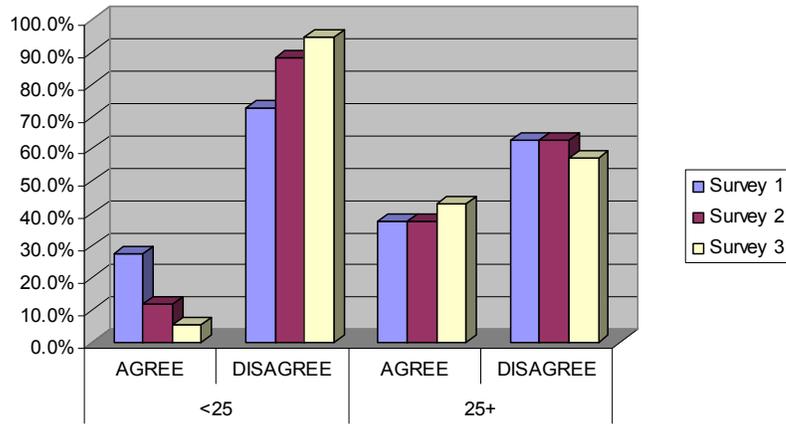


Figure 2. This graph shows the variation in beliefs about the innateness of mathematics ability by students who are less than (non-adult) or older than 25 years (adult). Surveys 1 to 3 are compared.

In response to the statement: ‘All elementary teachers must like mathematics to teach it well’, 62.5% of adult learners believed this to be true while only 36.4% of non-adults believed this to be true at the time of the first survey. At the time of the third and final survey, adult learners who agreed with this statement decreased to 28.6% while non-adult learners dropped to 27.8%.

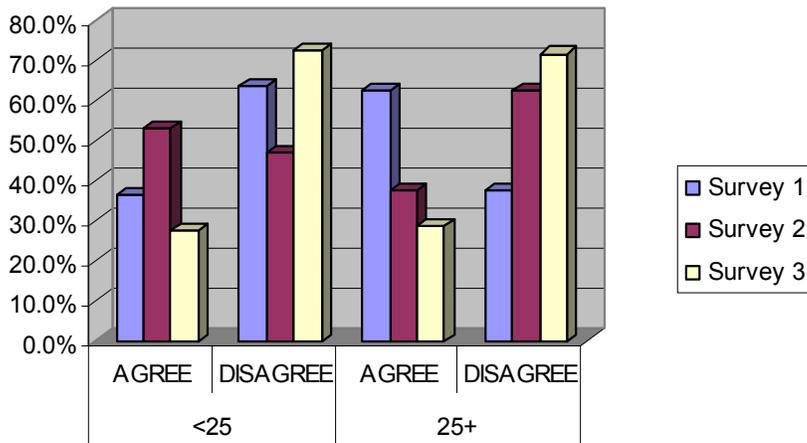


Figure 3. This graph describes what students who are less than (non-adult) or older than 25 years (adult) think about the direct correlation between liking math and being able to teach it well.

Using a Likert Scale of 0 to 5 with 0 being ‘strongly disagree’ and 5 being ‘strongly agree’, we asked what helped the students most in their preparation to teach elementary mathematics. There was a general consensus that the most helpful aspects of the course were the professor (knowledge, experience, teaching style and support), peer group support, and the children’s mathematics literature discussed in class (these were the categories that received an average rating of 2 out of 3 or better). When asked to rate their ability to understand mathematics at the first survey, adult learners responded with an average of 2.5 on the 5-point Likert scale. This number increased to 2.75 at the second survey and at the third and final survey had increased to an average of 3.3. In terms of self confidence with regards to mathematics, adult learners’ response went from an average of 1.6 in the first survey to 3.0 in the second to 3.4 in the third and final survey (Figure 4).

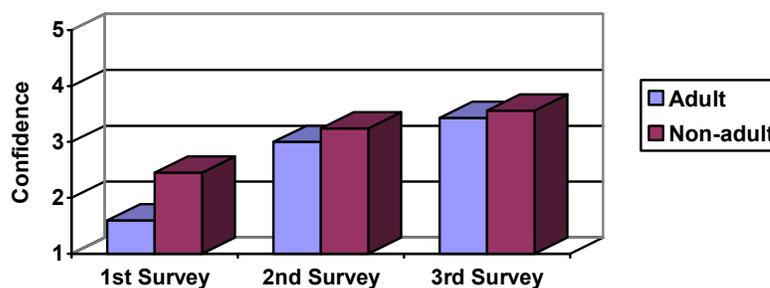


Figure 4. This graph shows the increase in confidence, where 1 is least confident and 5 is most confident, during the course of the semester.

The observed higher increase in confidence of adult learners when compared to the non-adult learners is an interesting one. As one adult student who previously worked as a teaching assistant said,

‘To be honest... I never thought I would be able to teach a math class as my own skills are so weak, but through perseverance and a little guidance, I taught an entire math unit successfully. I think it had a lot to do with looking at math differently than my own childhood experiences which had been so rote and so negative’

The third and final survey (taken after the 6-week practicum section of the course) introduced a new question regarding how various components of the practicum helped each student understand and appreciate mathematics more. Overall, on a Likert scale of 0 to 3 (with 0 being ‘not effective’ and 3 being ‘very effective’), the most frequent rating given to each one of: Observing a teacher, designing a lesson, reflection with classroom teacher and teaching a class was 3, whereas tutoring a student one on one in mathematics was frequently rated a 2. Adult students rated these different aspects of the practicum lower in terms of value than the non-adult students. As one adult student reflectedz:

Designing a math lesson and teaching it was great because I needed to take what I learned, make sense of it and try to determine how I would teach it. One thing that I ran into when I went into my placement was that I was not able to use constructivist methods and the materials I had collected from my resource folder within my new classroom because the associate teacher used a different approach to math, a more traditional approach. I had to fall into his mold for continuity of the class.

This highlights one of the issues our newly trained teachers are going to face in their schools: ‘seasoned’ teachers who have always done it the ‘old’ way and who believe that it is still the best way despite mounting evidence that the three significant aspects of mathematics education: coherence, reasoning and precision are woefully missing from the standard math textbooks and curricula that teachers are using everyday (Wu, 2007).

## Discussion

While some education programs have called their program of mathematics competency training an intervention (Simon & Schifter, 1991), there is some indication that an education program that combines mathematics competency with mathematics teaching methodologies and confidence boosting approaches in the form of constructivist teaching methods may be successful at producing teachers who are not afraid to teach mathematics. These teachers may teach differently (and yet better) from how they were taught. Research has shown that there is a direct correlation between performance attributions, self efficacy and achievement in mathematics and this is even more profound in girls (Lloyd, Walsh & Yailagh, 2005). When girls underestimate their capabilities, they tend to avoid mathematics courses and careers because their attribution pattern is one of internalising failure and externalising success (Pajares, 1996). Despite the fact that one of the perceived weaknesses of this study was the all-female pool of participants, this allowed us to remove any gender variability so that the result of confidence boosting approaches to mathematics study was easily observed.

Simon and Schifter indicate that their methods resulted in teachers being more confident and most importantly, being able to use more hands-on methods in their own classrooms. Prior to initiating this study, the authors were aware that adult learners bring a wealth of experience to their new careers as teachers but this experience, although significant, can be crushed by an overwhelming sense of ineptitude when it comes to mathematical competency. Through a carefully designed syllabus that sought to recall and in many cases re-teach basic mathematics concepts, previously math-anxious adult elementary pre-service teachers experienced an increase in confidence and a change in beliefs regarding who could teach mathematics well. This confidence was palpable. By going out into the field to teach mathematics to a whole class, as well as one on one with a struggling student, participants in this study were able to augment their learning with practical experience producing an overall sense of accomplishment. Although the adult learners started out with the lowest confidence in their abilities (Figure 4), they experienced a larger increase in confidence over the course of the fourteen week program than non-adult students. It was also evident that along with an increase in confidence came a change in beliefs about who could understand and teach mathematics. The results indicate that adult learners especially had grown to believe that they could teach mathematics well even if mathematics was not their favourite subject. One adult student said:

‘My overall experience was good. It helped me understand that I don’t have to be a mathematics genius to be able to teach it (by the way, this was not what I thought when I first started taking the course), but now I understand that you can learn it while learning how to teach, it just needs an open mind and willingness to try to learn it’

Also noteworthy was the finding that although all student teachers benefit tremendously from a practicum experience, adult learners seemed to gain less overall from the experience than their younger counterparts. The only aspect in which the adult learners made significant gains, higher than those of the non-adult learners was an increase in confidence. It would seem that the practicum period seemed to be a return to the ‘workplace’ and was used as a time to build confidence facilitated changes in perception about who can understand and teach mathematics.

There is little doubt that an individual’s life chances for employment and income in

contemporary societies worldwide is strongly related to their level of literacy (Wagner & Venezky, 1999), in mathematics (also referred in some studies as numeracy) as in other subjects. A student's ability to comprehend mathematics and to use it effectively depends in large part on the teacher's ability to teach mathematics (Kaplan, & Owings, 2002). Ontario's teaching landscape (like many parts of the world) has shifted dramatically over the past few years. In the late 1990s and early 2000s, new graduates were in strong demand because of higher than expected retirements. In 2000, for example, 7100 teachers retired and 8800 new educators graduated. Despite a reported surplus of English language teachers in the province of Ontario (McIntyre, 2007), all the faculties of education continue to report record numbers of applicants to both concurrent and consecutive programs, with more than half of the applicants applying for elementary teaching. Of this number, an increasing number identify themselves as adult learners (personal observation). What remains to be seen is how our adult pre-service teachers hold up in the classroom over the long term: by how much does their pre-service confidence improve? Do they continue to be lifelong learners? Are they motivated to learn more mathematics? Do they see a correlation between their ability to teach mathematics and any in-service mathematics education they may have taken advantage of?

If the goal of the elementary mathematics curriculum is to provide children with a solid foundation in mathematics, it makes sense to equip elementary teachers with the necessary content knowledge so that confidence is not only boosted but sustained. Our preliminary study showed that the likelihood of a teacher 'teaching for understanding' will be greater when she knows and understands mathematics and is confident enough to let this knowledge 'trickle down' to her students.

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