Adults Learning Mathematics

An International Journal

Chief Editor
Janet Taylor

Volume 2 (2)
September 2007

ISSN 1744-1803

Objectives

Adults Learning Mathematics – ***an International Research Forum*** (see http://www.alm-online.org/) has been established since 1994, 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.

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- 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.

The ALM Journal will be published twice a year.
ISSN 1744-1803
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Adults Learning Mathematics - An International Journal

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Editorial

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Welcome again to *Adults Learning Mathematics — An International Journal.* In this issue we celebrate the diversity of research into the mathematics learning of adults with 4 papers from 3 different countries. The first two papers from Ireland look at two facets of Irish mathematics education. The first paper by Olivia Gill and John O'Donoghue takes on a journey through the teaching and learning practices within university service mathematics courses. They have used Brousseau's concept of didactical contract to uncover implicit contracts present in Irish university classrooms. This paper is an early step in their characterisation of service mathematics in Irish universities and we look forward to more work from these authors on this topic.

The second paper from Ireland is about commonsense and mathematics and is a consolidation of Noel Colleran's and John O'Donoghue's earlier work. They discuss the perceived divide between commonsense and mathematics understanding with some examples of it in practice. The challenge, they say, is for us as educators to cultivate learning environments which will enable students to draw on their commonsense resources to build mathematics commonsense.

Jeff Evans, Anna Tsatsaroni and Natalie Staub, take us on a very different journey into the world of advertising and films in their paper on the images of mathematics in popular culture. Their work is underpinned by the relationships between motivation, beliefs, attitudes and emotions about mathematics. In the instances examined in this paper the images of mathematics in advertisements were generally negative while those in films were ambivalent. Of particular interest will be the discussion of the images create by the artefacts of people doing, using and teaching mathematics and their relevance to today's market economy societies.

The final paper takes us on a journey to Brazil and the Landless Movement. In her paper Gelsa Knijnik, unpacks the notion of ethno mathematics within the context of Brazilian peasants to support her ideas about different 'mathematics'. The paper has rich examples of the mathematics produced by the Landless peasant form of life and Gelsa discusses the interplay between their mathematics and school mathematics.

The work of ALM cannot continue without the fine work of its members, many of whom have contributed unreservedly by reviewing the above papers. Their professionalism is valued by myself and the Editorial team. Of course this issue would not be published without the ongoing assistance and support of this editorial team: Mieke van Groenestijn and Juergen Maasz.

In my final words I would like all ALM members to consider publishing a paper or two in their journal, so that the collegiality and international flavour of the journal will continue to grow.

Service Mathematics in Irish Universities: Some Findings from a Recent Study

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Abstract

In this paper the authors report on a qualitative investigation into service mathematics carried out in Irish universities against a backdrop of major concerns nationally and internationally embodied in the so-called "Mathematics problem". The enquiry involved a close inspection of how service mathematics is perceived, planned, delivered, evaluated, assessed and experienced by both lecturers and students in selected service mathematics courses in all seven Irish universities. Murphy (2002) used Brousseau's concept of didactical contract to uncover the implicit contract present in Irish second level classrooms. The authors emulated this work to discover the hidden learning contract in university service mathematics lectures in Ireland. Major outcomes of the study include insight into the nature of the didactical contract at work in the service mathematics courses surveyed, and the development of a preliminary characterisation of service mathematics in Irish universities. Service mathematics is also an issue for adult mathematics education and impacts on it.

Keywords: university mathematics, first year, pre-requisite knowledge

Introduction

It is generally acknowledged that adult mathematics education (AME) is not well conceptualised in the research literature. However, there has been progress in this regard as evidenced in the work of researchers, such as, Coben (2006), FitzSimons, Coben and O'Donoghue (2003) and Wedege, Benn and Maaβ (1999). Indeed, it is clear from the work of FitzSimons et al. (2003) that a broad view of adult mathematics education is accepted and includes, inter alia, "specialized mathematics and service mathematics (as in higher education), school mathematics, vocational mathematics" (p. 117).

The authors, who are based in the Mathematics Learning Centre (MLC) at the University of Limerick (UL) have a deep professional stake in service mathematics. Service mathematics is one of those crossover areas between mathematics, mathematics education and adult

mathematics education and is grossly under-theorised and under-conceptualised. As researchers in AME we should be engaged in service mathematics research for the following reasons:

- It is identified as being under the umbrella of AME;
- It is under-theorised and under-conceptualised;
- Elucidation of the nature of service mathematics and its practices can contribute to improvements in AME;
- Considerable numbers of adults engage in service mathematics courses around the world having entered through a variety of routes (e.g. as adult returners, mature students entering via successful Access, Bridging or Transition programmes, direct mature student entry);
- Service mathematics is an academic environment that needs to be better understood because it impacts on significant numbers of adult learners.

The importance of service mathematics for AME is captured and highlighted by the situation at the University of Limerick which is by no means unique in this regard. Adult learners of mathematics (e.g. mature students, access students) comprise a significant group of the student service mathematics population in the University. Fifty-one mature students were admitted to first year undergraduate programmes in 1999-2000 and this number rose to 155 in 2004-5. A total of 474 mature students were registered in UL in 2004-05 (Callaghan, 2005). This number rose to 614 in the subsequent academic year (Coveney O'Beirne, 2006). Most degree programmes in UL (with the exception of the humanities) contain some mathematics modules, so many of these mature students will have mathematics throughout their study.

The UL Mathematics Learning Centre provides support for all students participating in mathematics intensive courses. A drop-in facility is available for 22 hours a week and support tutorials are provided for any mathematics modules where students encounter difficulties. In the larger of these groups, mature students are provided with their own support tutorials. In 2005-6 143 mature students attended support tutorials provided by the Mathematics Learning Centre specifically for mature students. One hundred and eighteen tutorials (44% of all support tutorials) were provided and a total of 909 attendances were recorded. Thirty-seven percent of attendances at support tutorials were by mature students. They represent 22.3% of all students participating at these tutorials. Many mature students also attended the drop-in facility provided by the centre but numbers for this are not available.

The study reported in this paper involved a close inspection of how service mathematics is perceived, planned, delivered, evaluated, assessed and experienced by both lecturers and students in selected service mathematics courses in all seven Irish Universities. Murphy (2002) used Brousseau's concept of didactical contract to uncover the implicit contract present in Irish second level classrooms. The authors emulated this work to discover the hidden learning contract in service mathematics courses in Irish universities. Major outcomes of the study include insight into the nature of the didactical contract at work in the service mathematics courses surveyed, and the development of a preliminary characterisation of service mathematics in Irish universities.

The study reported in the following paragraphs is one of three unique studies (in the Irish context) that were conducted by Gill (2006) between 2001 and 2006. The study was conducted against the backdrop of the so-called Mathematics problem in Ireland and treats service mathematics as an embodiment of the problem in Ireland. This paper elucidates the problem, describes the study including methodology, data collection and analysis, and summarises the

findings with a special focus on the didactical contract in service mathematics courses and the nature of service mathematics.

The Mathematics problem

The so-called Mathematics problem as it is styled in the United Kingdom (UK) research on mathematics education encompasses issues in the transition from school mathematics to university service mathematics and beyond. The Mathematics problem and variants of the problem in western societies have been the subject of widespread debate and concern internationally at a time when there has been a major debate on mathematics education at all levels (e.g. NCCA, 2005; Smith, 2004; PISA, 2003; Engineering Council, 2000; TIMMS, 1997; IMA, 1995; LMS, 1995; NCTM, 1991).

At present there is widespread concern among university academics in many countries (e.g. Australia, United Kingdom) about the poor level of mathematical preparedness of first year undergraduates in mathematics intensive courses. Research shows also, that the problem is not just that some students are *under-prepared* but that even students with good School Leaving Certificate/A-Level grades struggle with even the most basic aspects of mathematics (NCCA, 2005; LMS, 1995).

Added to this problem is the fact that many believe that not only are students under-prepared, but that there is also a decline in standards in school mathematics. In this regard, for example, there is evidence based on a study of data at Coventry University from 1991 to 1995 to suggest that there has been some grade dilution over those years for students entering university (Hunt & Lawson, 1996). There are concerns that this under-preparedness will have serious short and long-term consequences not only for individual students (i.e. failure and dropping out (O'Donoghue, 1999)) but also for the professional reputation of various universities and for the economic progress of a country (Flynn, 2005; LMS, 1995). There are fears in the UK that a drop in the level of the mathematical proficiency of undergraduates will lead to them falling behind their peers in other countries and, as a result, the country itself will have to rely on others for inventions and developments (Smith, 2004; LMS, 1995).

The Mathematics Problem in Ireland

A collection of descriptions of the Mathematics problem has been assembled in Ireland by O'Donoghue (2004) and includes the following:

- Mathematical shortcomings of entering students;
- Mathematical deficiencies of entering students;
- Pre-requisite mathematical knowledge and skills;
- Mathematical preparedness/under-preparedness;
- Mathematics at the school/university interface;
- Issues in service mathematics teaching; and
- Numeracy/Mathematical literacy.

These are overlapping descriptions and for the purposes of this research the authors focus on issues in service mathematics teaching and the impact of the Mathematics problem on adults learning mathematics in Irish universities.

The problem of mathematical under-preparedness has been reported throughout the higher education sector in Ireland over many years with reports from universities and institutes of technology (Cork Regional Technical College, 1985; Hurley & Stynes, 1986; O'Donoghue, 1999). The concern for a drop in standards and inadequate preparation extends as far back as 1984 when research carried out in Cork Regional Technical College (Cork RTC) drew attention to the problem of the poor mathematical grounding of their first year students. The authors concluded that the incoming undergraduates were deficient in basic mathematics. In the following year, Hurley and Stynes (1986) carried out a similar investigation in University College Cork (UCC) with comparable results: their first year students demonstrated poor articulation of basic prerequisite mathematical knowledge.

Also in the late 1980's in the National University of Ireland at Maynooth (NUIM) and more recently in Dublin City University (DCU), it became apparent that students were having the same difficulties in mathematics as students elsewhere in Ireland. Academic staff initiated diagnostic testing to establish where the weaknesses lay and continue this process to the present day.

Due to mounting concern in the Department of Mathematics and Statistics at the University of Limerick (UL), a study entitled *An Intervention to Assist 'At Risk' Students in Service Mathematics at the University of Limerick* was undertaken to gauge the degree of mathematical under-preparedness of first year undergraduate students in mathematics intensive courses. Mathematics lecturers complained that students displayed:

- Lack of fluency in basic arithmetic and algebraic skills;
- Gaps (or in some cases absence of) in basic prerequisite knowledge in important areas of the school syllabus e.g. trigonometry, complex numbers, differential calculus; and
- An inability to use or apply mathematics except in the simplest or most practised way (O'Donoghue, 1999, p. 3).

A pilot study (O'Donoghue, 1999) carried out in 1997-8 suggested that up to 30% of incoming students were *at risk* and would need supplementary help to complete first year successfully. Evidence from this study and a similar study carried out the following year convinced the author that the problem would persist and take on a permanent disposition. This is particularly pertinent in the area of adult mathematics education as many of these students were mature, had not studied mathematics for many years and had presented with significant gaps in their mathematical knowledge.

Many reasons have been put forward to elucidate why things have gone wrong or why this state of affairs in mathematics education exists in Ireland. These include:

- Government policy;
- The Points system for entry to higher education;
- Changes in the Irish second level system; and
- Large class size in higher education institutes.

The existence of the Mathematics Problem was one of a number of contributing factors leading to the establishment of a Mathematics Learning Centre at the University of Limerick in 2001. Since then the Centre has been active in the support of students, including adults engaged in service mathematics, and in researching issues in this area.

Some conceptions of service mathematics

Although service mathematics has not been formally defined in the literature, we presuppose that it refers to degree courses where mathematics plays a part, be it small or large, but is not the main focus of the students' studies. The organisation of mathematics teaching/education in the Irish higher education sector can be seen in Figure 1.

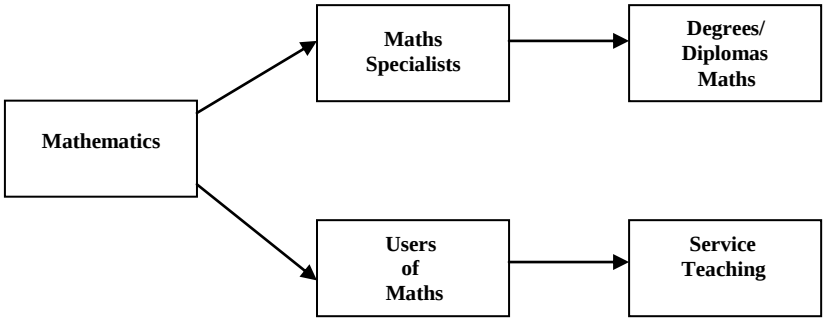

Figure 1. Mathematics Teaching in Higher Education (O'Donoghue, 2002)

Throughout this paper, the authors distinguish between mathematics specialist students and service mathematics students. Those pursuing careers/degree courses in mathematics fields are referred to as mathematicians and mathematics specialist students.

While it was once the case that service mathematics solely referred to engineering mathematics, this is no longer true. Chevallard (1989, p. 52) stated "… the empire of mathematics is steadily spreading and keeps encroaching on domains which until recently had remained foreign to its influence". Today, all professions have varying requirements for the knowledge and use of mathematics skills, with O'Donoghue (1999) correctly predicting that in the 21st century professionals would require higher levels of mathematical proficiency than ever before.

Kent and Noss (2001) ask the question: what is mathematical knowledge? There are, they claim, different perceptions depending on the domain of each profession (i.e. science, engineering). They indicate that this occurs because each person sees a different purpose for mathematics, one that is relevant to their own particular realm. For example, the IMA (1995) assert that engineering mathematics is not simply pure mathematics taught to engineers, but that the mathematics syllabi must be constructed and taught within an engineering context. However, it is clear that service mathematics is not an inferior form of mathematics. Howson, Kahane, Lauginie and de Turckheim (1987) emphasise the point, stating that the term *service mathematics* does not connote a lesser form of mathematics. They refer to it as "…mathematics in its entirety, as a living science, able - as history has ceaselessly show - to be utilised in, and to stimulate unforeseen applications in varied domains" (Howson et al., 1987, p. 1).

A qualitative study of service mathematics in Irish universities

The purpose of the study was to examine the context, the practice and experience of service mathematics teaching in Irish universities (Gill, 2006). No such study has ever been undertaken in Ireland. Consequently, the findings constitute a significant source of new data on service mathematics teaching in Ireland and serve as a basis for developing a meaningful characterisation of service mathematics in Irish universities today. The study aims to define more clearly the teaching/learning contract that exists between the actors in this sphere of activity using the concept of "Didactical Contract" as developed by Brousseau (Balachef. Cooper, & Sutherland, 1997).

In Brousseau's theory an implicit contract exists within every mathematics classroom between all actors in the sphere. Students are presented with mathematical tasks/problems by their teacher/lecturer. The students are required to work on the tasks whilst adhering to various constraints governed by the teacher/lecturer and the learning environment. The expected behaviours of the students from their teacher/lecturer and vice versa determine the didactical contract present in the classroom. Brousseau proposed that this contract has a significant impact on the teaching and learning that occurs in the class (Balachef et al., 1997).

Methodology

Qualitative non-participant observation was selected as the most appropriate strategy for data collection (Cohen, Manion & Morrison, 2000). This choice was influenced by the authors' need to gain an holistic insight into service mathematics teaching including mathematics lectures, tutorials and programmes in the world of Irish higher education. Brousseau's exhortation that an in-depth study of the routine happenings is the only way to establish the contract was also a major consideration. The study was guided by the following research questions:

- How is service mathematics perceived by lecturers and mathematics departments?
- How is service mathematics organised, planned and implemented?
- How is service mathematics taught?
- How is service mathematics assessed and evaluated?
- How do lecturers and students experience service mathematics?

Data collection instruments

The analysis presented is based on direct observations of classroom practice in each of Ireland's seven universities, and semi-structured interviews with experienced mathematics lecturers involved in service mathematics teaching. A purposive sample of lecturers, students and courses was used as explained below.

The method of inquiry was characterised by a multi-pronged approach involving both staff and students. Service mathematics lecturers from each of the seven Irish universities were approached in February, 2005 and asked to participate in the investigation. Selection was based on whether they taught first year service mathematics courses in the second half of the academic year. The lecturers (9) who replied and agreed to participate were the ones selected. The author first collected course documentation on each of the service mathematics courses in Irish universities to analyse their content. The selected lecturers were asked to:

- Complete a questionnaire (by e-mail);
- Participate in a semi-formal interview; and
- Allow structured observations of a *typical* mathematics lecture.

The participation of all lecturers extended the scope of study from University of Limerick experience (Science, Engineering and Technology) to all seven Irish universities and to include Arts, Commerce and Business Studies.

Once the initial lecturer-based investigation was complete, participating lecturers were approached for permission for the researchers to interview students on their courses and to observe some tutorial sessions. As some universities were approaching examinations/holidays at this stage of the process, this phase was conducted in only four of the original seven universities. Twelve (12) students in total volunteered to take part in interviews. The researcher also completed a journal of reflections after every lecture/tutorial observed.

All interviews were recorded and later transcribed for analysis. Data collected from interviews with lecturers and students, and from the lecture/tutorial observations were coded to distinguish between student-generated and lecturer-generated data. These data were subsequently analysed using the constant comparative method (Glasser & Strauss, 1967; Miles & Huberman, 1994).

Data analysis – the lecturers

Interview questions were based on current literature and authors' experiences in service mathematics courses and aimed to explicitly explore the behaviours lecturers may expect from their students. Such questions aimed to fully establish the didactical contracts within lectures. They were deemed essential by the authors in order to gain insight into what lecturers believed to be the nature of service mathematics e.g. mathematics for engineers, mathematics for scientists, applied mathematics or mathematics especially construed as service mathematics. For example, Howson et al. (1987, p. 1) suggest that the term s*ervice mathematics* refers to "mathematics in its entirety*"*. Consequently, it should be possible to devise an apt, authentic curriculum for these students (Kent & Noss, 2001). It is crucial to examine how seriously service mathematics is treated within mathematics departments and client departments, how it is planned, implemented, assessed and evaluated.

Data analysis – the students

The 12 student interviewees (5 male, 7 female) were all first year university students of approximately 18 years of age. Mature or foreign students were not considered, as issues of transition from Irish second level were the principle research questions. However, issues that arise out of this analysis will impact significantly on adult learners. The student interviewees were enrolled in various degree courses which had a mathematics element such as Science, Commerce and Business Studies. Two students were studying an Arts degree and had elected mathematics as one of their first year subjects. Some of the students were interviewed individually, while others were interviewed in pairs or threes. Each interview took place at the end of the lecture/tutorial and lasted about 10 minutes. The potential bias was that the students interviewed were the ones who actually attend their tutorials. It was not possible to interview students who did not attend class.

Summary of findings

One of the findings from the qualitative study is that service mathematics is viewed as a very important enterprise within Irish universities for financial/staffing, political and educational reasons. Five of the universities have coordinators to facilitate the preparation and delivery of service mathematics courses. It is a significant role to be filled as they have a number of important duties to fulfil.

The lecturers interviewed stated that all students should have a good mathematics education and it is their job to provide it. It was disheartening to see that over half of the lecturers interviewed still viewed the teaching of mathematics students as a higher priority than service mathematics students.

The lecturers indicated that they perceive service mathematics as mathematics for students not doing mathematics degrees. This marginally negative perception is interesting because it shows that lecturers understand that students see service mathematics as something that is not chosen for its own sake as a path to some career. Superficial definitions were given to explain how the lecturers characterise service mathematics.

Mathematics lecturers prepare service mathematics syllabuses in conjunction with the client departments. The client departments decide what they would like their students to know and the mathematics departments tailor courses to suit their requirements. Apart from the client departments (and the external examiners) there is no external input into course design. Industry and prospective employers are a potential source of input but are not exploited. This runs contrary to accepted practice espoused by earlier researchers such as Bajpai (1985) who advocated industry involvement in course design. The aims and objectives for the service mathematics courses are outlined in the course documentation. They infer that service mathematics courses are technique/application based as opposed to theory-based courses. The level of rigour is not, rightly or wrongly, as deep as that in mathematics specialist courses. The lecturers interviewed stated that the *general gist* would do for their service mathematics students and they do not attempt to get them to really grapple with the concepts involved. This is worrying in the context of what other researchers (e.g. Howson et al., 1987) have to say about service mathematics as not being inferior mathematics. However, Mason (2001) cautions against an overly theoretical approach.

The students in these courses are required to have attained a pass (C3 for some, B3 for others) in Ordinary Level Leaving Certificate mathematics (Irish School Leaving Certificate is offered at 3 levels in mathematics: Higher, Ordinary and Foundation) to gain entry to these courses with the exception of the Engineering degree courses who require a grade C3 or higher at Higher Level Leaving Certificate mathematics. As these are the minimum entry requirements, the mathematical abilities/knowledge of students vary to a great extent, as many groups will have students with anything from an Ordinary Level C3 up to a Higher Level A1. In addition, there are transferees, foreign students and mature students. Many of the latter have not studied mathematics for many years and some have not even sat the Leaving Certificate examination at all. Class size and the diverse mathematical backgrounds of students negatively impact the lecturers and students. The smallest service mathematics group observed/surveyed had 50 students enrolled. The rest contained between 100 to 400 students. The lecturers interviewed admitted that it was more difficult to get to know students and monitor their progress as a result of the class sizes. It inhibited their teaching and led to chalk and talk styles of lecturing. They seemed despondent about this situation but accepting of it. There was a distinct lack of

interaction, group work and discussion within these lectures as lecturers felt it was not feasible and students feel too intimidated to do anything other than passively participate.

The use of relevant, real-life examples was something that was absent from the lectures observed. It would not be possible for an observer to tell if some of the classes were for engineers or scientists unless they were informed so. Time constraints were partially blamed for this while some lecturers said it was very difficult to always give relevant examples from everyday life. As a result, students *participate* in mathematics lectures which they have not chosen to study without being given clear reasons why. The use of appropriate examples from science, engineering and technology is strongly advocated by IMA (1999), Kelly (1994) and Ahmad, Appleby and Edwards (2001).

Observations revealed that students passively participate by listening and taking notes. There were very few opportunities for group work or discussion with the result that there was very little interaction within lectures. Class size was the main reason given for lack of interaction and questioning. Lecturers do not like to intimidate students and students are too shy to speak up in class even if they do not understand something. Very little questioning took place in the lectures observed. The students admitted that they would not ask questions in class. Lecturers rarely asked questions either. A few questions were "tossed out" by lecturers at the groups observed. There were no individual questions. The students interviewed for this study indicated that their attitudes to mathematics were once positive but are now neutral and, at times, negative. This implies that mathematics has been an unsatisfactory experience for them thus far in higher education.

Tutorials were taught by teaching assistants/tutors or, sometimes, by fourth year students. The lecturers stated that tutorial/homework materials were a combination of technique-based and applied problems based on material covered within the lectures. It was left at the assistants' discretion how best to teach the tutorials. Lecturers tried to make examples as relevant as possible to core areas but often found this difficult. Tutorials were seen as an opportunity to practice skills taught within lectures. They were also seen by students as an opportunity to pick up on material they had missed/misunderstood/not understood within lectures. They felt more comfortable approaching tutors than lecturers. The students admitted that they did not do enough independent study outside of lectures and tutorials. Attending tutorials offered students the chance to practice the mathematics they may or may not have the confidence or knowledge to attempt on their own.

Assessment varied from university to university. Students were assessed by either continuous assessment methods or one final end of term/year examination. The lecturers interviewed said that they were somewhat focused on the final examination but they did not go out of their way to teach to it. Still, some of these groups have final examinations that worth 100% of the assessment mark so this, in addition to their second level experience and its emphasis on the Leaving Certificate examination (Murphy, 2002), leads students to focus more on passing the examination than on understanding the mathematics. The students interviewed stated that they relied on previous examination papers to prepare for their next examination. It was possibly the shortest route to getting through the examination as none stated that they referred to textbooks, online support or drop-in centres as an aid to their learning.

It was evident that there was a clear mismatch in expectations and delivery within these classrooms and one that could contribute further to the problems within service mathematics teaching and learning. Lecturers expected students to attend, listen, behave and think. They also

expected them to take responsibility for their own learning. Students had great difficulty taking this responsibility on board. The transition to third level education was seemingly a substantial hurdle for students as attendance and participation rates were poor. It is the students' responsibility to attend lectures and tutorials, but it may be more than laziness or indifference that stops them from going. They seemed to expect certain things from their lecturer e.g. extra office hours, but then do not take advantage of them. The lecturers said that they do not expect very much of their students as regards classroom etiquette and participation.

Discussion of findings

Observations on the nature of the didactical contract in service mathematics in Irish universities

As stated, one of the purposes of this study was to determine the nature of the didactical contract within service mathematics classes in Irish universities: to see if, where and why there are mismatches in expectations. It is clear that there are many such mismatches evident in the data from within these groups.

Lecturers expect students to attend lectures and tutorials yet, attendance is a problem in these universities. While in class the students are expected to behave, listen and think. Questions are welcomed from students but not expected or encouraged because of large numbers within the service mathematics groups. Lecturers do not ask individual questions but on occasion they do ask some questions to the group as a whole. Students are compliant with this. Thus large classes are taught in traditional ways where student attitudes towards their task are less then ideal. This finding echoes Simons (1987) and more recent work by Crawford, Gordon, Nicholas, and Prosser (1994) and MacBean (2004). However, students feel more comfortable asking questions in tutorials and sorting out their problems there. This is the one area where students and lecturers have the same expectations of each other. Students expect not to be asked questions and lecturers do not ask them. Some form of intervention is needed to encourage attendance and participation rather than just accepting that this is the way it is. Maybe if expectations were more obvious at the start of the academic year, everyone would be enlightened as to their own contribution to the service mathematics experience.

There are few opportunities for students to practice their mathematics within lectures because of time constraints and because the lecturers expect students to do some independent work of their own outside of class. Students, however, expect time, opportunities and plenty of examples to practice. They expect the lecturer to explain everything in detail, as practiced inn secondary school. Having spent 5 years experiencing teaching of this form, it is difficult to make the change to the lecturing style of teaching. Students are not satisfied if they are left to work alone. A mismatch in expectations is evident. The students expect more than the lecturers provide. They expect everything explained in detail something the lecturers do not do. The lecturers expect students to fill in the gaps for themselves but the students believe this the lecturers' role. This mismatch causes frustration for the students who feel they are being short-changed. If the lecturers' expectations were made clear at the start of the term, it is possible students would not have this added frustration. They would know that the onus is on them to do some work themselves. Lecturers expect students to take more responsibility for their own learning i.e. to become more self-directed in their approach.

Tutorial sheets and homework are given to students on a weekly or fortnightly basis. The lecturers expect students to spend one-hour of independent study per one-hour lecture on their lecture material and their homework. The students admit that they do not spend this much time on their mathematics study. The lecturers expect students to attempt their homework but students do not attempt it unless it is part of their final mark. They do, however, attempt the work within tutorials under the guidance of their tutor/teaching assistant. Teaching assistants decide how they teach the tutorials and should report back to the lecturer if there is a problem. Again, there is a mismatch in expectations. Students do not put in the effort lecturers' expect so this causes some annoyance for all parties. It seems that Irish students have resolved the issues in some of the more important debates around service mathematics teaching in favour of 'lesser mathematics' e.g. skills rather than concepts (Bajpai, 1985), and tools rather than understanding.

Students are expected to revise for examinations themselves. It is not the lecturers' responsibility to revise examination papers in class. The students do expect the lecturers to revise past examination papers in class, inform them of the layout of the paper and the order of questions on the paper. They also feel that the lecturer should revise material taught months beforehand. They have not revised material from the previous term themselves and feel the lecturer should help them out more.

Students expect their lecturers to make themselves more available to students and be approachable. They should put on extra office hours around examination time for any queries they might have regarding their lecture notes or examinations. The lecturers do inform students that they already have this opportunity but few students take advantage of the offer.

In summary the principle features of the didactical contract that operates within the Irish service mathematics contexts surveyed in this study are:

- Lecturers expect that students will attend lectures and tutorials;
- Lecturers do not ask or expect questions in large lectures nor do students expect or ask questions in large lectures;
- Students are expected to come prepared to tutorials and participate fully;
- Lecturers expect students to prepare for examinations themselves;
- Students are expected to do independent study including filling gaps in concept development, practicing skills and procedures, preparing for tutorials and completing assignments;
- Students expect the lecturers to explain everything in detail in lectures and to provide time, opportunities and examples to practice;
- Students expect lecturers to revise past examination papers in class, discussing the layout of the paper and the order of questions; and
- Students expect their lecturers to be available and approachable to discuss queries regarding their lecture notes and examinations.

When a mismatch in expectations occurs, one or all parties are going to feel hard done by and frustrated. Motivation levels are likely to drop as a result and negative feelings are likely to increase. By the end of the academic year these frustrations may snowball and add disappointment, irritation and resentment to an already problematic area. This is particularly pertinent for adults trying to learn mathematics. Many have not studied advanced mathematics for many years, if ever, and so from the outset have added fears and frustrations that students entering directly from second level do not often possess.

Preliminary characterisation of service mathematics

The authors contend that the nature of service mathematics has never been fully defined or truly understood by service mathematics practitioners because it is under-theorised. This lack of understanding may exacerbate an already difficult situation in a vulnerable arena where student mathematical proficiency is not as high as it once was or is not strong as in non-traditional groups e.g. adult learners. The following is a characterisation of service mathematics as practiced in Irish universities today. This profile emanated from direct observation of classroom practice in all seven Irish universities, in addition to analysis of questionnaires, course documentation and semi-formal interviews with lecturers and students on service mathematics courses.

Service mathematics is distributed across many disciplines and faculties and is identified in various ways such as engineering mathematics, mathematics for engineers and scientists, mathematics for computing, mathematics for business, technology mathematics. The following statements capture the meanings associated with the concept *service mathematics* in the study:

- Service mathematics is directed at client groups composed of non-specialist users of mathematics;
- Service mathematics is technique/application based as opposed to theory based;
- Mathematics content is negotiated between mathematics and client departments with no external input from industry or employers;
- Courses are usually offered in the traditional large lecture/tutorial format;
- There is a large diversity in mathematical background and attainment of learners;
- Lecture style is usually "talk and chalk" supported with limited resources e.g. white/ blackboard, overhead projector;
- There is very little interaction or questioning in lectures;
- The use of real-life mathematical examples is acknowledged as being important but is invariably absent;
- Assessment varies between end-of-term examination and end-of-term examination combined with some form of coursework or continuous assessment;
- Additional learning support may be available and comes in a variety of formats including drop-in centres, support tutorials and other learning centre activities; and
- It is common for class notes to be supplied in book form supported by appropriate textbooks for non-specialists.

The authors adapted research tools and frameworks from education to advance our knowledge and understanding of service mathematics and the practice of service mathematics in Irish universities. These include Brousseau's didactical contract (Balachef et al., 1997). While mature adult learners were not involved directly in the study, emphasis in this case is the service teaching/learning environment as a place where a significant and growing number of adults are involved, hence the focus on the didactical contract and a characterisation of the whole environment in a different way.

Results of this study uncover a narrow didactical contract from which lecturers and students rarely deviate. It is worth noting in this context that the analytical tool used, viz., the didactical contract, was developed from studies of school classrooms and that university conditions differ significantly in a number of respects that affect the contract. University conditions for service mathematics teaching involve very large class sizes and an implicit multi-partite agreement distributed over several actors including students, lecturer and tutorial assistant(s). This and other aspects of the *university learning contract* merits further research attention. Class size

inhibits teaching styles and, therefore, students' mathematical progress. This poses many problems for mature students who start university after an absence from study and with lower mathematical proficiency and then are faced with less than satisfactory learning environments.

One of the authors, Gill, has taken this analysis forward in her doctoral thesis (Gill, 2006) and developed a theoretical model of service mathematics as a pedagogic discourse within the discipline of mathematics following Bernstein's (1996) work on curriculum.

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Adult Mathematics Education and Commonsense

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Abstract

The relationship between quantitative problem solving and commonsense has provided the basis for an expanding exploration for Colleran and O'Donoghue. For example the authors (Colleran et al., 2002, 2001) discovered the pivotal role commonsense plays in adult quantitative problem solving and suggest commonsense is an important 'resource' in the adult problem-solving context. In more recent papers *Adult Problem Solving and Commonsense:* (Colleran et al., 2003a) and *Adult Problem Solving and Commonsense: new insights* (Colleran et al., 2003b) the authors explored the valued position given to 'higher order' thinking as distinct from the 'other', 'lower' form of thinking, sometimes described as commonsense thinking. They also looked at the manner in which commonsense is created from 'natural learning' in a range of different environments. In Colleran and O'Donoghue (in press) the authors broadened the investigation to include the views of a number of researchers in the field of commonsense who suggest that commonsense is a powerful intellectual resource and provides the bedrock on which mathematical understanding is built. The authors have come to the view that the creation and use of commonsense require intelligent, creative thinking and this 'order' of thinking takes place naturally in the commonsense environment. Further this intelligent thinking is supported by attitudinal as well as structural elements that facilitate the individual to engage new commonsense situations so that they become natural learning environments.

Key words: adult, quantitative problem-solving, commonsense, natural learning.

Introduction

The authors' work on adult quantitative problem solving and commonsense has evolved over a number of years. For example the authors (Colleran, O'Donoghue & Murphy, 2001, 2002) have argued that commonsense plays a pivotal role in adult quantitative problem solving and suggested commonsense is an important 'resource' in the adult problem-solving context. In a more recent paper *Adult Problem Solving and Commonsense* (Colleran, O'Donoghue & Murphy, 2003a) and in *Adult Problem Solving and Commonsense: new insights* (Colleran, O'Donoghue & Murphy, 2003b) the authors explored the valued position given to 'higher order' thinking as distinct from the 'other', 'lower' form of thinking, sometimes described as commonsense thinking. They also looked at the manner in which commonsense is created from 'natural learning' in a range of different environments. They concluded that the creation of the commonsense resource requires a broad-based, adaptive use of intelligence and a form of

thinking which is intelligent, resourceful and creative. This intelligent thinking takes place naturally in the commonsense environment. Furthermore this intelligent thinking is supported by attitudinal as well as structural elements that facilitate the individual to engage new commonsense situations so that they become natural learning environments. In Colleran and O'Donoghue (in press) the authors broadened the investigation to include the views of a number of researchers in the field of commonsense who suggest that commonsense is a powerful intellectual resource and provides the bedrock on which mathematical understanding is built.

In this paper we start by describing the background and the manner in which commonsense became an important issue for the authors in the context of adult mathematics education. We then provide definitional aspects of commonsense, and follow with a discussion on the creation of commonsense in natural learning environments. We then evaluate the resource provided by commonsense in practical settings. We conclude by identifying some convergence regarding the role commonsense plays in mathematics education and suggest that further exploration is validated.

Background

In Colleran et al. (2001) the authors describe an educational programme for improving adults' quantitative problem-solving skills. There were three pillars on which this programme was built. Firstly, the quantitative problem situations addressed by the learners throughout the programme were drawn from appropriate contexts. This helped ensure that the problems were relevant, realistic and meaningful for the learners. Secondly, the process of *Action Learning* provided a social learning environment. This environment enabled discussion and dialogue which were fundamental to the development of thinking skills. Thirdly, an adaptation of Lonergan's (1957) philosophy enabled learners to discover the way they think when they are solving problems.

Lonergan's philosophy is derived from his 1957 publication entitled, "*Insight: A study of human understanding"*. He was a Canadian theologian and philosopher who died in 1984. In his book he describes how 'catching on' or 'getting the point' is a frequent event in the course of our daily lives. It would seem absurd to suggest that this act, the act of insight, could provide the foundation for a whole new philosophy on human understanding, however Lonergan's *Insight* develops this foundational view and also provides a number of cogent reasons why his philosophy is suitable in the context of adults solving problems:

- His problem-solving 'programme' is adult-orientated,
- He believed that a good starting point for the development of problem-solving skills is with the natural thinking process of the adult,
- He provides a *cognitional structure* which identified the thinking processes used by adults when they solve problems.

Lonergan's cognitional structure is at the heart of an educational programme to improve quantitative problem-solving skills among adult basic education learners developed by the authors (see Colleran et al., 2001).

Lonergan believed that the process by which adults come to know and decide is the same for all normal adults. Not only is the process the same, it is activated and employed without direction on the part of the individual. Therefore, the cognitional structure is *invariant* in that it remains the same for each knower and it is *naturally innate* because it happens without direction or effort on the part of the knower.

The preliminary stage of Lonergan's programme is the uncovering of one's cognitional structure, i.e. the innate, invariant thinking process. This discovery process, Lonergan postulates, will lead to an improvement in problem-solving and decision-making skills of adults.

Lonergan's programme unfolds on three levels of knowing:

- Commonsense knowing,
- Scientific knowing,
- Critical knowing.

Commonsense knowing, because it happens spontaneously in the concrete world, does not require the engagement of the problem-solving processes. *Scientific knowing* is employed when an individual engages a novel situation and the mental processes outlined in the cognitional structure (Figure 1) move from the concrete to the abstract.

Lonergan suggests that adults become effective problem solvers in two modes - the direct mode and the indirect mode. The *direct mode* of problem-solving requires the individual to concentrate on achieving a solution to the problem at hand - problems are solved by engaging the mental processes of the cognitional structure. However, the *indirect mode* requires the individual to attend not only to the solution but also to the *process* - the mental operations engaged during the solution episode. Understanding the process by which solutions are found is known as *critical knowing*.

In the context of our educational programme critical knowing enables learners not only to solve quantitative problems, it also provides the means by which they can engage with confidence the new quantitative situations that present themselves regularly and frequently in the ever-changing conditions of their daily lives.

Therefore, Lonergan's problem-solving and decision-making programme offers more than a structure for understanding, knowing and deciding. It offers a *developmental process* in which an adult learner can move from understanding, knowing and deciding at a commonsense level to a scientific level and finally at a critical level. It is also a *creative process* in which the individual struggles to spark new insights that may hold the key to a required solution. Lonergan's problem-solving and decision-making programme can therefore be visualised not as a two-dimensional cycle of mental activities but as a three-dimensional helix (Figure 1) which dynamically connects concrete understanding at the lower, commonsense level, to a deeper and more abstract understanding at the intermediate, scientific level, and finally to an even deeper metacognitive understanding at the top of the helix. Knowing at the concrete level provides the basis for scientific understanding and both commonsense and scientific understanding provide the basis for critical understanding. In this manner the learner builds understanding *from concrete understanding to abstract understanding to process understanding*. The loop structure enables the learner to back track if at any stage understanding becomes shaky. The loop also points to the relationship and the sequence of development of the three types of knowing.

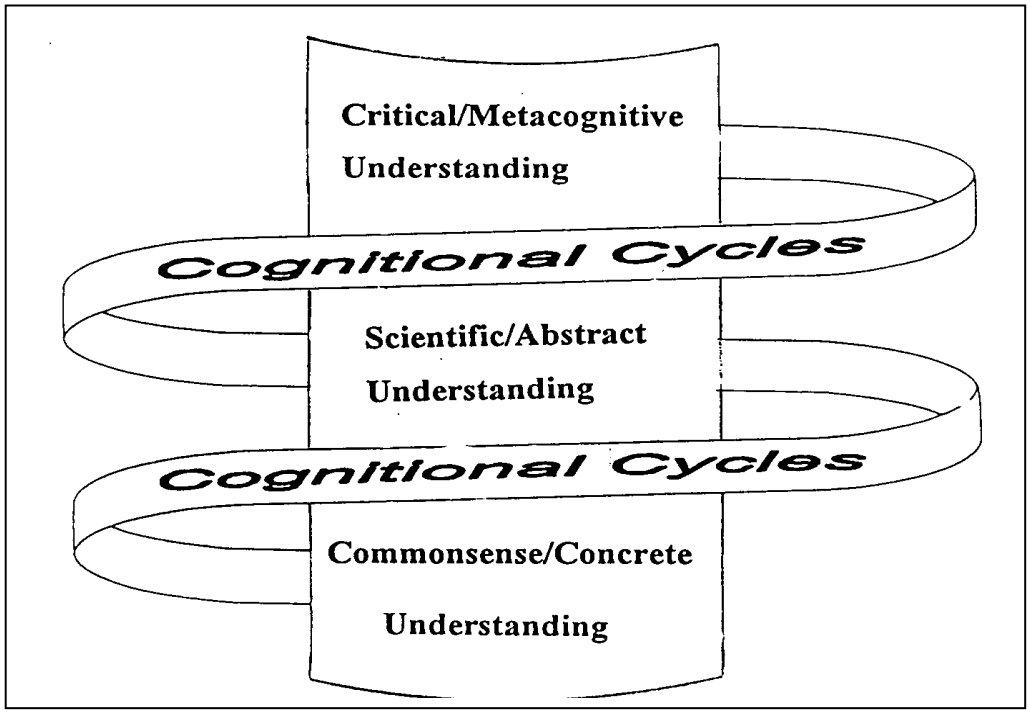

Figure 1. Helix illustrating Lonergan's dynamical and developmental process for understanding.

Evaluation of our educational programme provided a number of striking insights (see Colleran et al., 2001), however the most striking was the important role commonsense played for adults as they approached, engaged and resolved quantitative problems. It is therefore important to explore commonsense and commonsense environments.

Commonsense and commonsense environments

Lonergan (1957), who provides the source for much of the authors' understanding of commonsense, suggests that commonsense is a collection of insights accumulated by a community or individuals within that community, in a socio-historic setting. It is bounded by the concerns of human living and by workable solutions to daily tasks. Therefore, the knowledge that commonsense seeks is not motivated by the pleasure of exercising the mind but for the purpose of making and doing.

Coben (2002a) explores the origin of commonsense in Western thought pointing to a clear distinction between the British tradition regarding this concept and that of continental Europe. The British conception was "one of a practical faculty which the ordinary person exercises in his or her everyday life" while Continental European tradition regarded commonsense as that *"*which is expressed in the ideal being of a nation or people*"*. She goes on to explore the commonsense of Gramsci which she proposes springs from the Continental tradition. It would be difficult to situate the commonsense of Lonergan (1957) in either tradition; however it is clear that his understanding resonates with elements of both traditions and particularly that of Gramsci.

In his recent paper *Making Sense of Common Sense Knowledge*, Kuipers (2004) suggests that commonsense is used without concentrated effort to meet the everyday demands of the physical, spatial, temporal and social world. He continues that commonsense knowledge consists of *Foundational Domains* of understanding that are learned at a young age. These domains, such as space, time, properties of materials and certain aspects of the social and physical world, are used to reason with commonsense issues.

Howson (1998, p. 258) defines commonsense as a vague, culturally dependent concept. It is based on local knowledge, past experiences and simple reasoning. "Common sense is distinguished by the way in which it depends upon evidence, accepted truths and conventions, and upon 'innate' operating systems of perception, meaning and understanding".

While there is no doubt that commonsense has been used by many people to mean different things there is general agreement that it operates spontaneously in the concrete, social world. The environment within which it operates is quite specific. It is specialised in the concrete objects of everyday living in terms of their relationship, not to one another, but to the individual. It is bounded by the concerns of human living and by workable solutions to daily tasks. "[Commonsense] ... clings to the immediate and the practical, the concrete and the particular. ... Rockets and space platforms are superfluous, if you intend to remain on this earth" (Lonergan 1957, p. 179). Common sense is pragmatic because it deals with practical problem-solving situations that present themselves in the course of everyday living.

However the content of commonsense understanding does not reside wholly in the mind of any single individual. It is divided out among the different individuals operating in different roles throughout the community. The result is a collection of specific totalities with their individual socio-cultural, and historical common sense. So to capture an understanding of a particular community one must inquire into the commonsense of many fields to discover the particular unity of commonsense understanding which "organically binds together the endlessly varied pieces of an enormous jig-saw puzzle" (Lonergan, 1957, p. 211).

Having established our understanding of what commonsense is it is now time to explore commonsense thinking and how commonsense is created.

Commonsense thinking

In Colleran et al. (2003a) we discussed the invisible nature of commonsense in action. Commonsense is used *without thinking* and therefore is not deliberately adverted to. It is employed in social environments that are routine and familiar. It is a dynamic intellectual process that moves from *Experience of Familiar Situations* to *Commonsense Understanding* and spontaneously to a *Decision*.

However, even though the term is called commonsense, *it is not common to all people*. The intelligent person of commonsense demonstrates a greater readiness "in catching on, in getting the point ... in grasping implications, in acquiring know-how" (Lonergan, 1957, p. 173). And while commonsense is not a natural endowment of all normal adults the capacity to create this resource is. This capacity is explained by Lonergan through a naturally available, innate and invariant cognitional structure by which all normal adults come to understand and learn (Colleran et al., 2001). However, there is a suggestion made throughout *Insight* (Lonergan, 1957) that the rigour of scientific thinking is not required to create new commonsense understandings - that new practical, concrete, commonsense understandings do not require a

similar form of sustained concentration as do new conceptual, theoretical and scientific understandings. However, Brio (1988) has the following observation regarding the creation of commonsense:

> The common sense 'circuit' of learning generates a noetic[1] 'nucleus', a habitual 'core' of understanding. This core emerges and develops in response to his multiple and advancing engagements with his situation. It expresses itself in the repertoire of gestures, concepts, linguistic capacities, skills, etc., which fit him for judging and dealing with it (pp. 48-49).

Whether practical or theoretical, concrete or conceptual, the creation of new insights requires individuals to think and use their cognitional capacities. In the context of commonsense activity, thinking takes the form of analysis and synthesis of available and accessible understandings. However, if available and accessible commonsense cannot provide for the situation at hand, the intellectual, creative processes must be engaged so that new commonsense insights and understandings can be created. This creative process is equivalent if not similar to the scientific knowing process delineated by Lonergan (1957, p. 285).

While the same explicit, elaborate procedure of the scientific researcher is not required for commonsense, something equivalent is to be sought by intellectual alertness, by taking one's time, by talking things over, by putting viewpoints to the test of action.

Commonsense thinking is not in search of the 'virtually unconditioned' (Lonergan, 1957) truth of the scientific inquirer, however it does require a truth which is conditioned by the sensible, meaningful and practical circumstances in which it finds itself. And because commonsense situations are dynamic the commonsense thinker must be creative and adaptive to these ever-changing contexts. In the next section we explore the manner in which commonsense is created and its adaptive nature.

Creating and 'adapting' commonsense understanding

In Colleran et al. (2003b) the authors proposed that the creation of commonsense understanding occurs naturally by employing a number of communicative methods as well as a particular predisposition. They suggested that talking as well as the use of gestures provide the means for communicating and creating commonsense. The use of these communicative methods is motivated and supported by an intrinsic and natural predisposition and an inbuilt desire to be intellectually creative and to behave intelligently among other people. The individual has no choice about behaving intelligently; the drive to understand is in-built (Lonergan, 1957). The result is that commonsense learning takes place naturally in commonsense environments.

The authors propose that there are a number of natural elements associated with commonsense learning that enable individuals to become commonsense capable as they engage a variety of real-life contexts. In Colleran et al. (2003b) they suggested that these elements include:

- An inbuilt desire behave intelligently;
- Utilisation of social commonsense; and
- Utilisation of relevant technical commonsense.

[1] The word *noetic* comes from the ancient Greek *nous*, for which there is no exact equivalent in English. It refers to *inner knowing*, a kind of intuitive consciousness - direct and immediate access to knowledge beyond what is available to our normal senses and the power of reason.

"An inbuilt desire to behave intelligently" is the natural endowment of all normal adults (Lonergan, 1957). This element remains constant in all natural learning environments when the individual is motivated to engage and participate. The experience of being 'in the dark' about things that matter to an individual is one that all normal adults wish to avoid.

Social commonsense is generated and utilised in an inter-subjective environment where speech and gestures are the mode of communication and where values, individual characteristics and personality are displayed in an effort to generate admiration and a good social relationship. This element of commonsense enables the individual to adapt to the social setting by employing the social commonsense already available and by building on this resource. *Technical commonsense* on the other hand is related to the specific skill domains, for example, carpentry, cooking, teaching, researching. This element of commonsense may also require adaptation in the new context and is developed quite naturally by building on the skills already acquired.

The authors contend that because of a number of attitudinal and structural elements such as those mentioned above the issue of 'transfer' takes on another dimension - one that challenges the impenetrable barriers constructed between contexts by those who view transfer of learning as problematic. These elements enable individuals to engage non-routine situations so that they become natural learning environments. This 'adaptive' characteristic associated with commonsense may open another perspective on the 'transfer of learning' problem and provide a framework for exploiting this resource in the formal learning context.

There are a number of elements associated with the creation of commonsense understanding; an inbuilt desire to behave intelligently, communicating through speaking and gestures, and the use of social and technical commonsense. These elements facilitate the creation of a 'natural learning environment' in which individuals can adapt commonsense understandings to each new commonsense situation.

Having developed an understanding of commonsense, commonsense thinking and how commonsense is created we now turn to the 'resource' commonsense provides particularly in the problem-solving context.

Commonsense as a resource

In Colleran et al. (2003a) we discussed the resource commonsense provides in the problem-solving context, i.e. it provides a resource with three distinct elements:

- An accumulation of practical understandings,
- A form of knowing,
- A basis for scientific understanding.

An accumulation of practical understandings

Commonsense is a collection of insights accumulated by a community, or individuals within that community, in a socio-historic setting. The context within which it operates is quite specific. It is specialised in the concrete objects of everyday living in terms of their relationship, not to one another, but to the individual. It is bounded by the concerns of human living and by workable solutions to daily tasks. "[Common sense] ... clings to the immediate and the practical, the concrete and the particular. ... Rockets and space platforms are superfluous, if you intend to remain on this earth" (Lonergan, 1957, p. 179).

A form of knowing

Intelligence is met in every walk of life. It is this everyday, practical, concrete, intelligence that Lonergan (1957) calls commonsense. However, even though it is called commonsense, *it is not common to all people*. And while it may be accessible to all normal individuals there are no acknowledged specialists or experts (Coben, 1997). The intelligent person of commonsense demonstrates a greater readiness "in catching on, in getting the point, ... in grasping implications, in acquiring know-how" (Lonergan, 1957, p. 173).
Commonsense knowing can be identified by the following:

- Pragmatism,
- Spontaneity,
- Socially generated,
- Temperamentality,
- Taking things for granted,
- No theoretical inclination.

Commonsense activity is not characterised by periods of sustained thinking and reflection - new understandings are required but they are already in the mind's inventory and are accessible. Intelligence activates a 'micro', instantaneous cycle of the cognitional structure with the purpose of establishing the familiarity of the situation and a satisfaction that no new insights are required to deal with the situation encountered. However, when the commonsense inventory comes up short and new insights are required to deal with a novel situation, the creative, intellectual processes must be activated.

One must also consider the difference between spontaneous commonsense decisions and actions and impulsive responses with resultant rash decisions. We do not want to confuse impulsive, rash decisions and actions with spontaneous commonsense actions. Dewey (1938) pointed out that education is about self discipline, and thinking creates the breathing space that transforms impulsive, ill disciplined, rash decisions and actions to reflective and disciplined decisions and actions. He suggested that education and learning are the agents that enable an individual to control these desires and impulses. While Dewey was not referring to commonsense his observations have been helpful in differentiating between sound commonsense decisions and impulsive, rash decisions.

In summary, common sense is confined to the particular, the experiential, and the concrete, where only non-technical, descriptive terms are used. It is the field of human interaction, where people operate during their everyday living. Commonsense is not impulsive and rash, however it operates within a cultural context where it settles for a mode and measure of understanding that enable human activity and human interaction to operate intelligently.

Commonsense as a basis for scientific understanding

However despite its limitations where would we be without commonsense? There would be no place for human temperament, spontaneity, practicality, intuition, aesthetic appreciation, love, hate and so on. In other words there would be no room for what makes us human, imperfect though that may be. However there is another type of understanding which tries to reduce the subjective 'drawbacks' to produce a more objective understanding, for example, scientific understanding. Lonergan tells us that the scientist is not the whole man or woman functioning "but the rest of the man subordinated to his intelligence. Like Thales so intent upon the stars that he tumbled into the well" (Lonergan Research Institute, 1996, p. 113). While an individual

requires commonsense understanding to survive effectively in this world, occasions may arise when scientific understanding is required. This is not to say that the subject is not intellectually engaged in the field of common sense. Commonsense requires an equally intelligent subject; it is the context that determines the function to which the intelligence is directed. Therefore commonsense can be regarded as a sea within which arises here and there islands of conceptual, scientific understanding and knowledge (Tekippe, 1996). Without this sea or concrete world of commonsense understanding, science has no starting point. It is into this particular, concrete world that science attempts to introduce universal, theoretical understanding.

Kuipers (2004) suggests that commonsense is a 'qualitative' rather than 'quantitative' resource. This qualitative knowledge is relatively easy to learn and enables individuals to solve a surprising number of problems. The interesting thing about qualitative solutions is that there are usually a number of possible courses of action unlike the single quantitative solution. He continues that part of the power of commonsense knowledge comes "from the ability to represent and use knowledge even when it is incomplete". However Kuipers suggests that qualitative solutions can be *strengthened* with quantitative information.

According to Howson (1998) commonsense acts as a resource:

- That provides a means to talk about mathematics,
- That educators must try to develop in students,
- Which we must draw on in our teaching,
- That provides a foundation for mathematical development,
- That provides and external motivation for learning mathematics.

Howson cautions, however, that there are limitations associated with commonsense because although mathematics is built on commonsense it can provide a constraining force on the development of mathematics because commonsense and the mathematical worldview are often apparently contradictory. We are reminded that mathematics too has its own commonsense so, as educators, we must attend to everyday commonsense as well as the commonsense of mathematics.

Therefore, in the context of solving quantitative problems, commonsense provides a wealth of practical experience, a spontaneous yet not impulsive feel for the solution to the problem through the commonsense knowing structure, a confident basis on which to build a scientific solution and an external motivation for learning mathematics.

Employing commonsense as a resource in the resolution of quantitative problems (Practical examples)

In the evaluation phase of our educational programme (Colleran et al., 2001) a number of instances provided clear evidence of situations where learners mobilised their commonsense as the starting point for the solution to 'real-life' quantitative problems. This was particularly apparent in the 'Stocks and Shares' and 'Designing a Car Park' problems. Learners began to feel confident enough to contribute what they thought was relevant in a particular discussion and were willing to take help from other learners or from the tutor if other learners could not help.

The 'realistic' context created in the 'Stocks and Shares' problem provided an opportunity for discussing reasons for strong and weak share prices. Learners talked about the relevance of bad press and how this could affect share prices. In the 'Designing a Car Park' problem learners

discussed issues such as the average size of a family car, the size of a minibus, how much room is needed to open the door of a car and how to represent the size of the car park site on a sheet of paper using an appropriate scale.

These quantitative problems provided fertile ground for the use of learners' commonsense including sense-making, judging, reasonableness and mature decision-making. Building on these 'commonsense' discussions learners began to discover and employ the following mathematical skills on a daily basis:

- Adding, subtracting, dividing and multiplying of whole numbers and decimals,
- Calculator work,
- Data tables,
- Percentages,
- Time,
- Estimation,
- Predictions,
- Linear measurements,
- Areas,
- Averages,
- Scales.

In an effort to clarify the qualitative difference between commonsense and scientific understanding the tutor used the image of a circle (see Figure 2). Firstly the tutor displayed the shape for a few moments and asked learners what did they see?

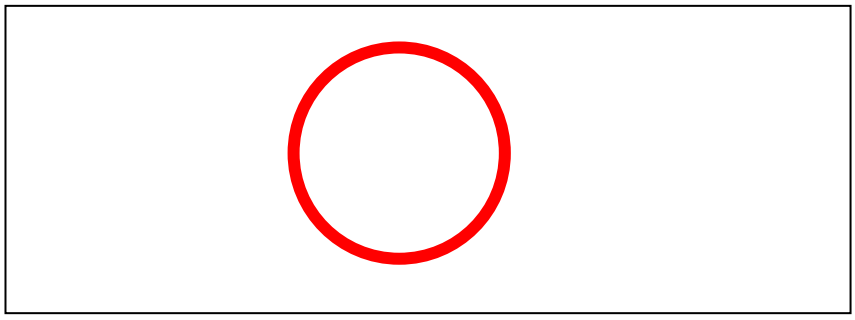

Figure 2. "What do you see?"

Immediately learners began to suggest 'a round shape', 'a red ring', 'a wheel', 'the Sun', 'a shape with no beginning or end', 'a universal symbol', 'it can be any size', and so on. The tutor then uncovered the image so that learners had time to concentrate. He then asked if this shape was displayed in a mathematics class what would it mean? There was immediate reaction from some learners with words such as 'circumference', 'degrees', 'area of circle', 'sphere' and 'perimeter'. The tutor continued with more probing questions such as why is it a circle? and what is the meaning of the word 'circle'? In struggling to come to an understanding learners suggested 'other shapes have corners', 'you can bisect this shape continuously'. Then one learner suggested that 'the midpoint to the edge will always be the same'. Again the tutor probed with a question, 'is a football a circle? 'All learners agreed that the circle must be flat. Finally learners agreed that a circle is a line on a flat surface that is equally distant from a point inside the circle. The tutor then confirmed the qualitative difference between the first,

commonsense, spontaneous description of the round shape and the scientific, thought-out 'definition' of the circle.

This was an excellent and enjoyable exploration for many learners for many learners who participated in the field trials of our educational programme. In his post-class interview Learner 8 was astounded and satisfied with this session:

> I thought it was interesting because at the start of it was just, oh, a circle right. But we kinda started talking about it and got more into it and we managed to get half an hour of talk out of it … from a circle? which I thought was amazing… I thought well, how am I here thinking and talking about a circle for so long. I found it very interesting. [L8:LI:Dec 14th 2000]

Learner 1, in his journal reflects the affective aspect to the class when he suggests *feeling* good about and *liking* thoughtful classes:

> A feel-good class with interaction and thinking… I like provoking, thoughtful classes. Today's 'circle' example was a good example of that. [L1:LJ: Dec. 7th 2000]

This was an important session for many learners because they were enabled, through the gentle probing of the tutor, to uncover what they knew about the circle and develop understanding. They also discovered that new understanding is achieved by taking time to think. There was a sense of achievement at having come to a 'definition' of a circle.

These examples provide evidence that commonsense provides not only a confident starting point but also the invaluable resource. It brings some clarity to the qualitative difference between commonsense and scientific understanding. And even though there are two intellectual fields of operation it does not imply that different people exclusively inhabit each field. A single human mind can and does operate effectively within both fields. When the individual is engaged with practical issues he or she is concerned with the development and growth of common sense of the particular place and time in which he or she operates. However, that same individual may need to develop scientific understanding in relation to their job or profession. This shift from commonsense to scientific understanding is similar to the developmental process described in Argyris and Schon, (1996). They describe a process that moves from routinised, tacit, commonsense understanding, which leads to no significant change of action, to a far deeper, scientific understanding, which brings about a change in the way the individual acts. The former is described as 'single-loop' learning while the latter is described as 'double-loop' learning. Until one attends to experiences in this reflective manner things will continue in the routine, however, with reflection the situation will become transformed from commonsense, single-loop learning to scientific thinking and double-loop learning. Again, the basis for scientific understanding is the routine world and it is reflection and scientific thinking that leads to new understanding and knowledge.

Lonergan (1957) assures us that science does not have a monopoly when it comes to intellectual demands and ability. Common sense and science are equally intelligent and they have a functional synthesis. Without commonsense there is no starting point for scientific understanding. Both science and commonsense operate as partners in the development of human understanding. However, there is concern that scientific knowledge has become a "fetish used to alienate students (and teachers) from their own native ability to know the world" (di Norcia, 1975, p. 27). Making sense of the experiential world is intellectually demanding and fundamental to everyday living and may provide an invaluable resource, particularly for adult learners when they are engaged in formal education.

Convergences and speculations

The authors have begun to recognize the convergence of a number of different strands in our work and the work of others e.g. Howson (1998); Coben (2002a, 2002b); Kuipers (2004). Kuipers (2004) in his definition of commonsense identifies foundational elements of commonsense including number and geometrical awareness, thus clearly identifying mathematics as part of the structure of commonsense. This may explain why adults describe the mathematics that they master as commonsense, i.e. this may go some of the way towards explaining the phenomenon of 'invisible' mathematics as reported by Coben (1997). Kuipers (2004) classification of commonsense is supported in part by recent findings of the cognitive scientists who have discovered that number concepts are 'hard-wired' into humans when they are born as discussed in Devlin's (2000) book *The mathematics gene.*

There is clear agreement that commonsense provides not only the bedrock on which mathematical understanding is built but also a resource that scaffolds mathematical development. Radical constructivism (von Glasersfeld, 1990) focuses on leaning as serving an adaptive purpose i.e. learning is a survival mechanism. Therefore we should learn to exploit natural learning in different environments, e.g. everyday life and workplaces. These ideas are implicated in commonsense knowing and therefore the challenge for us is to exploit commonsense in the service of adults mathematics education.

Conclusion

The perceived divide between commonsense and mathematical understanding provides both the insight and the challenge. The insight, which is similar to that of Tekippe (1996) when illustrating the relationship between primordial knowing and conceptual knowing, is that commonsense can be regarded as a sea within which arises here and there islands of mathematical understanding and knowledge. Without this sea or commonsense world, mathematics has no starting point. The challenge for educators is to cultivate learning environments which will enable learners to draw from their commonsense resource to strengthen and build mathematical commonsense (Kuipers, 2004; Howson, 1998). The authors suggest a convergence of a number of strands in adult's mathematical education research and seem to provide a basis for future research.

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Images of Mathematics in Popular Culture / Adults' Lives: a Study of Advertisements in the UK Press

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Abstract

The success of policies to attract adults back to the learning of mathematics, at various levels, is often linked to questions of motivation. However, motivations depend on relevant beliefs, attitudes and emotions about mathematics - which themselves reflect, together with experiences with maths in school and in the home, wider cultural discourses on mathematics. The work presented here is part of a larger study examining the complex relations between popular cultural products such as advertisements and films, the way that knowledge is portrayed by them, and possible consequences for people's affective responses. The initial phase of the project (Evans, 2003, 2004) analysed small 'opportunistic' samples of advertisements and films. The advertisements portrayed mathematics as generally negative, whereas the films were more ambivalent. In the next phase, we produced larger samples of both advertisements and films. In this paper, we report on our search through a systematic sample of issues of UK daily newspapers for 'mathematical' advertisements. A notable finding was the very small number of advertisements containing images of mathematics. Those few advertisements we found were most frequently for cars, or for services to businesses. Using a discourse theoretical perspective and a hybrid methodology, we categorise advertisements according to features such as their 'appeal' to potential consumers - and we also produce semiotic readings of a sub-sample of advertisements, as to their 'message', in particular their images of mathematics, and of people doing, using, or teaching mathematics. Here we find these images to be much more varied and subtle than in the initial phase. We end by discussing some of the consequences of our analysis for perceptions, teaching and use of mathematics in today's market economy societies.

Keywords: images of mathematics; popular culture; advertisements; discourse analysis; emotion; motivation.

Introduction

Despite long-term neglect of emotional issues in education, they are today firmly on the educational policy agenda. This is evident from the way that resources are drawn from diverse cultural fields to please and to educate learners in formal educational settings. The "emotional turn" (Hartley, 2004) has shifted the emphasis in the polarity *rational vs. emotional*, within the educational discourse. But terms such as *emotional intelligence* and *emotional literacy* theorise emotions as something to be taught, learned and evaluated. They function to regulate and to manage learners - especially adults, a newly significant target group, since, for instance, the inception of the UK government's *Skills for Life* strategy, launched in 2001.

The emotional and attitudinal issues are especially important in mathematics education, since mathematics functions as a gatekeeper, both as a qualification for further study and desirable jobs, and as a prerequisite for certain types of cultural participation. Thus, recent policies on lifelong learning, in the United Kingdom (UK), in the European Union (EU), and around the world, argue for a substantial return to learning by adults, notably in mathematics and numeracy, to help eliminate inequalities (e.g. Parsons & Bynner, 2002; Hughes, Blaxter, Brine, & Jackson, 2006) Yet there is concern over the persistence of low levels of motivation and high levels of avoidance of mathematics and resistance towards it (e.g. Wedege & Evans, 2006), both among schoolchildren and adults. These 'negative' attitudes have been linked in the research literature to emotions experienced during school activity, in "numerate everyday contexts" (Evans, 2000) - and as a result of exposure to various kinds of media representations.

As Paul Ernest (1995) notes

> A widespread public image of mathematics is that it is difficult, cold, abstract, theoretical, ultra-rational, but important and largely masculine. It also has the image of being remote and inaccessible to all but a few super-intelligent beings with 'mathematical minds'.
> (Ernest, 1995, p. 1)

He argues that negative attitudes to mathematics are likely to be associated with the traditional *absolutist* image of mathematics (as described in the quotation), rather than a more *humanised* image of the subject.

Gail FitzSimons (2002) sees the *public images* of mathematics as "created and reflected both in the cognitive and affective domain and concern[ing], *inter alia*, knowledge, values, beliefs, attitudes, and emotions". She argues that

> a very strong influence on the public image of mathematics comes from the experience of formal mathematics education … [and] other influences such as stereotypes reinforced by popular media, or personal expectations conveyed explicitly and implicitly by significant others such as peers and close relatives. (2002, pp. 43-45)

For these reasons, the public images of *mathematics* and the images of *mathematics education* are exceedingly difficult to disentangle.

The work-in-progress presented in this paper explores representations of mathematics as articulated in a variety of ways - and not only as 'stereotypes' - through powerful media forms. From the beginning of this project, we have decided to focus on advertisements (largely in the press) and films as our two media forms. This is because of our belief that these are two from among the most socially potent media in present times, and because the relevant research

materials are relatively convenient to manage. Further, presentations and discussions based on them tend to be accessible to a wide range of audiences (including international ones): many films (at least mainstream ones) tend to be well known globally, and advertisements can be portrayed on one side of paper (or on one projector slide).

The initial phase of the project analysed small and 'opportunistic' samples of each (amassed with help from friends, and colleagues, and mostly from before 2001). Our initial thinking and analysis of these advertisements and films focussed on issues such as:

- the extent to which dominant discourse(s) on mathematics could be identified in such samples of materials;
- the extent to which there appeared to be systematic differences in the representation of mathematic(ian)s between films and advertisements (especially the most recent ones); and
- the extent to which there appeared to have been changes in these discourses over time.

In connection with the latter issue, we asked whether we might find a more 'positive' tone (in terms of the image of mathematics and mathematicians) in advertisements and films after 1995[1], than before.

Our initial results were as follows. The advertisements we found generally portrayed mathematics as something to be disliked, feared and mistrusted. On the other hand, the films (e.g. *Good Will Hunting* (Bender & Van Sant, 1997), *A Beautiful Mind* (Grazer & Howard, 2001), *Enigma* (Michaels, Jagger & Apted, 2001)) produced ambivalent messages. Mathematics was there portrayed as perhaps the most powerful form of thought - and as therefore supporting a quest for truth and beauty. But too much mathematics can be dangerous: it can be an expression of - or perhaps a trigger for - 'madness' (see also Evans, 2003, 2004).

In the second phase of the project, we aimed to produce larger samples of both advertisements and films. A larger number of films were thus identified as relevant, and systematic sampling of UK national daily newspapers from 1994-2003, supplemented by our earlier 'opportunistic' sample, resulted in a small corpus of print advertisements to analyse.

In this paper, we focus on our sample of print advertisements. Drawing on several conceptual approaches, we first discuss our discourse theoretical perspective, followed by an outline of our methodology. We then present an analysis of our sample of advertisements, as well illustrating our semiotic readings of several of them. We conclude by pointing to some of the implications of our analysis for images, teaching and use of mathematics in the current conjuncture.

Theoretical Considerations

Our starting point is that films, advertisements and other such cultural productions are representations which both reflect, and contribute to the construction and maintenance of, dominant social discourses. Such discourses, formed partly by appropriations of popular cultural ideas or images, might be reappropriated by official educational discourses and reinterpreted by individual agents, be they policy makers, teachers, pupils, or adult learners. This means that we are interested in cultural productions because they play a significant role in constructing and

[1] We chose this point in time partly in response to features of the early data, and partly on the basis of the initially positive reporting around that time of Andrew Wiles's efforts at proving Fermat's Last Theorem. As will become evident, we no longer propose such a simple factor for such a substantial ideological change, nor are we sure that such a change has occurred! And, even if it has occurred, there may have been a time-lag (see also Conclusions).

reproducing dominant and dominated positions of power affecting individuals in many contexts of social and educational activity.

Our theoretical approach uses discursive perspectives (see Evans, Morgan & Tsatsaroni, 2006; Evans, 2006), based on Critical Discourse Analysis (Fairclough, 2003) in socio-linguistics, work on pedagogic discourse in the sociology of education (Bernstein, 2000), and post-structuralist analyses, drawing on psychoanalytic concepts (e.g. Walkerdine, 1988, 1997; Evans 2000; Mendick, 2006).
Discursive perspectives focus on specific societal/institutional practices as recurrent forms of behaviour/action. A discourse here is seen as a system of ideas/signs organising and regulating the related practices, crucially, with respect to social relations of *power*. Discourse has several functions:

- defining "how certain things are represented, thought about, practised and studied";
- providing resources for constructing meanings, and accounting for actions; and
- "construct(ing) identities and subjectivities", which include affective characteristics and processes (Hall, 1997, p. 6).

Power is exerted in micro social interactions, in 'meso' institutional contexts, and in the wider culture, including by policy-makers and by the media within popular culture (Appelbaum, 1995).

A key concept is that of *positioning*, a process whereby an individual subject takes up and/or is put into one of the *positions* which are *made available* by the discourse(s) at play in the setting. In this approach, a person's *identity*, which includes more durable aspects of affect such as attitudes and beliefs, comes from repetitions of positionings, and the related emotional experiences, in a context of a personal history of positionings in practices.

Bernstein's sociological theory is also a main theoretical source (Bernstein, 1990, 2000). First, his concept of recontextualisation is a key concept in understanding the construction of discourse. This was developed by Bernstein to describe (initially) how pedagogic discourse is created through social processes which involve selection, simplification, repositioning and refocusing of elements drawn from knowledge producing discourses (Bernstein, 1990). These processes entail transformations of these elements and changes in social relations. Therefore, like official pedagogic discourses, media discourses are regulatory, having consequences for the construction and reconstruction of identities and subjectivities.

Of particular relevance for developing our problematic are two key assumptions forming the basis of Bernstein's theory. The first is that education today, more than ever before, serves symbolic control functions rather than functions related to material production (i.e. transmitting knowledge and skills). The second assumption is that education, while belonging as an institution to the general cultural field, is nonetheless distinguished from it - since historically it has become the state's official site for social and cultural reproduction. This means that in the context of Bernstein's theory the pedagogic discourse assumes priority over and against other ('unofficial' or non-state, e.g., media) institutions and their discourses in the cultural field. However, a post-structuralist reflection on Bernstein's notion of discourse (Tyler, 2004; Lemert, 2006) would recommend greater consideration of the interconnections between the wider field of symbolic control and the field of education; or, more precisely, of the perpetual constitution and reconstitution of their respective boundaries and relations through the influence of internal (to each), as well as external, political, social and cultural forces.

Nevertheless, Bernstein's later emphasis on media discourses (2000, Ch. 11) provides important theoretical insights into our research object. The first insight comes from his view that *cultural productions*, whether oral communications in the classroom, textbooks, syllabuses, advertisements or films, are the means by which power relations translate into discourse and discourse into power (Bernstein, 1990). Of importance here is to describe what Bernstein calls the *code modality* regulating communication processes; his concepts of classification and framing are indispensable in such activity. *Classification* helps to conceptualise power relations between different categories of agents (e.g., transmitter and acquirer), discourses (scientific and everyday), forms of knowledge (mathematics and history). *Framing* helps to ask questions regarding who has control over what in the process of communication/interaction. Furthermore, both concepts utilise the idea of boundary pointing to the importance of describing changes in its strength in the processes of recontextualisation through which (pedagogic) discourse is constructed, taught and learned.

The second theoretical insight stems from his view that contrary to pedagogic discourses that form more durable pedagogical relations and communications, media representations contain a range of discourses that are segmentally organised. These segments may have a variety of discursive realisations, and may result in different motivations - aiming as they do to maintain, develop or change an audience niche (Bernstein, 2000, Ch. 11). We can assume therefore that due to their segmental organisation, media discourses are multi-layered, *creating a variety of modes of communication*, and are therefore complex as to their reception. That is, we cannot expect a strong, or even indirect, control over the context, social relations and motivations of the receivers/consumers. On the contrary, what is acquired, at what level and for what purpose is open to investigation and debate. Nevertheless, Bernstein calls this form of media discourse a *quasi-pedagogic discourse*, thus indicating that media discourses entail some form of pedagogic (i.e. social) regulation, irrespective of the ways in which messages are acquired.

This basic analysis of media discourses as quasi-pedagogical justifies at this theoretical level of discussion the focus of our current study of mathematics representations in the media. In particular, it allows us to argue that the modalities of communication created by the organisation of media discourses attempt to distribute forms of consciousness, identity and desire[2]. At the same time, these theoretical insights point to the difficulties of such a project; especially with regard to the implications, for individual receivers of messages, of any analysis of the modes of communication embedded in a given discourse.

Thus far we have argued for the importance of approaching our topic with the view that the production of cultural objects simultaneously inscribes ways of producing identities and subjectivities. Our second key starting point is the idea that central to the constitution of subjectivity in sites of cultural production are the links forged between the cognitive and the affective, here understood as the question of the place of emotion in cognitive-affective *chains of signification*. By this, we mean chains of developing meanings produced by chains of signifiers in the relevant text.

On emotion, the following points are important for us. First, just like thinking, learning, or working with mathematics, emotional expression and experience are embedded in social contexts, and thus can be seen as *socially organised* (see Evans, Morgan & Tsatsaroni, 2006).

[2] Leiss, Kline & Jhally (1990) point to the possibility of a given culture of 'consumers' of advertising being 'educated' over time through changing forms and strategies of advertising.

Second, we see *emotion* as related to *desire*, which is considered to permeate the workings of language. Thus emotion can be visualised as a charge attached to ideas and the terms in which they are expressed. This charge has a physiological, behavioural (including verbal) expression, and a subjective 'feeling' aspect. This allows emotion to be seen as 'attached' to ideas (cognition), but in ways that are fluid, not fixed. Some of this fluidity can be seen as related to psychic processes of *displacement*, where meanings and feelings flow along a chain of ideas (or signifiers) and *condensation*, where meanings and feelings 'pile up' on a single signifier (Evans, 2000). This is how the psychic/'individual' and the linguistic/social interconnections could be conceptualised.

Third, emotions may be *unconscious* in the psychoanalytic sense of being pushed into the unconscious, via the operation of *repression*, one of the defence mechanisms. In psychoanalytic approaches, ideas which have strong emotional charges, such as anxiety, or which mobilise intrapsychic conflict, have a tendency to meet defences, and thus to be repressed. Therefore, much thought and activity takes place outside of conscious awareness: everyday life is mediated by unconscious images, thoughts and fantasies (Hunt, 1989). This unconscious material is linked to complex webs of meaning (Evans, 2000, Chs.7-10).

Thus, emotions must be understood in connection with *desires* and *fantasies*. Many desires are unconscious, since they may be felt to be 'unacceptable' or in conflict with the person's desired social image; fantasies are specifically 'unrealistic' or 'irrational' images and narratives that express the desire for some object on the part of the person entertaining them. Both have 'social' aspects, in that desires are connected with social imagery, as is the case with advertising and films, and fantasies can manifestly be shared at the group, professional, or national cultural level (Walkerdine, 1988, Chs. 9 & 10).

An excerpt from *Enigma* (Michaels, Jagger & Apted., 2001), a film which portrays mathematicians at work and at play, allows us to illustrate the role of fantasy in the effectivity of films and their articulation of powerful elements of social imagery. In this excerpt, the themes of desire and fantasy are illustrated in a story of the code-breaking headquarters at Bletchley Park in Britain in World War 2. In this scene, the hero, a mathematician, goes to the home of a woman with whom he had earlier fallen in love. He does not find her there, but he cannot resist entering her room; there, he recollects her image, as he smells her perfumes, and, in particular, one earlier meeting with her:

> *Theme song in the background, they are sitting on a sofa.*
> She: Why are you a mathematician? Do you like sums?
> He, holding a rose: Because I like numbers - because, with numbers, truth and beauty are the same thing … you know you're getting somewhere, when the equations start looking … beautiful. (He looks at her slightly appraisingly/appreciatively.)
> Then you know the numbers are taking you closer to the secret of how things are. A rose is just plain text…
> He hands her the rose; she takes it, but, as he passes it over, a thorn pierces his thumb and makes it bleed. She kisses his thumb; they embrace.
>
> Illustration from Enigma (Michaels, Jagger & Apted., 2001)

In this scene, the beauty of mathematics is intertwined with that of the rose and that of the classically attractive woman. He exhibits his desire for these beautiful 'objects', and further, in aligning beauty with truth in mathematics, he suggests a 'higher' form of beauty. His desire to follow "the numbers […] closer to the secret of how things are" suggests a heroic goal shared by many mathematicians, and also perhaps attractive to some young mathematics students at

school or university. Others have considered the extent to which this version of 'Reason's dream' can be usefully understood as *fantasy* (e.g. Walkerdine, 1988).

In the illustration above, the beginning of the scene can be interpreted to show that the male mathematician is experiencing pleasure through entering the room, and smelling the perfume of the woman he loved as these are associated with her. He is also experiencing pleasure through remembering the encounter with her. These re-experienced pleasures derive from the original experience with her, which was imbued with feeling - but they also reformulate that experience, as they reverberate with pleasures experienced in practising mathematics. Such instances of emotion are experienced by individuals who already have beliefs and attitudes that are to a great extent *culturally transmitted* by the person's 'significant others', such as parents, siblings, teachers. But there is also a role for the media and other means of communication, which transmit images of mathematics and mathematicians in popular culture (Appelbaum, 1995; Evans, 2003, 2004; Mendick, 2006).

Emotion can also arise through an association with objects or ideas different from those to which it was originally linked. Psychoanalytic approaches see this as happening through the capacity of an affective charge to move from one idea to another along a chain of associations by *displacement*. A number of examples are given by Evans (2000, pp. 116-9). The following excerpt from another film featuring a mathematician illustrates the meaning of displacement, and how it works.

In *Smilla's Feeling for Snow* (Eichinger, Moskowicz, & August, 1997), the heroine, who investigates the mysterious death of a young boy in a block of flats in Copenhagen, is also a mathematician. In one scene, where she is having a meal with a man who clearly has strong feelings for her (apparently unreciprocated), she is describing how difficult it was for her to be relocated from Greenland to Denmark, as a young girl:

> *He*: And you were never happy here?
> *She*: The only thing that makes me truly happy is mathematics … snow … ice … numbers [*She smiles*.] To me the number system is like human life. First you have the natural numbers, the ones that are whole and positive, like the numbers of a small child. But human consciousness expands and the child discovers longing. Do you know the mathematical expression for longing? [*He shakes his head.*] Negative numbers, the formalisation of the feeling that you're missing something. Then the child discovers the in-between spaces, between stones, between people, between numbers – and that produces fractions. But, it's, it's like a kind of madness, because it doesn't even stop there…. There are numbers that we can't even begin to comprehend. Mathematics is a vast open landscape: you head towards the horizon, it's always receding … like Greenland. And that's what I can't live without, that's why I can't be locked up….
> *He*: Smilla, can I kiss you? [*She moves away.*]
>
> Illustration from Smilla's Feeling for Snow (Eichinger, Moskowicz, & August, 1997)

This scene again associates mathematics with beauty and seduction: here we have a beautiful female mathematician herself talking about mathematics. As we listen to her talk, what comes across most strongly is her longing … for numbers, mathematics, Greenland, and the sense of loss as she sees them "always receding": the linking of these signifiers forms a *chain of signification*. The original (in this excerpt) feeling of loss and longing appears to relate to Greenland, which itself may stand for another object, such as her dead mother; that feeling is *displaced* onto mathematics, and in turn onto the negative numbers – that part of mathematics which for her "formalises" the feeling of loss, and which she contrasts with the "whole and positive" natural numbers of the young child.

Thus we see that objects of popular culture such as films are sites for the articulation of discourses within which meanings are defined, images are built up, and hence power is invested. This illustrates another way in which emotions are socially organised. These different objects of popular culture may relate to each other as texts via *intertextuality* (the insertion in one text of ideas, terms, or images from another - see examples below). Further, discourses operating in one field may allow an influx of terms, symbols and ideas from other fields, that is, *interdiscursivity* (Fairclough, 2003). From our discourse theoretical perspective this points to the importance of *key signifiers*, which 'arrest meaning', in the sense of re-articulating and stabilising meaningful contexts for action - though always precariously, with no guarantee of permanence or fixity.

Research Questions

Following on from the theoretical premises above, and from the general issues indicated in the introduction, we can assume that popular representations may play a major role in reinforcing (or challenging) long-term public images of mathematics, thereby reproducing dominant social and educational discourses. Furthermore, we assume that the way that mathematics is recontextualised in such representations may become a significant influence on subjectivity. This in turn indicates that it would be crucial to examine mathematics in popular representations by exploring questions such as:

- From what discourses do advertisements or films draw resources in order to construct the public/reader/viewer/consumer as a person?
- How do they construct him/her as knowledgeable in mathematics?
- What branch and level of mathematics does an advertisement draw on to convey the intended message and consequently what level and depth of knowledge is a citizen of average educational experience assumed to have?

In this second phase of our work these issues led us to produce the following set of specific research questions with which to systematically approach the advertisements data:

- RQ0 To what extent do advertisements use mathematics as a resource to construct their messages?
- RQ1 What kind of discourse(s) on mathematics, people doing mathematics, school mathematics, and/or teachers of mathematics can be identified in the images portrayed in our sample of advertisements?
- RQ2 Are there changes in these discourses/images over time?
- RQ3 On what discourses do advertisements draw to construct the public/reader as a person, who is knowledgeable (or otherwise) in mathematics?

Methodology

Initially, we needed to decide on several methodological issues:

- Criteria/Indicators: how to determine whether an advertisement was an instance of a 'representation' of mathematics or mathematicians
- Fieldwork method: how to gain access to a set of newspapers that could be scanned for advertisements satisfying the definition
- Sampling: how to select the sample of newspaper issues for scanning.

As criteria for an advertisement to qualify as containing a representation of mathematics (or mathematicians), we looked for one or more of the following keywords in the text:

- mathematics; mathematician; math/s; geometry/geometrician; algebra; equation(s); number(s); science/scientist; calculation(s), sum(s) (or related terms);
- the name of a prominent mathematician (such as Einstein, Stephen Hawking).

Alternatively, we looked for one or more of the following graphics:

- a graph, a formula or equation;
- the picture of a prominent mathematician (such as Einstein, Hawking).

As a fieldwork method, we decided that we would look for advertisements in a sample of newspapers in the Colindale Newspaper Library in London, rather than using an agency. The reason for this was that we were uncertain as to whether the 'proxy researchers' available from an agency would have sufficient understanding of our requirements, and sufficient flexibility for dealing with borderline cases.

For sampling, we designed the sample on the basis of readership profiles (available from British Rates and Advertising Data - BRAD). We decided to focus on national daily newspapers, as providing the most generally representative indication of advertisements placed in the British press. We selected three 'quality' newspapers (*Times*, *Daily Telegraph*, *Financial Times*), one mid-market paper (*Daily Mail*), and two 'popular' papers (*Sun*, *Daily Mirror*) - and systematically selected two periods (each 10 to 15 days long) for each of the four years 1994 (i.e. before 1995 - see footnote 1), 1997, 2000, and 2003. This systematic sampling method resulted in almost 550 editions being examined from cover to cover for 'mathematical' advertisements (as characterised above). However, this work yielded fewer advertisements than we had expected. So we added further sampling periods from 2001 (before September). At the same time, we decided to stop before completing the *Sun* sample, since no appropriate advertisements were found in it or the *Daily Mirror*.

Once we had amassed our sample of advertisements, they were analysed on three levels:

- basic characteristics: e.g. newspaper, timing, overt aim of the advert;
- content analysis indicators, based on those used by Leiss, Kline & Jhally (1990); and
- 'semiotic' readings of the images of mathematics, school mathematics and people doing mathematics portrayed by the advertisement.

(See Appendix A for further details on the coding categories used.)

The first level relied on relatively straightforward categorisations, whereas the next two required interpretations of the possible meanings of the advertisements. This had the potential to fruitfully combine 'quantitative' and 'qualitative' analyses, as in the hybrid 'qualitative cross-sectional' analyses by Evans (2000), using a sample of semi-structured interviews.

Results

In this section, we produce a selection of initial results from the data analysis. The results of the trawl for advertisements are indicated in Table 1. The first notable finding is how few advertisements were found in which 'mathematics', 'mathematician', or similar terms (see above) figured. Of the almost 550 editions of daily newspapers examined from cover to cover, only 9 advertisements were found. Furthermore, they were concentrated in the quality and mid-market papers, with none being found in the popular newspapers; see Table 1.

Table 1. Advertisements found in editions of daily newspapers in the systematic sample.

Newspaper	No. editions examined	No. of Ads	"Success rate"
Times	105	4	**4/105 = 4%**
Financial Times	124	0	**0**
Daily Telegraph	76	1	**1/76 = 1.3%**
All Qualities	305	5	**5/305 = 1.64%**
Daily Mail	97	4	**4/97 = 4%**
Sun	53	0	**0**
Daily Mirror	88	0	**0**
All Papers	**543**	**9**	**9/543 = 1.66%**

That is, only 1.66% of the daily editions examined included an advertisement that made reference to mathematics, and all of these were in either the quality papers represented by *The Times*, the *Financial Times*, and the *Daily Telegraph* (various success rates ranging from 0 to 4%), or in the *Daily Mail* ('success rate' a little over 4%), the sampled representative of the mid-market newspapers. No advertisements making reference to mathematics were found in the 'popular' newspapers, represented by *The Sun* and the *Daily Mirror*. As far as advertisements in the daily press are concerned, mathematics appears to be marked by its absence as being outside the range of attention of most ordinary people.

Basic characteristics of the advertisements

In considering basic characteristics of the advertisements, the whole sample of 15 was analysed; nine from the systematic sampling over the period 1994-2003, and six from the 'opportunistic' sample from 1986 to 2004[3]. The product category of the advertisements are detailed in Table 2. We compared the results from the systematic sample with those of the overall merged samples.

Table 2. Product category of the advertisements

Product category	Number in systematic sample (number in overall sample)	Advertisements in systematic sample {Advertisements in opportunistic sample}
Automobiles	3 (4)	Jaguar (2003), Daihatsu (2003), BMW (2003) {Peugeot (1999)}
Business Services	3 (3)	Concert (2000), Thales (2000), Sun Microsystems (2001)
Study Aids	-- (2)	{Letts (1986), Sharp home computers (1987 ca.)}
Food	2 (2) [1 campaign]	Quorn (2003)
Consumer Telephone Services	-- (1)	{Mercury (1994 ca.)}
Bank	1 (1)	Abbey National (2001)
Rail Transport	-- (1)	{South West Trains (2004)}
Men's Cosmetics	-- (1)	{Givenchy (2002)}
Total	9 (15)	

[3] Of the latter, three were from *The Guardian*, a 'Quality' daily not included in the systematic sampling procedure, two were from the Sunday newspapers (*The Observer*), and one (the Givenchy advert discussed below) from a company's website (though it may well have featured in print also).

In both our systematic and the overall merged samples, 'mathematical' (or 'scientific') portrayals seem more likely to appear in advertisements for cars and business services. Combining this with the information that a large percentage of 'primary car buyers' and senior managers consuming business services are male, suggests that an appeal to mathematics in advertising in the UK is somehow gendered (cf. Williamson, 1978)[4].

It is noted that all of the advertisements found in our systematic sampling procedure were in the period 2000-2003, and only three of those in the opportunistic sample were published before 1995. Thus, despite research question RQ2 above, we are unable in this paper to make any conclusions about changes in advertising images over time.

In interpreting these results and considering the extent to which they might generalise to a description of advertising practices in the UK, we must express two types of caution. First, despite the reasonably large number of editions examined, the sampling was still 'light', in that it covered only a small percentage of the editions of daily papers published during the period: the presence of a further three 'mathematical' advertisements in *The Guardian* during the sampling period suggests that our sampling may have missed a substantial number of relevant advertisements. Second, with only 60% of our merged sample chosen by our systematic methods - and 40% resulting from the research team's reading habits or from referrals from colleagues, the results from the merged sample may fall short of the claims of representativeness that the systematic sampling sought to justify. Nevertheless, we think it is worthwhile to present our results for our merged sample (n = 15), since this allows us to give a slightly more broadly-based account.

Content analysis and semiotic readings of the mathematical images presented

Here we present a discussion of our readings of five of the advertisements, as to the content analysis of a key indicator, and the images they present of mathematics, mathematicians and school mathematics (Table 3).

Table 3. Sub-sample of advertisements considered

Advert	Product	Newspaper	Year
XJ(CO2xOTR)=low B1K	Automobiles (Jaguar)	Daily Mail	2003
"If I've got my sums right, … "	Automobiles (Peugeot)	The Guardian	1999
"Wednesdays are lousy. Certified"	Food (Quorn)	Daily Mail	2003
"I hereby scientifically declare; Wednesdays stink"	Food (Quorn)	Daily Mail	2003
π: BEYOND INFINITY	Men's Cosmetics (Givenchy)	Corporate website	2002 ca.

Two of the five advertisements were chosen to illustrate the range of advertisements for cars, one of the two markets that referred most to mathematics in our sample. The two food advertisements were chosen as they were paired in one campaign. The men's cosmetic advertisement for the perfume, π, was chosen for several reasons: it apparently appeals to more interesting realms of mathematics; by its nature, it might suggest insights concerning gender;

[4] It is worth noting that there is an appeal to science (and to mathematics, at least implicitly) in advertisements for skin creams and other cosmetic products for women, too (Heather Mendick, personal communication).

and it is perhaps the most long-lived advertisement in the sample and is the focus of much ongoing comment on the internet (as a web search on 'Givenchy Pi' shows).

We consider each of these advertisements in relation to several selected indicators from those indicated for the content analysis and the semiotic readings (see Appendix A). From among the content analysis indicators listed, we focused on those related to the 'appeal' of the advertisement (Leiss et al., 1990), and investigated in a more 'semiotic' fashion the images of mathematics and people doing mathematics.

The Jaguar advertisement (Figure 1) was visually one of the most sumptuous of the advertisements we found: light shines onto the car from all sides, and, besides the car, the biggest object in the frame is the jaguar, which seems to leap off the car and to soar above everything else. The overt aim of the advertisement is to inform the reader and potential customer of the low BiK (environmental) tax payable at purchase, because of the low CO_2 emissions of the car, due to the 'unmatchable' construction. The largest element in print is the equation:

XJ (CO_2 x OTR) = low BIK.

Figure 1. Advertisement for Jaguar

Though apparently mathematical, the equation turns out on closer inspection to be somewhat different. Without the material in brackets, it may be a way of expressing something like 'The XJ has the lowest BIK tax bill (in its class of car)' - which is what the text says further down. The material in brackets (which could not in any case be multiplied by the non-quantitative XJ) also appears to represent the 'product' of CO_2 by something undefined (which may turn out to

mean something like 'On the Road'). Not really the stuff of which mathematics is made[5], this equation appears to be inserted to attract attention, or perhaps to allude to the high-quality engineering that lies behind the construction of this car.

The image of mathematics presented here is that of simplicity, succinctness, precision, and an association with high-quality engineering, science, and consciousness of the environment. The implicit image of a mathematician, or of the engineer or scientist using mathematics, is of someone who expresses or confirms simple, straightforward statements, in this case about the car. The advertisement's appeal is thus 'rational' (Leiss et al., 1990), as well as 'sensual'.

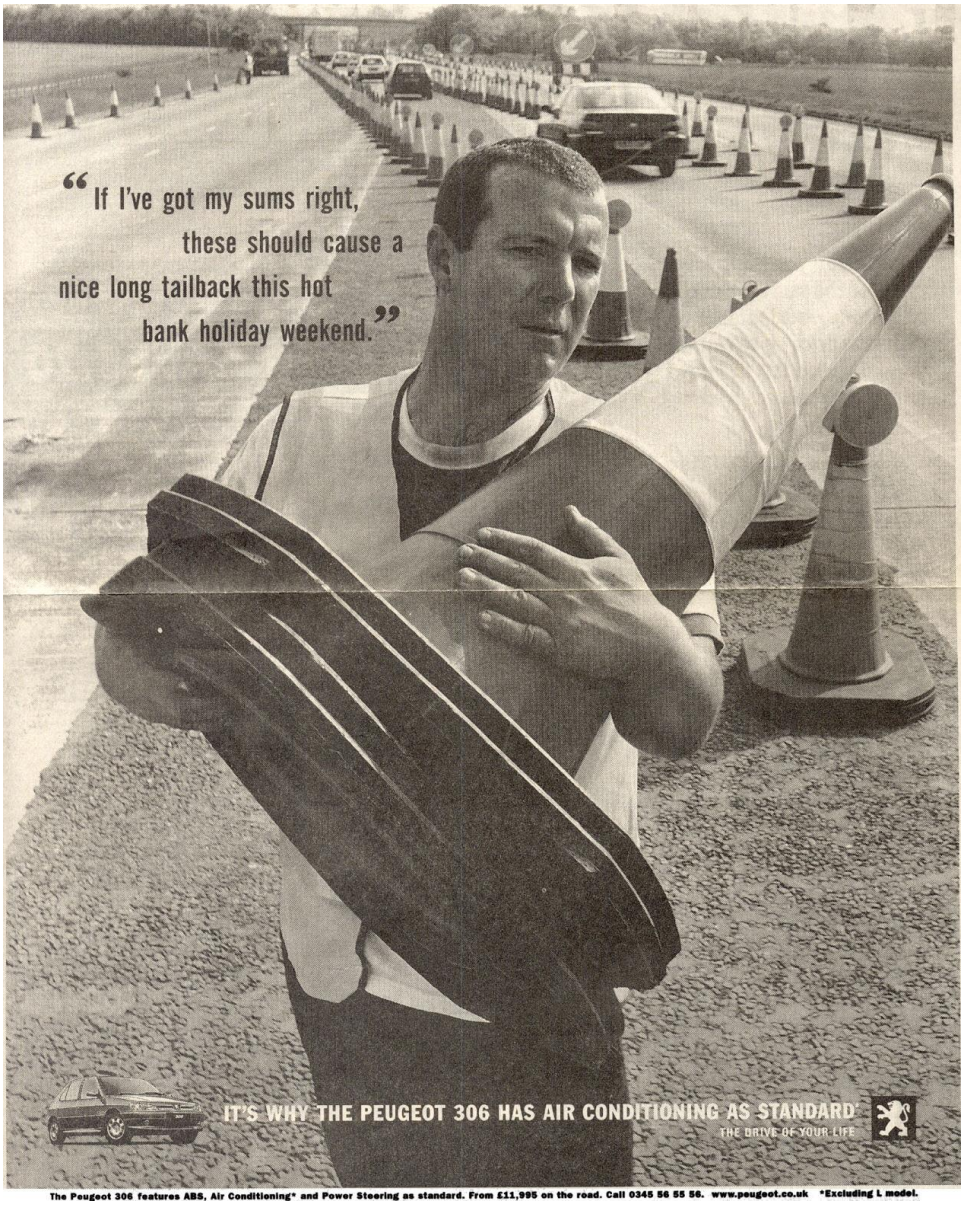


Figure 2. Advertisement for Peugeot

[5] Glendinning (1998) presents an even more striking picture (a still image from a television advert for VW Golf), which shows a baby holding a placard, which purports to show the evaluation of an integral: he argues that the first two lines have been cropped (presumably to save space in the frame), and several errors in the reasoning have been inadvertently introduced, presumably by someone who does not understand mathematics.

The Peugeot advertisement (Figure 2) was published in *The Guardian* in August/September 1999. On the overt level, it aims to inform the reader of the availability of in-car air conditioning "as standard" in the advertiser's models. However, this advertisement functions by creating a 'lack' (Williamson, 1978); we might say that its appeal is based on 'worry', followed by 'relief' (Leiss et al., 1990). It aims to establish a need for in-car air conditioning, by sketching a worrying fantasy of a vindictive public road service, staffed by aggressive, nasty workers, who want to make the reader's life a misery, even (or especially) on a holiday weekend. The relief is provided by the advertiser's cars, which have a built-in 'private' solution - personal air-conditioning. Volume 2(2) – September 2007
Mathematics here is portrayed as "sums" - which can be used in a clever, 'calculating' way, to gain advantage, to 'put one over' on people who, perhaps do not have to work on this "hot bank holiday weekend"; see the discussions of the reverberations of 'calculating' in Walkerdine (1997) and Evans (2000, Ch10). Here, we note that what might be an interesting mathematical problem – whatever its social merits – of modelling the relationship between the pattern of deployment of traffic cones and the resulting restriction of traffic flow, is trivialised.

Anxieties around school mathematics are perhaps invoked by the mention of "sums", and whether they have been "got right". And the portrayal of the particular person who is 'doing maths' is nasty and aggressive.

Other plausible themes are social class antagonism, and suspicion of public services and their employees. This 1999 advertisement also provides an example of *intertextuality*, in recalling the UK public's irritation with traffic cones earlier in the 1990s, culminating in the then Prime Minister, John Major's call for a "Motorway Cone Hot-line", aiming to allow road users to use their mobile phones to report any unnecessary traffic cones on a particular stretch of road.

We now turn to the pair of advertisements for Quorn (a protein substitute), published in the *Daily Mail* over 4 days in March 2003 (Figure 3). The overt aim of these is to relate 'sympathetically' with readers that on Wednesdays they feel the "mid–week blues" and are short of ideas, and to suggest that Quorn "lifts the spirits" and inspires on Wednesdays. Here the advertisements function by creating a worry, about under-performing or feeling low on Wednesdays. Allegedly this is brought on by the day itself, rather than the readers themselves. The advertisers then offer their product as a "solution" or 'relief'.

We classified these advertisements as mathematical, since they used graphs of frequency distributions. On the most straightforward level, mathematics is portrayed as simple (frequency counts) data analysis. These statistics are used to "certify" that Wednesdays are "lousy" (due to "mid-week blues"), or that Wednesdays "stink" (allegedly "nobody has good ideas" that day). On reflection, however, we are struck by several unusual aspects of these 'data'. The headline language is most unscientific – "lousy" and "stinks". The person asking for our attention is dressed, not as a scientist, but as a cook, complete with cooking utensil. The graphics are not 'professional', but suggest an inexperienced schoolchild. And these 'data' – problematical on their own terms, regarding validity of indicators, and the likelihood of reliable data production – could be recognised further (by some readers, at least) as fabricated.

Thus we have an image of mathematics as simple frequency count analysis - and possibly as wrong-headed on several accounts. But the original 'conclusions' do not matter anyway, as Quorn will make it all right - and, apparently, none of the maths (or "science") was necessary, since it was all 'rubbish' anyway. This is an example of a particular sub-category of advertisements figuring mathematics and science, which suggests that it is not necessary to be

concerned with mathematics, science, evidence, or argument - as you will 'know' what to think anyway, with the help of the advertisements[6].

One might respond that part of the appeal of these advertisements – or part of their defence – is that they are 'humorous'. However, this pair of advertisements creates different subject-positions for different readers, as do many advertisements post-1970. This differential positioning of readers corresponds to general processes of *market-segmentation*, and of customising of consumer goods by companies in an age of accelerated consumerism.

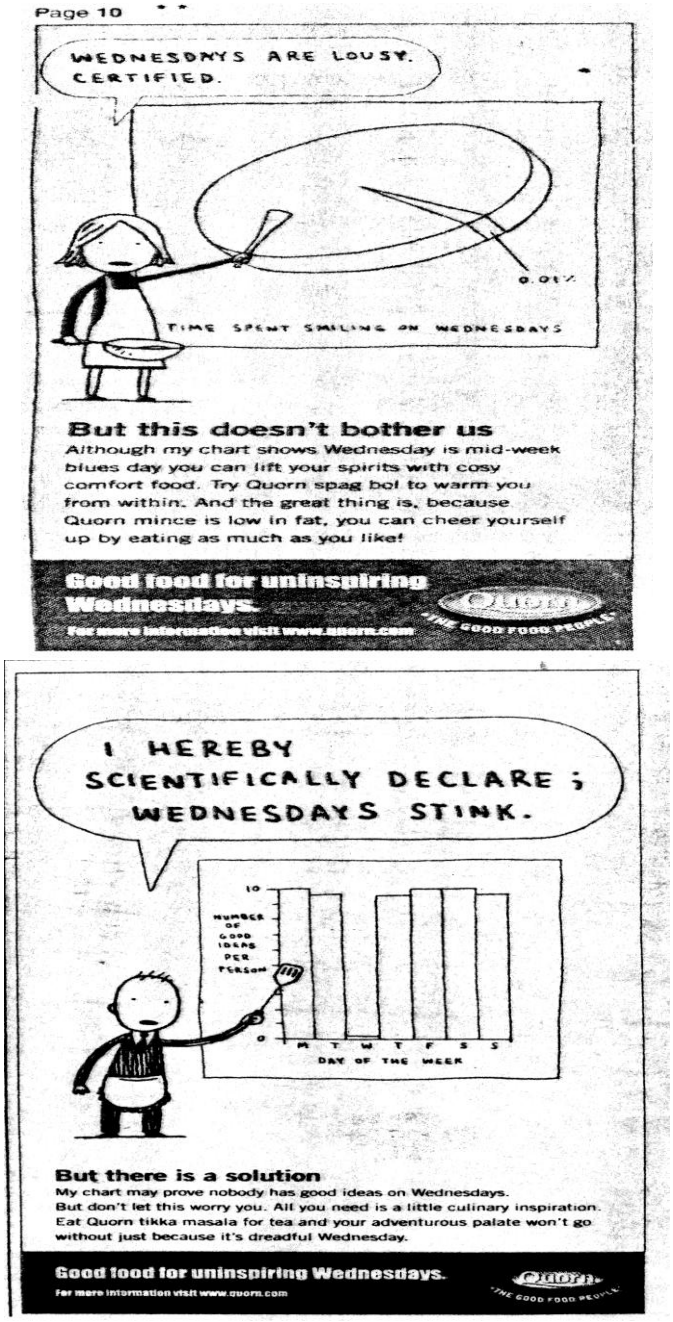
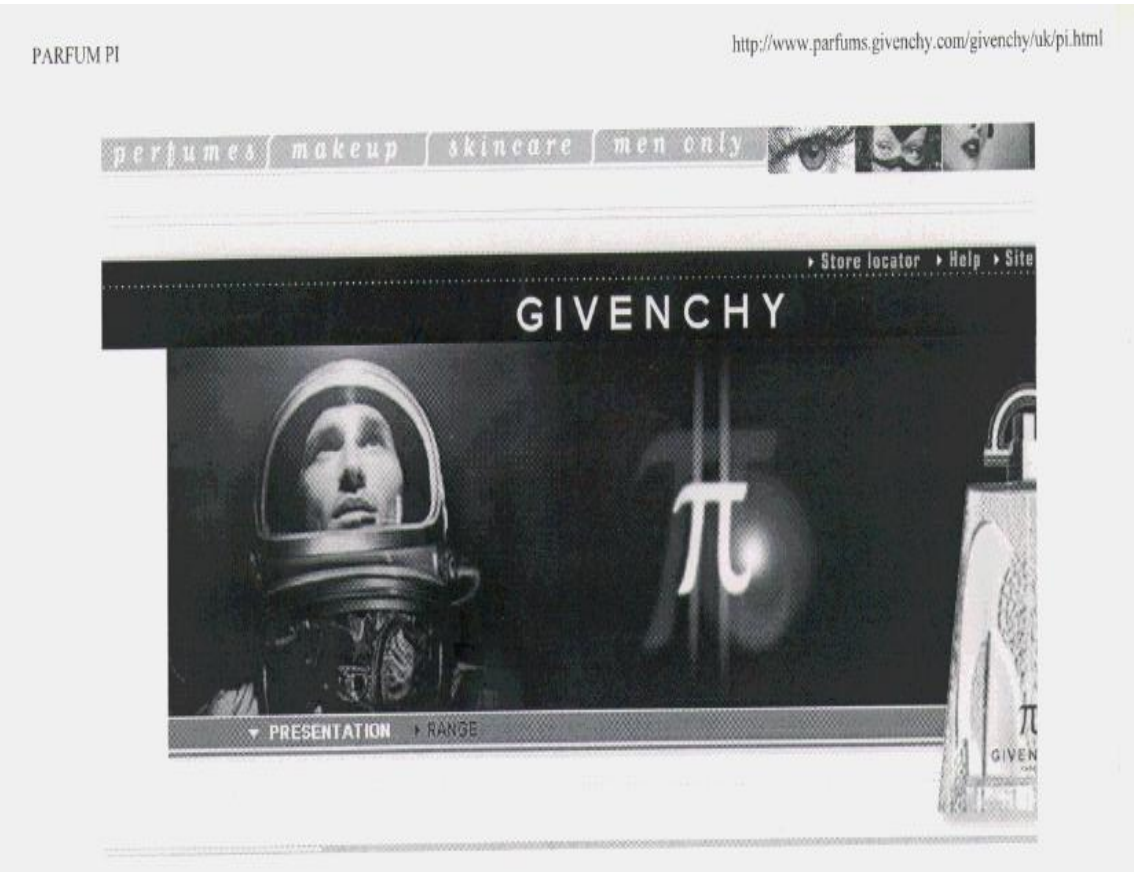


Figure 3. Advertisements for Quorn

[6] Other examples of advertisements promoting this message in the sample, but not discussed here include the Mercury telephone services advert (1994 ca., *The Guardian*), and the BMW car advertisement (2003, *The Times*).

The last advertisement is for a men's perfume called π (Pi), produced by Givenchy in 2002 (Figure 4). The picture at the top shows a man in a spacesuit looking upwards towards the light; to the right are two symbols of π superimposed, and to the far right, partially hidden is a bottle of the fragrance.



π: BEYOND INFINITY

Deep in the nature of man is the will to go further than any man has ever been before. The quest is symbolised by the Greek letter π, which evokes infinity. Men are still in pursuit of the end of its innumerable string of decimals…. A perfume which is synonymous with this pioneering spirit, π celebrates internal force and an adventurous imagination: energy and sensuality, unruffled calm and strength.

Figure 4. Advertisement for Givenchy's Pi[7].

The overt aim of the advertisement is to announce a new men's perfume, with an appeal to a distinctive segment of the market - and to associate positive (masculine) qualities with it. Its appeal is neither 'rational', nor related to worry/relief, as with the previous two, but might be characterised as 'sensual', as was the Jaguar advert. We can note the 'sensuality' and sexiness

[7] The version shown here is taken from the company's webpage.

of the pictures and the text. Of course fragrances (as commodities), in most Western societies at least, are heavily gendered. This is reinforced by the pictures and the text in this advertisement (with its references to "man…", "men…").

On the face of it, mathematics is portrayed in a much more open-ended way here than in the previous advertisements. In terms of the portrayal of mathematics, the mathematical object, π, we are told, "evokes infinity"; this is associated with the product's "pioneering spirit" and "adventurous imagination". As for mathematicians, "men" are claimed to be "still in pursuit of the end of its innumerable string of decimals": this allows the claims of "internal force", "unruffled calm", strength and energy to be asserted. This advertisement reinforces the association of masculinity and mathematics (see also Mendick, 2006). It does indeed appear to be designed to appeal to men, and especially those who are knowledgeable about mathematics, or for whom it has an allure.

However, there is a problem about the portrayal of mathematics, and especially π, here. For people who know a little about mathematics, π does *not* mainly "evoke infinity" in mathematics: despite its infinite, non-repeating decimal expansion[8], it is itself a finite number! And not many "men" are "still in pursuit of the end of its innumerable string of decimals" (!). This claim again seems to bring mathematics back to being basically mere calculation, despite the key reference to infinity. The heroic aspect of the doer of mathematics thus appears severely limited – to the quest for "the end of its innumerable string of decimals". In this advertisement, mathematics is considered as something which can be selectively drawn on, and moulded (by the text), so as to produce the desired associations for the product.

Conclusions and Suggestions for Further Research

A striking result from our fieldwork, in response to research question RQ0, is that there appear to be relatively few advertisements where 'mathematics' (broadly defined) is used as a resource in the UK daily press recently. Caution is in order because of the relatively 'light' sampling used here. However, within our two samples, any advertisements portraying 'mathematics' appear to be concentrated in the quality and mid-market press. Their apparent absence in the popular press suggests a question, as to whether mathematics, science, are being 'silenced', especially in this domain, rather than being considered as a resource for public discussion for the average person.

'Mathematical' and 'scientific' portrayals appeared more frequently in advertisements for cars and for business services – domains traditionally identified with men (see below). The discussion of the Givenchy men's perfume advert, and that of the Jaguar car, suggests that these advertisements not only pick up on gender stereotypes in the wider society, but also *reinforce* and *extend* such stereotypes. For example, the Pi advertisement appears to promote an image of numbers of men engaged in a quest for "the end of its [π's] innumerable string of decimals" – which is of course misleading as to the actual activities of mathematicians or indeed of other men (see also the discussion of the advertisement in the previous section). Thus, in relation to research question RQ1, we can see that some of the advertisements we examined do allow the identification in their images of gendered discourses on the type of people who do mathematics; see also Mendick (2006).

[8] Therefore, a so-called 'irrational number'.

In relation to research question RQ2, about changes in the images of mathematics over time, the Peugeot advertisement (1999), like the other three pre-2000 advertisements in the sample (Letts study aids, 1986; Sharp home computers and study aids, 1987 ca.; Mercury telephone services, 1994 ca.) drew on 'negative' aspects of mathematics, such as its supposedly "hateful", scary, or "too clever" character (see Evans, 2003), as part of their message. This tendency has not been apparent in the 11 advertisements produced post-2000, four of which have been discussed here. This may suggest a gradual change trend towards focussing on the 'positive' aspects of mathematics, even if in a limited way, since around 2000. But it is difficult to be certain, with so few advertisements from before 2000.

The portrayal of mathematics in the advertisements examined here is very often as basic calculation (Peugeot), or as single equations. Moreover, the equations may be meaningless (Jaguar), trite ("A + B = C" to indicate cooperation or "Concert" between AT & T and British Telecom), or erroneous (see footnote 5). Some of this result from the constraints on advertisements – the need to attract attention, and to project a message in an instant - but these messages circulate nonetheless.

With respect to RQ3, on how the advertisements construct the reader as knowledgeable (or otherwise) in mathematics, the Quorn advertisements (and others in the sample, but not discussed here) illustrate a particular category of advertisements in which mathematics and science figure, but which suggest that it is not necessary to be concerned with the content of mathematics, science, or with (real) evidence or argument – as you will 'know' what to think anyway, with the help of the advert. On this reading, there is a danger that the advertisements will help to reinforce social relations where large corporations speak to the consumer, whose critical faculties are 'dumbed down' by the process – and that intellectual tools like mathematics that are useful for critique might be trivialised by the process. Other readers might respond more positively to aspects of the advertisements, such as the 'knowing' parody of mathematical/scientific data in the Quorn advertisements, and find it a challenge to their mathematical identity to figure out the advertisement.

The discussion of these advertisements, in particular those relating to Quorn, shows that the deceptive complexity of the processes needed to decode them 'fully' may lead to different categories of readers being differently positioned vis-à-vis the advertisements. This differentiation parallels a process of market-segmentation, so that the same advertisement is not expected to 'speak' to all readers, in the same way. This suggests that different categories of readers, and indeed different cultures at different times, may be expected to be (and perhaps are) more or less 'literate' in reading the messages of advertisements (see Leiss et al., 1990).

Nevertheless, any effects in terms of trivialisation of evidence, data, science, and mathematics are not without danger for the company commissioning such advertising. It may want to market some of its products on the basis of scientific production processes, and it implicitly appeals to research on physics and engineering in the case of automobile producers, nutrition for food producers like Quorn, or to skin care for cosmetic producers (see also Glendinning, 1998).

The consequences for citizens/consumers of assumed limitations on their 'mathematical literacy' are not restricted in their consequences to their general appreciation of the role of mathematics and science in the surrounding culture. Many medical treatments involving medication, for example, include written instructions which require the reader to make choices in the use of the medication, based on information and conditions that often have a numerate aspect (see Eagle, Reid, Hawkins & Styles, 2005).

The analysis so far suggests several lines of further research. There are links to be made with the analysis of films, in this project. Television, cinema, internet, and further print advertising might be investigated, including that in 'niche' publications, such as educational journals for advertisements on teaching aids, and trade or professional journals for job advertisements. It would also be useful to investigate the aims and images of mathematics of those working in advertising agencies, who were responsible for some of the campaigns discussed here. Comparative work would be useful, especially between the UK and cultures with possibly different levels of numeracy[9].

There is also a need to look comparatively at discourses in fields of activity such as educational policy making, by examining official documents promoting mathematics learning in the EU or in the UK, on the one hand, and discourses constructed in recent films and advertising, on the other, to see whether intersections or cross-fertilisations among them can be located.

Leiss et al. (1990) point to the possibility of a given culture of 'consumers' of advertising being 'educated' over time through changing forms and strategies of advertising. This could relate to current UK government policies on advertising and discussions on Corporate Social Responsibility (CSR).

Acknowledgements

We would like to thank the following: Heather Mendick and Mariana Bayley for helpful discussions on this and their own similar projects; May Alnazer for assistance with the presentation of the advertisements; and audiences at the British Educational Research Association 2006, the Finnish Mathematics and Science Education Research Conference 2003, the Adults Learning Mathematics Research Forum 2002 and 2003, participants at seminars at the Universities of Brighton, Middlesex, Patras, Roskilde, and Surrey, plus the editor and two anonymous reviewers, for helpful comments and suggestions.

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[9] Cf. Lida Arnellou's ongoing study at the University of the Peloponnese, Dept. of Social and Educational Policy, of advertisements portraying science, in UK, France, and Greece.

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Appendix A. Coding Frame for Advertisements

Basic Characteristics

Advertisement No. : RS*j* – from systematic sample; A*i* – from opportunistic sample
Advertisement Description: 'strapline' (quotation of key text)
Product Category
Brand
Publication Name, Year, Date
Overt Aim of Advert

Content Analysis Indicators (drawn from Leiss et al., 1990)

Appeal: motivational/persuasive technique: rational, worry/relief, sensual, testimonial
[categories apparently not exhaustive – Leiss et al., 1990, Fig. 9.27, p268]
Display Area Allocation: % devoted to text, as compared with % for visuals
Pattern of Combination of Elemental Codes (Product, People, Setting): product-information, product-image, personalised, life-style
Values: quality, leisure/work ethic, progress/tradition, individualism/family.

Semiotic Indicators (see also Mendick, Moreau & Epstein, 2007)

Public Images/Discourses of mathematics:
Complex language, meaningless/"beyond understanding" to most
Powerful language of nature/science, technology/human behaviour
Satisfying activity for own sake: puzzles, intellectually stimulating/beauty, patterns to be appreciated aesthetically
Useful: positive - individual's everyday affairs, business, 'save the world'; negative - militaristic, destroys environment [NB links with science, technology]; useless

Public Images/Discourses of school mathematics

Elite subject/accessible to all
Scary, humiliating experience
Boring

Public Images/Discourses of people doing mathematics

Not like ordinary people: unusual intelligence, brilliance
Madness/eccentricity/obsession
Nerds, Geeks
Rational, cool, lack of emotion
Lack of social skills, ability to communicate, to relate: a compensation

Public Images/Discourses of people teaching mathematics

Clear-headed, "calculating"/Absent-minded
Impatient, cruel
Lack of social skills, ability to communicate

Brazilian peasant mathematics, school mathematics and adult education

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Abstract

The paper analyzes adult mathematics education from a cultural perspective. Specifically, its purpose is to broaden our comprehension about this field of knowledge using as a theoretical tool-box an Ethnomathematics perspective founded on post-modern thought, post-structuralism theorizations and Wittgenstein's work developed in his book *Philosophical Investigations*. This Ethnomathematics perspective allows us to study the Eurocentric discourses that constitute academic mathematics and school mathematics; to analyze the effects of truth produced by the discourses of academic mathematics and school mathematics; to discuss issues of difference in mathematics education, considering the centrality of culture and the power relations that institute it; and to problematize the dichotomy between 'high' culture and 'low' culture in mathematics education. Taking elements of the empirical data produced in many years of fieldwork with peasants of the Brazilian Landless Movement who participate in adult education courses as students or as teachers, the paper discusses some aspects of this social movement, especially the educational work they are developing; it outlines the theoretical background that supports the idea that there are different mathematics; it presents and analyzes some elements of the mathematics produced by the Landless peasant form of life, establishing relations with school mathematics, problematizing curricular issues of adult mathematics education.

Key words: ethnomathematics; different mathematics; culture and mathematics education; peasant adult mathematics education.

Introduction

This paper analyzes adult mathematics education from a cultural perspective. More specifically, its purpose is to enlarge our comprehension about this field of knowledge using as a theoretical tool-box an Ethnomathematics perspective founded on post-modern thought and post-structuralism theorizations, mainly Foucault's work (2002, 2003).[1] Moreover, the ideas discussed in the paper are rooted in what I have been learning with peasants of the Brazilian Landless Movement who participate in adult education courses as students or as teachers. They inspire my academic life and provide the empirical data as well as the guidelines for the ideas I

[1] In considering the Ethnomathematics' perspective as a theoretical tool-boxI am following Gilles Deleuze who argues that "a theory is exactly like a box of tools. It has nothing to do with the signifier. It must be useful. It must function. And not for itself. (...). We don't revise a theory, but construct new ones (...). A theory does not totalize; it is an instrument for multiplication and it also multiplies itself.(Bouchard, 1977, p. 208)

present here[2]. Such ideas have as their kernel the discussion about the uses of different mathematics in adult mathematics curriculum, which will be developed in the next sections of the paper. The first gives a glimpse of some aspects of Landless Movement, especially the educational work they are improving. The second section outlines the theoretical background that supports the idea that there are different mathematics and the third presents empirical data that show two different mathematics: one mathematics produced by a 'form of life' found in Landless peasant culture and another mathematics produced by a 'form of life' found in school culture.

Setting the scene: Brazilian Landless Movement and its struggle for land and education

Hardt and Negri (2000) begin their well-known book *Empire*, saying that "it is materializing before our very eyes (...) [since] we have witnessed an irresistible and irreversible globalization of economic and cultural exchanges" (p. 11) which instituted "a global order, a new logic and structure of rule – in short, a new form of sovereignty. Empire is the political object that effectively regulates these global exchanges, the sovereign power that governs the world." (p. 11). This new imperial order is taken as a background to this paper, considering the importance of attempting to understand adult education as a field of knowledge as well as the contemporary social movements and their educational processes within this new world configuration characterized by the "absence of boundaries", in which "the rule of the Empire operates on all registers of the social order, extending down to the depths of the social world" (Hardt & Negri, 2000, p. 15).

Among the many struggles of social movements that could be analyzed in their relationship with education, especially mathematics education, we can situate the struggles for land reform carried out by the Brazilian Landless Movement. This movement is well known in the international scene mainly due to the 'new' aspects it has brought to education, as written in the official Movimento Sem Terra's (MST, 2003) website:

> Landless Movement, in Portuguese, Movimento Sem Terra (MST) is the largest social movement in Latin America with an estimated 1.5 million landless members organized in 23 out of 27 states. The Landless Movement carries out long-overdue land reform in a country where less than 3% of the population owns two-thirds of the land on which crops could be grown. Since 1985, the MST has occupied unused land where they have established cooperative farms, constructed houses, schools for children and adults and clinics, promoted indigenous cultures and a healthy and sustainable environment and gender equality. The MST has won land titles for more than 250,000 families in 1,600 settlements as a result of MST actions, and 200,000 encamped families currently await government recognition. Land occupations are rooted in the Brazilian Constitution, which says land that remains unproductive should be used for a larger social function.

The educational process that has been developed by the MST over its 22-year history must be understood beyond schooling, since each landless subject educates her/himself through her/his participation in the everyday life of their communities and through a wide range of political activities developed by the Movement. This means that the children, youth and adult peasants are educated by the multiple facets of the struggle for land, which produce very specific social identities. Nevertheless, these social identities do not form something compact, uniform, in which hundreds of family from different social strata become a unified whole, homogenized by the struggle for land.

[2] This paper is an extended version of the plenary talk given at the 13rd Adult Learning Mathematics Conference (Belfast, 2006).

To look at this social movement through such lenses implies that if there is some kind of intention of establishing a 'landless identity'. But in their educational processes there is a sort of rebellion against fixing *one* social identity. In summary, the landless educate themselves in the struggle - in the occupations, the marches, in their ways of organizing the settlements, through their cultural artefacts – learning the many possible meanings of 'being landless'. There are many axes – such as those of gender, sexuality, ethnicity –- which in their crossovers ultimately shape multiple landless identities, multiple ways of giving meaning to the struggle for land. In summary, it can be said that the peasant culture of the Brazilian Landless Movement is marked by difference.

The schooling activities developed by the Landless Movement cover child education, elementary and high school education, teacher training courses and projects of education of youths and adults. As shown in the MST website, the Landless Movement Schooling Project involves 1800 schools in camps or settlements (grade 1 to 8), with 160 thousand students and 3900 teachers; 250 educators who work with children up to 6 years; 3000 educators working with 30 thousand peasants of literacy and numeracy projects of adult education; and teacher training courses implemented in partnership with public and private universities around the country.

This schooling project, according to one of the Landless Movement official documents, sees the need for

> two articulated struggles: to extend the right to education and schooling in the rural area; and to construct a school that is in the rural area, but that also belongs to the rural area: a school that is politically and pedagogically connected to the history, culture, social and human causes of the subjects of the rural area (Kolling, Cerioli & Caldart, 2002, p. 19).

The movement has dedicated itself to conceiving the schooling of its children, youths and adults paying attention to these two struggles. Such struggles contribute to the guidelines for its adult mathematics education using the peasant culture as a key issue to the teaching and learning processes related to mathematics. However, reference to this valorisation does not deny the relevance of acquiring mathematical tools connected to academic mathematics that can improve the uses of new technologies for managing the production in rural areas and can allow the adult learners to go further in their schooling trajectory. As it will shown in the next section, these ideas are strongly connected to the field of Ethnomathematics.

Ethnomathematics as a theoretical tool-box

In its mathematics education trajectory the Landless Movement has been inspired by Ethnomathematics ideas, which were first proposed by Ubiratan D'Ambrosio, in the 1970s (1991, 2001), at a time when issues concerning culture began to be strongly considered in Latin American People Education, as conceived by the Brazilian educator Paulo Freire. Since then Ethnomathematics has become a broad, heterogeneous field of knowledge. The work done with peasant social movements in the Brazil (Knijnik, 2002, 2005, 2006) contributes to our understanding of the landless adult mathematics education and allows us to view Ethnomathematics field through a new lens. But how can one describe this new lens? and what theoretical perspectives support them?

To answer such questions we must consider post-modern thinking, as enunciated by authors like Bauman (1997), and post-structuralist theories, specifically the work of Foucault (2001, 2003) and Wittgenstein (2004). In considering a post-modern perspective, I follow authors like Veiga-

Neto, when he says that it "rejects a totalized thinking, the illuminist meta-narratives, the universal referentials, the transcendencies and essences, that, imploding modern Reason, leave it in the shards of regional rationalities, of particular reasons" (Veiga-Neto, 1998, p. 145). It is these "shards of regional rationalities, of particular reasons", that occur in the mathematics used within the peasant cultures of Brazil, that are of concern to Ethnomathematics. Post structuralism, on the other hand, contributes to the Ethnomathematical perspective with its "aims to expose structures of dominations by diagnosing 'power/knowledge' relations and their manifestations in our classifications, examinations, practices and institutions. It aims to produce an 'incredulity towards meta-narratives', to disassemble the structures, the 'moves' and strategies of official discourse" (Peters & Burbules, 2004, p. 5). These aims were the productive inspiration for the Ethnomathematical perspective presented in my more recent studies (Knijnik, 2004, 2005, 2006), when I said that

> it allows us to study the Eurocentric discourses which constitute academic mathematics and school mathematics; to analyze the effects of truth produced by the discourses of academic mathematics and school mathematics; to discuss issues of difference in mathematics education, considering the centrality of culture and the power relations that institute it; and to problematize the dichotomy between "high" culture and "low" culture in mathematics education (Knijnik 2006, p. 121).

This Ethnomathematical perspective assigns a central role to the notion of culture. It is seen as a human production, which is neither fixed, determined nor closed in its meanings. This way of conceptualising culture implies that it is a conflictive, unstable and tense terrain, undermined by a permanent dispute to impose meanings through power relations. Culture is not considered as a body of 'traditional' knowledges or as an inert set of knowledges transmitted from generation to generation. Culture is taken as a system of meaning, through which people signify the multiple dimensions of their life. This includes their way of dealing with counting, measuring - all those issues we learn to call 'mathematics' in our schooling processes. This system of meaning is not static, but is repeatedly re-invented. From this perspective, it may possible to assume that there is a close connection between mathematics and culture: mathematics produces culture, but it is also produced by culture. However, what we usually call 'mathematics' is not a social production resulting from all our efforts; it does not incorporate mathematical contributions of all cultures, from the west and east, from the north and the south. Rather, we will see that the mathematical heritage of humankind is identified only with Western academic mathematics; the mathematics produced by the Western mathematicians. Identifying only part of the world's mathematical knowledge as 'the' mathematics masks power relations that legitimises a very specific way of producing meaning - the Western, white, male, urban and heterosexual way.

In summary, we can say that what we call 'mathematics' is a very specific way of interpreting the world, a way constituted by a very specific language, marked by a very specific grammar, closely connected to its uses, to a form of life. We, mathematics educators, are aware of this form of life, of this language, this grammar. We know how often its marks can be seen in teaching-learning school pedagogical processes, as well as in adult education.

Lately, I have attempted to go further in discussing these Ethnomathematics issues using the ideas of the German philosopher Wittgenstein especially those established in his work *Philosophical investigations* (2004). Wittgenstein's theorizations about notions such as *language-games*[3], *grammar* and *forms of life*[4] allow us to consider as mathematics other

[3] As mentioned by Glock (1996, p. 193), "the term 'language-game' is the result of Wittgenstein's extending, from 1932 onwards, the game analogy to language as a whole. (...) Like a game, language has constitutive rules, namely those of grammar. Unlike strategic rules, these do not determine what

mathematical knowledge besides the one usually identified by 'the' mathematics. His theoretical approach enables to consider different adult mathematical practices as mathematics in Wittgenstein words, different language-games, produced by different forms of life. Following Wittgenstein, we can say that the language-games associated with the Landless peasant's form of life are different to the language-games associated with the school's form of life and that such specific grammars produce different mathematics. In this I assume that there is more than 'a single' mathematics, denying the idea that the adult mathematical practices found in everyday life of diverse cultural groups are mere 'applications' of what is known as 'the' mathematics. Further, I assume there are many mathematics, all of them having *family resemblances*, as Wittgenstein highlighted.

However, it is important to stress that all these different mathematics do not have the same social value. From sociology we learn that there is one that is legitimized in our west culture: the one produced by the mathematicians at the academy. Academic mathematics, produced by the socially legitimated group that has the capability to 'produce' sciences is most valuable from the social standpoint. So, it is not a question of speaking naively about different mathematics, but of considering that these mathematics are, in terms of power, unequally different. For example, non-hegemonic groups like the Brazilian landless peasants are interested in learning the academic mathematics, because this may be a condition to access a more highly skilled, better paid job, or to achieve one's productive activities on more competitive levels. Therefore, when one refers to different mathematics, what is at stake is not simply the replacement the teaching of academic mathematics in its re-contextualized form (the school mathematics) by the other mathematics. There is not a single way of producing mathematics, even if we know that there is one which is acknowledged as a 'science', which must necessarily be taught.

Among these different mathematics we can include the mathematics produced by non-hegemonic groups like the Landless Movement, the mathematics I had called popular mathematics, even though I realised the theoretical difficulties involved in the use of the adjective 'popular' (see Knijnik, 2006) In order to avoid such difficulties, in more recent time I used the term 'peasant mathematics'. The next section of the paper is about some peculiarities of this 'peasant mathematics'.

move/utterance will bring success; but rather what is correct or makes sense, and thereby define the game/language. (...) We learn the meaning of words by learning how to use them, just as we learn how to play chess, not by associating the pieces with objects, but by learning how they can be moved".

[4] About this notion of Wittgenstein there is an interesting debate among the philosopher's interpreters concerning whether it has the same meaning when used in the plural or singular and to what extent it compasses both biological and cultural dimensions. For the purposes of this paper it is relevant to highlight that in his late work (corresponding to his work "Philosophical Investigations") Wittgenstein considered that "the meanings arise by the use of the words, mediated by rules, which emerge from our social practices, our habits, our form of life." (Condé, 2004, p. 52).

Two different mathematics

One of the research projects implemented with the Landless peasants had as its goal to examine oral mathematics practiced by adults of that peasant culture. We were interested in knowing more about their oral mathematics that involving addition, subtraction, multiplication and division. As we have observed in the fieldwork, oral mathematics practices are present in the everyday life of the peasants who participate in this social movement. Their low levels of schooling meant that they were not aware of written algorithms but required the constant use of oral mathematics to recall specific rules. However, in the context of adult education in Brazil, there is a sort of 'forgetfulness' about this world outside school, about this mathematics with its different uses and its grammar. In curricular terms, it is useful to investigate the meanings produced by this 'forgetfulness', by the dichotomization and antagonism of the school mathematics and the peasant mathematics, specially the language-games that shape their oral practices. The investigation of such meanings may lead to a localized and partial achievement of a 'curricular justice'. Cornell (1995) defines this as curriculum organization which takes as one of its principles consideration of "the interests of those who are at a disadvantage" (Connell 1995, p. 12).

I want to make explicit three rules that shape the oral mathematics grammar produced by the Landless peasant form of life.[5] The first concerns the close ties between oral calculation strategies and the contingencies in which they are situated. For example, a peasant explained that, on estimating the total value of what he would spend to purchase inputs for production, he rounded figures 'upwards', ignoring the cents, since he did not want "to be shamed and be short of money when time comes to pay". However, if the situation involved the sale of some product, the strategy used was precisely the opposite. In this case, the rounding was done 'downwards', because "I did not want to fool myself and think that I would have more [money] than I really had." What was observed is that, differently from the school mathematics grammar that emphasizes the uses of written processes and the 'forgetfulness' of the context (as discussed by Walkerdine (1988)) the Landless oral mathematics language-games are strongly contextualized and involve complex reasoning. As part of the peasant mathematics grammar, the oral mathematics rules (like the ones presented above) are marked by immanence. On the other hand, as shown in textbooks and other instructional materials, at school it is taught that to round figures 'upwards' or 'downwards' one must only take into account whether the amount of cents is more or is less than fifty. This rule - part of the school mathematics grammar - is marked by abstraction, transcendence. It is clear that there are similarities between the oral peasant mathematics rules presented above and the written school mathematics rules. Following Wittgenstein, we can say that those language-games (shaped by their specific rules) have family resemblances. They are similar, but not the same. There is a peculiarity that distinguishes the peasant mathematics rationality from the school mathematics rationality: the immanence of the former versus the transcendence of the latter.

A second rule of oral mathematics language-games refers to the strategy of adding, based on a decomposition of the values to be orally calculated. This is what happened with one of the students in the workshop given by the students, when faced with a situation in which he had to calculate 148+239. He explained that, "first one separates everything [100+40+8 and 200+30+9] and then adds up first the numbers that are worth more [100+200, 40+30, 8+9]. (…) This is what really counts". This rule was found among almost all adults who said that they 'were good' at mental calculation. Differently from the addition algorithm taught at school, in

[5] This part of the text is based on what was discussed in Knijnik, Wanderer & Oliveira (2005).

oral procedures the peasants considered all the values of each parcel that was involved and how much difference it would make if it were hundreds, tens or units, i.e., they prioritized the values that contributed more significantly to the final result.

This priority also emerged when the numbers involved in the calculation were decimals. It is observed that recurrently, the peasants use decomposition 'to make up integers'. This strategy was employed by *Dona Nair*, a retired settler, who, as a child, attended school for only one year, and did not learn to read or write. On explaining the way she used mental calculation in her daily activities, she referred to a situation in which two products are purchased, one of them costing R$2.70 and the other R$2.90. She said that to find the amount to be spent, she first of all adds up the integers and then the cents, as follows: "2+2 makes 4. I complete the 90 [cents] with 10[cents] of the 70[cents] to make another 1 *real*. So 4+1 completes 5 *reais*, plus the 60[cents], and I have 5 and 60." Like those previously mentioned, also in situations involving decimals, what is prioritized in the calculation process are integer values that, according to the peasants, are 'more relevant' to the final sum, a relevance which is given by their culture. Here, again, one can see the immanence that characterizes the rules shaping the peasant mathematics grammar, i.e., the immanence of peasant rationality, which differs from the immanence of school mathematics rationality.

A third rule concerns the duplication strategy present in the oral multiplications, a process similar to that used in ancient Egypt (Gillings, 1982; Peet, 1970). This could be seen in an interview with *Seu* Nerci, an illiterate landless man, which had been filmed and used in as pedagogical material in a training course for Landless pre-service adult education teachers. When multiplying 92×R$0.32 (corresponding to 92 litres of milk produced and sold at 32 cents of real[6] [R$0.32] a litre), he first doubled the value of R$0.32, and obtained R$0.64; then he repeated the 'doubling' operation twice, finding the amount of R$2.56 (corresponding to 8 litres). He added to this the value of 2 litres calculated previously, and thus found the value of 10 litres of milk (R$3.20). The next procedure was to successively double the values found, i.e., he obtained the result of 20, 40 and 80 litres. Keeping 'in his head' all the values reckoned throughout the process, *Seu* Nerci ended the operation by adding to 80 litres, those corresponding to 10 litres and 2 litres (calculated previously), and thus found the result of 92×R$0.32.

Seu Nerci never went to school. When he was a child, the closest school to his home was 20 miles away and there was no public transportation in the rural zone where his family lived. Since early childhood, boys and girls were introduced into agricultural labour and no children went to school. He did not use pencil and paper to write down the sums as he multiplied them. When the video was made he suddenly withdrew to another room at the back of his house to perform the multiplication, only reappearing after he had come to the final result. After consideration other characteristics of peasant oral mathematics were apparent. The first concerns the need, explicitly mentioned by the adults, 'to concentrate to think'. Like *Seu* Nerci, most of the adults observed doing oral calculation practices became deeply involved in the act of reckoning, in an attitude of isolation and introspection. But, unlike *Seu* Nerci, many of the literate adults observed usually took notes during their oral calculations. The notes were used as 'markers' throughout the process, especially in those involving greater complexity.

In summary, we have observed the high level of reasoning involved in the landless oral mathematics. Even from the perspective of what we consider 'the' mathematics, there is a

[6] Real is the Brazilian currency which corresponds to 50 cents of the US dollar.

broad, important set of subjects operating in this oral mathematics, which shows the family resemblances of peasant mathematics and school mathematics. Another aspect that emphasizes such resemblances is the introspective attitude of the peasant when doing oral calculations, similar to that take on by those who work in academic settings.

It is clear that peasant oral mathematics is neither as formal nor as abstract as school written mathematics. Following the work of Wittgenstein (2004), we can admit the existence of these two mathematics, of two different rationalities associated with specific forms of life, each of them producing its own grammar. But we cannot say from an epistemological standpoint that one is more valuable than the other.

Final remarks

The issues I attempted to discuss in this paper are no more than provisional, unmarked by hopes for certainty, in the sense given by Stronach and Maclure (1997). Although provisional, they open new possibilities to look at the Ethnomathematics field, constituting a theoretical tool-box that allowed me to examine the data collected in fieldwork with the Landless adult peasants through a new theoretical lens. Observing these adults practicing their oral mathematics I understood the importance of analyzing it from a cultural perspective. It has been shown that the peasant oral mathematics is produced by the Landless culture and at the same time, such a culture is produced by this specific mathematics. Since this mathematics is part of their way of giving meaning to life, it would be almost impossible to ignore the necessary close connections between oral mathematics and the school curriculum. It cannot be assumed that at school the peasants could leave 'part of themselves' outside. When they come to adult education projects, their peasant culture comes with them, even when the school curriculum tries to impose a sort of 'forgetfulness' about who they are, the music they enjoy, the food they appreciate, the grammar they use when talking, the grammar they use when adding, subtracting, multiplying and dividing. When this subtle imposition of denying their culture occurs, it is not surprising to see that it brings with it a resistance process. This resistance can be expressed by adult peasants through rejection of school (no-learning attitudes); can be expressed by pretending that they accept such an imposition (simply pretending). When they go outside school, their peasant mathematics is revived, showing that it can survive the school conservative practices that are bound by only one kind of rationality, one kind of language-games as mathematics. Maybe it will be possible to enlarge our adult mathematics education world, including other mathematics, other rationalities other forms of life. This enlargement may produce broader repercussions and open possibilities for a better relationship among people from different parts of the world and from different cultures. If so then our dreams of solidarity in our societies can be fulfilled.

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