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Numeracy in REFLECT

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· Introduction

> 'There does not exist a single illiterate adult who has not acquired some mathematical knowledge and/or a mental logic that they can apply'
> *Luis Orrellana, El Salvador*
>
> 'Though people can live without being able to read and write, the ability to operate mathematically is an essential element of everyday life'
> *Teresa Casteneda, Peru*

Despite the above statements, mathematics is often given second place in literacy programmes. Even in progressive literacy programmes, numeracy is often an appendage, addressed using more traditional/formal approaches than those used in the rest of the education process. Numeracy is not conceived as a fundamental part of the empowerment process with practical application at personal and collective levels.

It is clear to all teachers of adult education that, prior to joining any learning circle, all adults have developed mathematical capacities through dealing with situations that they face in their everyday lives. This is a resource to be drawn on, but it is usually ignored. A gulf exists between the strategies people use for mental calculations (or practical interactions) and those used in formal, written mathematics. In adult numeracy teaching, the formal system usually dominates and people's own skills, knowledge and experience of dealing with numbers in everyday life is rapidly forgotten. This stems in part from to the fear and self-doubt of facilitators/teachers who have been through the formal system. They have been taught that there is only one right way, and only one right answer, in mathematics. Thus, it is necessary to go back to some basic questions, including: why teach numeracy? Can numeracy work contribute to, and be interwoven with, the empowerment process? What particular approaches to numeracy can be integrated with the REFLECT process?

Why numeracy?

There are many reasons for strengthening the role of numeracy within literacy programmes and, specifically, within REFLECT programmes. These reasons will vary from context to context, but the sorts of arguments that have been used by REFLECT practitioners in different contexts include:

- whilst people may have mental capacities, there are limits to these capacities;
- improving numeracy skills can be important for preventing people from being cheated in the market place (though often it is precisely mental skills that need strengthening to address on the spot needs);
- co-operative systems (e.g. group saving, collective buying, joint working) which may be important for improving productivity and/or equity, are often vulnerable unless record keeping is well maintained and understood by everyone;
- increasing understanding and access to permanent/written records (e.g. accounts) in a wide range of contexts can be important for increasing transparency and accountability;
- complex numeracy work is often involved in effective forward planning,

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

budgeting, projections, profit and loss estimates (and monitoring);
- understanding the forces at work on commodity prices (e.g. cotton, tobacco, coffee), how they vary between local, district, national and international levels, and changing trends, can be vital for enabling people to analyse their situation and make informed decisions; and,
- mathematics can play an important role in challenging gender divisions; improving mathematical understanding amongst women can increase their power (at critical moments) in the private sphere and their capacity to engage at strategically important points of the productive process (which men may otherwise dominate); analysing gender differentials in pay can be important in the process of women demanding equal respect and conditions.

The mental/written divide

People develop and consolidate their capacities for mental calculation through all sorts of life experiences, including the buying or selling of produce and playing games (e.g. cards or dice). Indeed, it is not uncommon to find non-literate people who have greater mental arithmetic skills than people with a high level of formal education (who may have found that the mental/written systems clash).

The mathematics used by illiterate adults often takes a very different form from that learnt in more formal situations. Nevertheless, the methods developed on an individual basis appear to be very similar throughout the world. In fact, work by German Marino in Colombia [1], confirmed by an investigation carried out by CIAZO (Interagency Literacy Committee) in El Salvador and CNTC (National Peasant Committee) in Honduras (and later by various other institutions) revealed some of the common approaches to mental calculations (and tensions with the written formal system). For example:

- when thinking about numbers, non-literate adults generally understand a quantity as made up of whole numbers. For example, the number 1,234 would be represented as 1000, 200, 30 and 4;
- subtraction is actually performed as an addition, adding up to the higher quantity. So, for example, when paying 32 pesos with a 100 peso note, the mental calculation would be similar to the following: 32 and 8 is 40, 40 and 10 is 50 (8 and 10 is 18), 50 and 50 equals 100 (18 + 50 =68) so this would be the change expected; and,
- in multiplication, a strategy based on doubling and using the 10 times table is preferred. Multiplication of larger numbers will often involve breaking the number up into constituent elements (focusing on 10s and often using the monetary values in the specific country). So, when multiplying 27x16, the process would be as follows: 10x16=160, 2x10=20 therefore 20x16=2x160=320. Now 7=5+2, so 2x16=32 (doubling) and 5x16=80 (half of 160). So now we have, 320+32+80=432;

These examples look complex when written down and this is precisely part of the clash between the written and unwritten systems. The 'tactics' used mentally as outlined above are often done in agile ways. Literate people also use many of these approaches in certain contexts (instead of the formal schooled approaches), but may resort to scribbling sub-totals on the way. Indeed, the remembering of sub-totals is one of the biggest obstacles to the complexity of calculation that a non-literate person is likely to encounter.

It should be noted that there is a great variety in the mathematics developed to solve problems such as volume, weight, length, area, geometric shapes, fractions, equivalencies, angles etc. This is probably due to the fact that the local systems for dealing with such matters vary substantially. Nevertheless, the diversity of systems used is reducing. This is perhaps one of the indicators of globalisation, with the decimal system now almost universal, replacing local systems. However, Box 1 provides an example of how changing systems can cause unforeseen problems for local communities.

[1] Such as in 'Como opera matematicamente el adulto del sector popular?' Published by Dimension Educativa, Bogota 1992.

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

BOX 1

A socio-mathematical survey undertaken by a REFLECT programme in Bangladesh revealed that a 1987 law (which made kilograms official and the use of pounds a criminal offence) had led to women being unable to deal effectively with travelling salesmen. The REFLECT programme addressed this transition and one of the focus points was on equivalencies between the systems.

Some principles

It is clear that there is enough convergence in the mental processes that people use for calculations (and sufficient divergence between these practices and the existing written system) to serve as a basis for breaking with the traditional, formal system of teaching and operating. This provides the opportunity for a radical re-definition of approaches to adult numeracy, respecting people's existing capacities and processes. A number of principles can be identified which would underlie such a re-definition:

- the knowledge and logical operations that illiterate adults possess are essential elements to take into account, and the foundation on which all programmes should be based;
- mental calculation should be seen as a valid form of operation and this should be the point of departure for the acquisition of new knowledge;
- it should also be recognised that various options/paths exist when approaching a particular situation and that all these are equally valid (as long as they work reliably);
- the daily experience of the participants must be used as a starting point, along with the systems of measurement and calculation that belong to the specific context;
- the learning process should be structured using maths to work in real situations to solve real problems;
- The process should be designed so that the participants find and control the logic, understand a problem and are able to identify the steps necessary to resolve it;
- The process should be designed to enable participants to perform these steps to arrive at a solution mentally and/or in writing;
- mathematics should concentrate on strengthening, rather than replacing, the mental arithmetic ability that people possess. It should improve this skill in such a way that they can use the operations required in their daily life and reinforce their faith in their own ability, constantly recognising their own knowledge and practices;
- We should respect and use the local measurement system, as this is a cultural expression tied to context and daily life; and,
- Prejudices embedded in the formal system should be challenged, such as the opposition inherent in the written system to any form of estimation. Estimates are effectively regarded as 'incorrect' and therefore inappropriate in formal mathematics. However, in 'real life' an estimate is often more useful than strict, precise calculation. Box 2 provides an example of when estimation is useful in daily life, as opposed to exact calculation.

BOX 2

Imagine you are going to the market or going shopping with a fixed amount of money to spend. While buying you estimate, as you go along, how much you have spent and this guides you in what else you can buy. Would it really be more useful to use precise calculation - counting every penny? Or rather would this not just confuse the shopper and force a greater interest in the sum rather than what is being bought?

Redefining numeracy in practice

There has been much academic discussion as to how numeracy can be defined and it is frequently commented that mathematics is a classroom subject, whereas numeracy is the ability to operate mathematically in everyday life. A REFLECT approach calls for the two to be understood together and any mathematics used in learning circles should be drawn from real life numeracy problems.

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

If numeracy is to be linked with the empowerment process and if the learning process is to build on previous knowledge, it is important that the curriculum is not fixed. In a REFLECT circle, problems should be devised directly from the participants' lives and therefore, the mathematics learnt will vary from circle to circle. Facilitators will need some guidance on maintaining a sequence in all calculation work, passing from simple to more complex problems. For example, numeracy work arising out of a first map might concentrate on the reading and writing of the numbers 0-9, with a lot of practice, directly relating to the graphic. However, larger numbers should be introduced rapidly. The size of the numbers reached might depend on the monetary denominations regularly used by a specific community. Indeed, money can be used as one of the most effective ways of linking oral/mental skills to a written form (see Box 3 on CIAZO).

Facilitator training

One of the starting points for implementing any new approach must be the training of facilitators. It has already been noted that many facilitators/teachers in adult literacy programmes have a fear of numbers, often rooted in their own limited mathematical capacities. This ironically makes them hold the formal system in awe as the only true path. They see mathematics as an academic subject with few ties to reality. Therefore training programmes need to emphasise a re-learning of mathematics for the facilitators themselves. Facilitators need to understand that they are not 'teaching' mathematics and accept that, as a starting point, they must work with how the participants operate mathematically, implying that they will need to forfeit their position of power within the learning circle.

BOX 3
A CASE STUDY FROM EL SALVADOR

There is a direct relation between monetary systems and how adults calculate. An innovative method developed in El Salvador by CIAZO (now also in use in Peru) uses money in the mathematical process.

Rough imitation copies were made of the currency notes presently in use in El Salvador together with cardboard cut out coins. This money was not just reduced to a material resource, used just to simplify the mathematical learning process, but was considered as fundamental to the way in which adults both conceive and use calculations in their daily lives. The money was used in practical exercises arising out of the themes touched upon by different graphics, facilitating the jump from existing knowledge to written operations. If one studies the methods used by adults in calculation (as noted above) and the methods required by handling money, it becomes clear that the two are directly linked.

It is therefore evident that a large part of the learning and usage of mathematical logic is tied in with money usage. This might be a cause-effect relationship in that:

- mental skills have been developed as a result of physical handling of money; notes and coins are used in salaries, in buying and selling, in transport etc. Thus mental calculation is carried out due to the denominations particular to a currency (prices, daily expenses, production costs, utilities, credit, interest etc.);, or in reverse, that
- monetary systems may have somehow been designed (or have evolved) to respond to the ways in which adults calculate mentally most easily.

Whatever the case, the monetary system can be a key means for drawing on experience and addressing important mathematical principles/concepts.

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

Reading and writing

Because of the advanced level of oral mathematics the participants have before attending a learning circle, a large part of a numeracy programme will focus on the reading and writing of numbers and mathematical operations. Reading will also include familiarity with and interpretation of formulae and prepared sums, while writing will involve graphic representation. Both will start by using basic numbers, and then move on to symbols for diverse operations and spatial understanding. The learning process will always incorporate error identification and participants should work together, helping each other.

REFLECT graphics and numeracy

Experience has shown that mathematical skills can be developed easily by using the REFLECT graphics. The creation of such graphics is, in itself, a very mathematical process, but going beyond this, the structure of the graphics also allows for the introduction of many basic mathematical ideas.

1. The maps, matrices, calendars etc. produced by the learning circle include mathematical elements that can be counted or represented in a numerical form (e.g. the people included in the maps, the points on the matrices and the incidences on the calendars etc.). At times, they also require measurement (e.g. distance simulation on a map) or call for specific operations (such as summing the totals in a map, or percentages in the circular graphics). In fact, nearly all the graphics include mathematical elements, to a greater or lesser extent.
2. Some units include direct calculations in the construction of the graphic (i.e. one cannot proceed in the construction of the graphic without mathematical processes). This is illustrated in an 'Income and Expenditure Calendar', 'Projection of Loan use Matrix' or 'Market Prices Calendar' (see Figure 1).
3. While working with each graphic, a means is provided to explore a particular theme, and a more profound understanding can be reached when using calculation. There are innumerable examples of this kind, as illustrated in the Box 4.

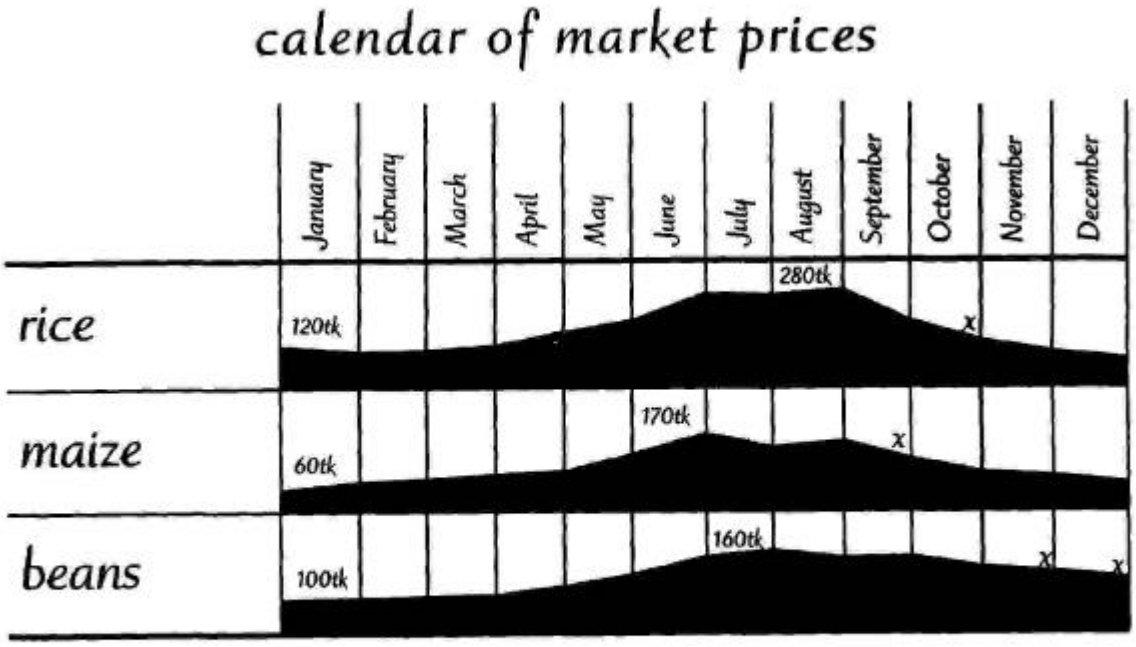
BOX 4
DEVELOPING NUMERACY FROM A GRAPHIC

Credit Matrices: loan repayment, relationship between capital and interest, interest rates, the relationship between investment and loan handling, credit registration options, individual loan books, group accounts, credit requests, bank systems, cheque and deposit books.
Map of Land Tenancy: land area, land distribution statistics (owned and worked on), percentage ownership by sex, calculation of investment in actual crops versus new crops, productivity from different fields, how much of a particular crop has to be given up each year.
Mobility Map: distances, time, cost of travel, differences between private and public transport, how market prices differ in different markets.
Schooling of Children/Education Matrix: Cost of schooling, level of schooling for different age groups, statistics relating to absence and drop out from school.
Hygiene Map: cost of latrine construction, installation of manual water pumps, cost of illness prevention versus cost of cure.
Chapati diagram of Community Organisations: Basic accounts of village organisations, suggested projects, financial explanations.
Map of services and opportunities: different types of employment (relationship with level of education), costs of different types of service (real figures; transportation, health and legal etc.).
Human rights violations: looking at national statistics (critically), types of violation and victims.

All the material used in these graphics, to introduce mathematical ideas should be local. The participants will achieve greater mathematical understanding if the methods use authentic relevant data, and familiar information. Box 5 shows an example where a community is working with graphics to develop numeracy.

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

Figure 1. Example of a numeracy graphic - a calendar of market prices (Source: REFLECT Mother Manual)



BOX 5
A CASE STUDY FROM PERU

In a learning circle in Piura, Peru, many of the participants were arriving late. This gave rise to a discussion about time and it became clear that the majority of the participants had little understanding of time, or how hours work. Following this, a decision was made to make cardboard clocks. The construction of these clocks provided an opportunity for the introduction of the concept of time and hours. Subsequently these clocks were also used to practise reading and telling the time. This resulted in a significant reduction in latecomers to the learning circle and people were able to use clocks in their every day life. In addition the clocks helped in the learning, understanding, reading and writing of numbers.

· Conclusion

The REFLECT graphics provide an excellent basis for the contextualisation of mathematics, which is a fundamental principle of adult numeracy work. The examples from Peru and El Salvador support our belief that mathematics should always be learnt in context, as the link with reality enables a higher level of learning to be reached very rapidly.

The precise numeracy content of a REFLECT programme cannot be pre-determined and should always be developed following a socio-mathematical survey (see REFLECT Mother Manual). A socio-mathematical survey looks at uses and practices of numeracy in people' lives, but also explores how people perform different mathematical operations (and the language they use). A part of the learning process must focus on the full diversity of tactics that adults use for mental calculations

Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London

which should be drawn out and reinforced (with participants exchanging their own 'secrets'). At all stages, numeracy must build on participants' prior skills and coping strategies). Once the survey is completed, it should not lead to pre-packaged materials. Flexibility is crucial and mathematics should be used for an end, to solve particular real problems and challenges, and to deepen the analysis of a particular topic. Facilitator training is crucial to build their confidence and enable them to break with the constrictions enforced on them due to their formal learning.

REFLECT gives equal prominence to oral skills (speaking, dialogue, language, discourse) as well as reading and writing. In the same way, numeracy work in REFLECT should give equal weight to mental skills and written forms and not seek to elevate one over the other, as if writing is the only legitimate path.

It will take some time before REFLECT programmes in practice succeed in giving numeracy equal status with reading and writing, but there are positive signs that this is the direction which is being pursued. In many cases, traditional boundaries are breaking down and numeracy is being interwoven with a wider learning process built around people's lives, in which calculations are not seen as abstractions but rather, form a key part in analysis and reflection.

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Source: PLA Notes (1998), Issue 32, pp.109–115, IIED London