Numeracy as a tool in adult education: Success or failure?

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Abstract. In 2001, a new programme in adult mathematics education was introduced in Denmark. The aim was that the students further developed their numeracy. The development of education and teacher education was research based and an operational model of Numeracy was the pivotal point in this work – and as such a kind of quality control in the process. Three years later, in 2004, the Danish Evaluation Institute evaluated this educational programme, Preparatory Adult Education (PAE) as it was named. In the light of her experience from the development and evaluation of this mathematics programme, the author questions whether the concept of Numeracy has been adopted in the teaching and learning practices of PAE-mathematics. Thus, the paper reports reflections provoked by the author’s observations during an evaluation process – not a study designed to answer this question.

At the beginning of the 21st century, adult and lifelong mathematics education forms two sides of the same coin in Denmark. The adult educational system is built up in parallel with the mainstream education system. Mathematics is offered to adults at lower and higher secondary level. Since 2001, basic mathematics education has been offered to adults in the new programme of Preparatory Adult Education (PAE). The aim is that students develop numeracy, which is defined as functional mathematical skills and understanding that in principle all people in society need to have. In English speaking countries, “numeracy” is a key word in basic adult education but this was the first time that numeracy was mentioned in a Danish Act. Five years before, Lindenskov and I had imported the term from the English speaking countries, translated it into Danish (numeralitet) and reconstructed it as a concept (Lindenskov and Wedege, 1997).

At the Third Nordic Conference on Mathematics Education (NORMA01) in 2001, I presented this concept of numeracy and some of the basic ideas of PAE-mathematics (Wedege, 2005). After my lecture, Bill Barton from New Zealand asked if it was really necessary to introduce numeracy to Denmark. My answer was that the concept of numeracy and our operational model of Numeracy formed the research base for developing the new mathematics curriculum. I also regarded a new term as important to avoid the usual teacher reaction when presented with a new curriculum: “This is what we have always done”.

As stated in the Act of PAE, the educational programme was evaluated in 2004. Numeracy is the aim of the course and the pivotal point of this teacher education programme. Nevertheless, neither teachers nor school leaders mentioned the word “numeracy” during the whole evaluation process. As someone involved in the development of the curriculum in 2000-2001 and in the evaluation of 2004-2005, I questioned whether the model of Numeracy is implemented in the teaching and learning practices of PAE-mathematics or not, and this paper reports my reflections.

Numeracy as a term, a concept and a tool
In English speaking countries, the term “numeracy” is used for certain basic skills and understandings in mathematics, which people need in various situations in their daily life. As mentioned above, numeracy is a key word in basic adult mathematics education. As a concept however numeracy is deeply contested in politics, education and research. Nevertheless, as an analytical concept, adult numeracy may be considered as mathematical activity in its cultural
and historical context. (For a review of research and related literature on adult numeracy, see Coben et al., 2003.) In policy reports and in international surveys, the term “numeracy” is often used as a parallel to literacy. “Quantitative literacy” and “mathematical literacy” are two other terms dealing with people’s mathematical competencies in relation to societal requirements (see OECD, 1995; 1999). In the Second International Handbook of Mathematics Education, Jablonka (2003) gives a critical overview of different constructions of mathematical literacy. She argues that any conception of mathematical literacy – implicitly or explicitly – promotes a particular social practice.

In the mid 1990s, the Danish language did not have a single expression corresponding to the term numeracy. Nevertheless, Lindenskov and I chose to use the term numeralitet, which was later adopted by the Ministry of Education. In our definition, adult numeracy describes a mathematics containing everyday competence that everyone, in principle, needs in any given society at any given time:

- Numeracy consists of functional mathematical skills and understanding that in principle all people need to have.
- Numeracy changes in time and space along with social change and technological development. (Lindenskov & Wedege, 2001:5)

It is the expression “in principle” that makes possible a general assessment of adult numeracy (as in the big international surveys) and the development of general courses in numeracy. All adults who participate in a numeracy course will, in fact, have their own perspectives (why am I here?), their own backgrounds and needs (what am I going to learn?) and their own strategies (how am I learning?). It is this definition of numeracy which is adopted as the aim in PAE-mathematics.

During the research and development work for the Adult Vocational Training system, Lindenskov and I developed an operative model for the study of adult numeracy. It has four interrelated dimensions, which are

- **Media** (a) written information and communication (b) oral information and communication, (c) concrete materials, (d) time and (e) processes.
- **Context** - in the meaning of situation context - (a) working life, (b) family life, (c) educational context, (d) social life, and (e) leisure.
- **Personal intention** (a) to inform/be informed, (b) to construe, (c) to evaluate, (d) to understand, (e) to practice, etc.
- **Skills & Understanding** - Dealing with and sense of (a) quantity and numbers, (b) dimension and form, (c) patterns and relations, (d) data and chance, (e) change, (f) models.

Our construction of the operative model of Numeracy was based on the paradigmatic socio-cultural studies such as Scribner (1984); Lave (1988); and Nunes, Schliemann and Carraher (1993); on conceptions of functional literacy such as OECD (1995); and on the six “big mathematical ideas” presented and discussed by Steen (1990). This model has been used and further developed as an analytical tool in adult mathematics and research. During the development of PAE-mathematics, we found inspiration in Bishop's (1988) cross-cultural studies of mathematical components in everyday activity and added mathematical activities such as counting, measuring, locating to the fourth dimension (skills and understanding) of the Numeracy model (see figure 1).

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1 Like numeracy we don’t have a translation of the term “mathematical literacy”, in the Nordic countries.
Where?  
Situation context  
Why?  
Personal intention  
Numeracy  
What?  
Media & data  
How?  
Mathematical knowledge and activity

**Figure 1.** Four analytical dimensions of Numeracy (Wedege, 2004:113).

In what follows, I will use the term Numeracy (with a capital N) to refer to the concept of numeracy as defined in this operational model and numeracy (with a small n) to refer to the underlying conception of numeracy as defined above.

**Preparatory Adult Education in Mathematics**

As mentioned above, Preparatory Adult Education is a vital element of the Danish lifelong education model. According to Rubenson (2001), one may find three generations of the idea of lifelong learning in the period from the late 1960s until now. The first generation – lifelong learning as a utopian-humanistic guiding principle for restructuring education – was introduced by UNESCO. The concept disappeared from the policy debate but reappeared in the late 1980s as the second generation driven by a different interest based on an economistic worldview emphasising the importance of highly developed human capital, and science and technology. From the late 1990s, it seems that a third generation (economistic-social cohesion) with active citizenship and employability as two equally important aims for lifelong learning – at least on the rhetoric level – is taking over. Preparatory Adult Education illustrates these new tendencies. During the political debate and the educational planning process of PAE Mathematics “active citizenship”, “employability” and “personal needs” were used as equivalent arguments (Johansen, 2002).

An obvious danger of lifelong learning as a political project is that learning for active citizenship and democracy is reduced to an individual project. From this perspective, it was important to notice that the following statement was formulated by the Danish government in the Bill of Preparatory Adult Education (Forberedende VoksenUndervisning), in 2000:

> Further development and maintaining of the individual’s skills are not only an individual and private affair and responsibility. It is also a common societal responsibility. PAE encompasses both a democratic aspect to maintain and promote the development of active citizenship and an economic perspective linked to the demands and needs of the labour market.

In January 2000, the Ministry of Education invited Lena Lindenskov and me to develop the national mathematics curriculum and teacher training for this adult education programme, which also contains a literacy curriculum.

In the national curriculum of Preparatory Adult Education in Mathematics, the purpose is formulated as to ensure students the possibility of clarifying, improving and supplementing their functional arithmetic and mathematical skills. The intention of the education is to increase the students’ possibilities of coping with, processing and producing mathematics containing information and materials.

A specific terminology is used and defined in the curriculum. The aim is reformulated as the adult students’ further development of their numeracy, as described above. The content is
described as a dynamic interplay between a series of mathematical activities, various types of data and media, as well as selected mathematical concepts and operations (see figure 2). As mentioned above, we found the inspiration to these activities (counting, localising, measuring, designing, playing, explaining) in Bishop’s work.

Figure 2. The content of the curriculum presented as a dynamic interplay

PAE mathematics has two levels: (level 1) figures and quantity and (level 2) patterns and relations, which in addition include the area of form and dimension, as well as data and chance.

According to the curriculum mathematical awareness is cultivated and trained in the students. The course aims to make it possible to clarify and formulate, and maybe change, students’ beliefs and attitudes to mathematics. Students should work with several different kinds of contexts. In addition to the mathematical context, they should work with everyday and societal contexts. The class decides upon the choice of context for class activities. With regard to individual activities, the individual students choose their contexts on the basis of what they need to learn.

The organisation, concrete aims and content should be arranged so that the background and foreground of the students take centre place. Dialogue is used to clarify and make use of the students’ background and perspective. The relevance of the content is made clear by concrete connections to activities outside education. The way the problems are posed and formulated as well as the problem solving methods should be authentic in relation to the chosen context (Lindenskov & Wedege, 2001:20-22).

The principles for organisation and content of PAE-Mathematics are presented and carefully discussed in the Teaching Guidance published by the ministry of education on the web, in 2002 (Undervisningsministeriet, 2002). In this publication, one may also find the four basic assumptions concerning adults’ relationship with mathematics on which the course is build:

- Adults’ numeracy has great influence on their participation in education, working life and societal life and their personal organisation in everyday life. However, many adults are not aware of this.

- Adults learn better when the mathematics education is meaningful i.e. the content and the methods used are authentic and relevant.
• Many adults’ school experience with mathematics is bad. This might cause blocks when they return to learn mathematics. Adults’ resistance towards learning is also a well known phenomenon.

• Adults learn in different ways. Thus they profit from different learning activities and materials.

In the Teaching Guidance, the operational model of Numeracy is presented and discussed in relation to the teaching practice, and the term numeracy is used through the whole publication. In the teacher training programme, which is compulsory, Numeracy is the key concept and adult numeracy is the main thread of the education.

The teachers’ views of mathematics
Before the start of Preparatory Adult Education in 2001, the Ministry of Education held three conferences to inform the mathematics teachers in basic adult education about PAE-mathematics. With the cooperation of 212 of the participating mathematics teachers (more than 90%), Henningsen and I made a survey of the teachers’ beliefs and attitudes towards mathematics (Wedege and Henningsen, 2002). As representatives from the adult educational institutions that were supposed to offer PAE, these teachers were all potential future teachers in PAE mathematics.

The questionnaire comprised both open and closed questions and we analysed the material using a combination of quantitative and qualitative methods. We elicited three kinds of answers from the teachers. Mathematics in their own words (the essay), biographical information (the teacher profile) and finally the teachers were asked whether or not they associated mathematics with 18 value items constructed on the basis of Bishop’s (1988) six categories (the value chart).

Ticking off the items in the value chart, the teachers generally agreed on the value items as words associated with mathematics. For example 95% of the teachers associated rules, logic and order with mathematics. However, in their essays, the teachers used different expressions to describe mathematics. No value item was found in more than 9% of the essays, and two out of three teachers (143 of 212) did not use any of the value items in their essay.

The descriptions of mathematics in the teachers’ essays centred on three different types of answers, which we tentatively denoted: everyday mathematics, curriculum mathematics and mathematics in the world. In accordance with the rhetoric of Danish basic adult education in mathematics, the majority of the teachers’ essays were in the first category of everyday mathematics.

Evaluation of PAE
In the actual Act, it was stated that the Preparatory Adult Education programme should be evaluated in 2004 and this task was given to the Danish Evaluation Institute (EVA) in 2003. I was appointed by EVA as one of the five members of the evaluation group (see below).

Mertens (2005) refers arguments of what distinguishes evaluation from other forms of social inquiry. It is its political inherency; that is, in evaluation, politics and science are inherently intertwined:

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2 The primary task of this institute is to initiate and conduct evaluations of education - from primary school and youth education to higher education and adult and post-graduate education.

3 EVA needed a Danish researcher with expertise within the area of adult mathematics education. My involvement in the development of PAE-mathematics and non-involvement in the implementation of the curriculum were assessed and they concluded that I was impartial.
Evaluations are conducted on the merit and worth of programs in the public domain, which are
their own responses to prioritized individual and community needs that resulted from political
decisions. Program evaluation “is thus intertwined with political power and decision making about
societal priorities and directions”. (Mertens, 2005:49-50)

Here merit refers to the excellence of an object as assessed by its intrinsic qualities or
performance; and worth refers to the value of an object in relation to a purpose. So merit
might be assessed by asking: How well does your programme perform? And worth might be
assessed by asking: Is what your programme does important?

The evaluation of PAE was to be a summative in the sense that it is an evaluation used to
make decisions about the continuation, revision, elimination, or merger of a programme. At
the same time the evaluation was to be formative in the sense that the educational institutions
involved were to improve the implementation of the programme locally (See Mertens, 2005).
The first perspective was required by the ministry and the second was a consequence of the
evaluation method employed by EVA.

The method
EVA employs different methods according to the requirements of the specific evaluation task.
However, there are a number of fixed elements in each evaluation: project team, preliminary
study, terms of reference, evaluation group, self evaluation, supplementary survey, site visit,
report and follow-up (see www.EVA.dk). For the purpose of this paper, I will go into more
details about five of these elements as they were realised in the evaluation of PAE:

The project team was responsible for the practical work, the methodology of the
evaluation, and took the responsibility for writing the final report. The members of the team
were employed in EVA. The terms of reference was laid down by EVA describing the
objective and framework for the evaluation. The evaluation group, where I was a member,
was established and composed of people with special academic expertise in the area that is
evaluated (a researcher in literacy, a researcher in numeracy, an experienced teacher in
literacy and numeracy, a school leader and a Norwegian adult educational planner). The
evaluation group was responsible for the academic contents of the evaluation and for the
assessments and recommendations of the report. The evaluation group was appointed by
EVA’s board, and the members were independent of the educational programmes evaluated
and also of EVA.

The self evaluation, which is an integral part of any evaluation, had a dual purpose: on the
one hand, it should be used as documentation for the final report and its recommendations
and, on the other; it should be seen as an inspiration for the evaluated educational programme
or institutions for quality improvement. In the self evaluation, 10 adult educational institutions
described and assessed their own strengths and weaknesses. Normally, the participants will be
the teachers and also the students or the pupils and management. However, in the case of
PAE, the project team had decided not to involve the students. The self evaluation was based
on guidelines prepared by the project team. Some of the headings in the self evaluation report
were students (profiles, learning needs), teachers (qualification), enrolment, framework of the
education (aim). The self evaluation reports together with the supplementary surveys and the
site visits formed the basis for the recommendations of the evaluation report.

During the site visit the evaluation group and the project team visited the 10 self
evaluating institutions. During the visit, the evaluation group had the opportunity to interview
the teachers, the students, the management team and representatives from local workplaces.
The purpose of the visit was to obtain further documentation for our report. Prior to the visit,
the project team prepared a checklist (questionnaire) for the evaluation group based on the
self evaluation reports. This procedure was to ensure that any obscurities in the self evaluation
reports are identified. However, only a few of the questions prepared by the team concerned
the education content, and the evaluation group added a series of questions e.g. tell us about your classroom practices; do you find that there is enough time to achieve the aims of the course; how do you adjust the teaching to the students’ needs. The project team prepared minutes of the meeting after each visit. The minutes of the meeting are only for EVA’s own use. During the site visit, I made my own notes and afterwards I used EVA’s minutes to check my own. The quotations from teachers or students below stem from either my personal notes or the official evaluation report (EVA, 2005).

Worth: Is what PAE does important?
The aim of EVA’s (2005) evaluation was to evaluate strong and weak points of preparatory adult education (PAE) and to assess whether the implementation of the Danish act on preparatory adult education is living up to its purpose, i.e. mainly to evaluate the worth of the programme. In the evaluation report, one finds the official results and recommendations from the evaluation group. In relation to the reflections in this paper, I find the following results relevant:

It appears that in spite of a great increase in the activity, the targets formulated on the adoption of the PAE Act in 2000 have not been reached. This is especially true of mathematics. I think that one of the reasons is that the workers’ unions and the big enterprises have focussed on the literacy problem for the last 10 years, very little attention has been paid to numeracy. Another reason might be that mathematics in people’s working life is invisible or not experienced as mathematics (cf. Wedege, 2001, 2004). However, many students benefit greatly from the course, both personally and socially, and a number of them use PAE as a springboard for further education. A general example was adults now being able to help their children with the home work. And happy people saying that, after all, they were able to learn mathematics. Although the word numeracy was not mentioned by the teachers I am sure that many students further developed their numeracy as a result of PAE-mathematics.

The first statement of the famous Math Anxiety Bill of Rights is this: “I have the right to learn at my own pace and not feel put down or stupid if I’m slower than someone else” (Tobias, 1993: 226). A common remark from the students was that they felt at the eye level with the teachers. They were actually treated as competent adults – another of the 14 rights.

According to the report, PAE is characterised by flexibility (EVA, 2005). This is apparent from the large number and the many different types of providers of adult education as well as from the way teaching activities are organised. Moreover, this flexibility is demonstrated by the recourse to relocation of teaching activities, in the sense that teaching may take place in business enterprises, organisations etc. However, when it comes to interpretation of the curriculum, flexibility is not only a positive term. Some of the mathematics teaching that we met during the visit didn’t have anything to do with PAE. We saw for example ordinary mathematics education compensating for young students’ poor mathematical skills in vocational education. In this school – like in others – we saw and heard of the use of standard mathematics text books. Like in an adult education school where a male student said: “He gave us a book and then we worked individually. We didn’t use the material from the workplace although we asked if we could do so. The teacher gave us a textbook from grade 2 to 3. When we told him that we wanted to learn to calculate area, he said that we would meet this problem later in the book.” The last comments lead us to the other dimension of the evaluation.

Merit: How well does PAE perform?
The main purpose of the evaluation was to assess the worth of PAE, however, the report also contains results concerning the merit. For example it is observed that, in general, PAE is characterised by dedicated teachers and managers capable of creating a successful
environment for adult education in which the students feel safe and with teaching based on the students’ needs and qualifications (EVA, 2005). In the evaluation group’s opinion, the teachers in general are well qualified and capable of carrying out their teaching on the basis of the qualifications and needs of the individual student. However, among the mathematics teachers, there are many examples of this not being the case. Thus, the evaluation group recommended the individual provider to assess the teachers’ qualifications in the light of the new requirements in order to ensure that all teachers include the experience of the students in their teaching and implement the teaching model from the curriculum (figure 2).

Here are a few examples from the visit: In the curriculum it is required that concrete material (e.g., juice, rice, wood, fabric) should be one of the medias used in combination with activities and mathematical operations or concepts. In a locker marked with the words “concrete material” in a well equipped classroom, I found only gadgets in plastic normally used in the children’s mathematics classroom.

When students spoke in general about mathematics they often used the terms “equation”, “x” and “y”, which were not in the curriculum. In the following statement, I found another example of the students’ views of mathematics and that their perception of mathematics had not changed. A woman who was fired after many years in the same job said: "For the last 32 years I have only worked in LEGO’s design department. I cannot do any mathematics." It seems that to her mathematics is still “what I cannot do” (see Wedege, 2005).

Conclusion and discussion
The purpose of the evaluation was not to investigate if the educational planners’ ideas, concepts and design as manifested in the curriculum were implemented in the teaching and learning practices of PAE-mathematics. However, being an educational planner and researcher not a politician, one of my personal interests was to assess the intrinsic qualities or performance of the education (merit), particularly the implementation of the operational model, Numeracy.

In her paper “Balancing the Unbalanceable”, Anna Sfard (2003) goes through the NCTM Standards in the light of theories of learning mathematics. As a part of the reform movement, she sees the Standards as a result of a serious and comprehensive attempt to teach “mathematics with a human face”: “Success of educational ideas, however, is never a simple function of the ideas themselves. There is no direct route from general curricular principles to successful instruction.” (p. 354). The conclusion of my reflections in this paper is in keeping with Sfard’s statement.

The same goes for Skott (2006) who suggests to moderate the idea that new theoretical constructions even empirically grounded could have decisive and direct influence on institutionalised teaching and learning of mathematics. In the case of PAE-mathematics we don’t deal with education already institutionalised. This is a new educational programme which replaces another programme in basic mathematics. However, the schools and the mathematics teachers are the same.

If we look at the teachers’ views of mathematics before the start of PAE-mathematics, we may find a reason why nobody talked about numeracy during the whole evaluation procedure (self evaluation and interviews). As mentioned above mathematics is associated with everyday mathematics in most teachers’ conceptions. Thus they don’t find it necessary to use the term “numeracy” in stead of “mathematics”. At one of the ministry’s three information meetings on PAE-mathematics, a teacher whispered to the person next to him: “We go to this meeting; we listen and we go home doing what we are used to do.” The new rhetoric was interpreted in ways that fitted with the current practices in adult mathematics education and resulted in little change to teaching.
With the focus on the worth of the new adult mathematics education, “success” may be the answer to the initial question concerning Numeracy as a tool in adult mathematics education. What PAE-mathematics does is important: many students benefit greatly from this course. But looking at the merit of the new programme the answer may be “failure”. PAE-mathematics doesn’t perform according to the curriculum with a dynamic interplay between activities, data & media, and mathematical concepts & operations.

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References


