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ABSTRACT

Criteria for placement tests on math skills of adult basic education (ABE) students are needed to develop tests that are not too "school-like" because the ABE students are often blocked by math anxiety due to past negative school experiences, students may encounter language problems that affect their math skills, simple math problems do not measure practical problem-solving skills, and a placement test having only right and wrong answers does not provide insight into mathematical procedures of adults. These are the criteria: (1) adult students should be enabled to show the best they can; (2) language in a placement test should not hamper the student from doing the math test; (3) adults, in particular second language learners, should have a chance to apply their own mathematical procedures and the algorithms they are accustomed to; and (4) the test should yield qualitative information about adults' mathematical skills in order to enable teachers and program developers to set up adequate and well-tuned programs for ABE students. (Contains two illustrative sample problems and example student solutions.)(SLR)

Assessment of Math Skills in ABE: A Challenge

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1. Introduction

Testing adults in Adult Basic Education (ABE) on their math skills is not easy, especially when it involves non-native speakers, but it is a challenge to try to discover what adults really know and can do when they enter ABE and what this means for math education in ABE.

In 1998 qualitative research was done into the mathematical knowledge and skills of a group of thirty-two non-native adults in ABE in the Netherlands. These adults came from twelve different countries. All of them received primary school education in their own countries and some of them also participated in low vocational courses. They did an intensive language training for about half a year before they started the math course. Part of this research was content analysis of their results on a placement test for ABE, developed in the Netherlands. Information based on this analysis should provide insight into their knowledge and skills and into appropriate ways of assessing non-native adults in order to improve math education in ABE. In this paper a few criteria for placement tests for testing adults in ABE are discussed and supported by a few students' examples.

2. Some Background Information

In the early 1970s Realistic Mathematics Education (RME) started as a new way of mathematics education in the Netherlands. RME was developed by Professor Hans Freudenthal and his coworkers at the IOWO institute (Institute for the Development of Mathematics Education), currently the Freudenthal Institute, in Utrecht. It starts with Freudenthal's assumption that mathematics has its roots in real life and constructs and reconstructs reality. This is a never-ending process. RME is a learning theory on its own and has five starting points: learning is a constructive activity; learning moves through various levels of abstraction with the provision of models, schemes and symbols; learning takes place by reflection; learning is a social activity; and learning mathematics leads to a structured and interwoven entity of knowledge and skills (Freudenthal, 1973, 1991; Gravemeijer, 1994; Treffers, 1991)

RME was enthusiastically embraced in ABE in the Netherlands when the new adult education system started in 1987. Based on the RME principles the first experimental materials for adults were developed in the years 1987-1992. RME in ABE started from scratch. ABE learning centers needed everything: a curriculum, student books, but also a way to determine the starting level of adults when they enter ABE.

3. Testing Adults in ABE

At the start of ABE in 1987 many teachers came from open school centers and from literacy projects. They were used to working based on Paulo Freire's theory: learning from experiences. Most of them did not want to use placement tests because that would be too "school-like" and might remind adults of negative school experiences. However, in the new system we had to grow to a way of systematic learning and teaching, including tests. That forced us to think about a way in which we could collect relevant information but not in a school-like way and more than only right/wrong answers, as was common for paper-and-pencil school tests at that time. Such tests might be sufficient to determine a placement level, but our concerns were multiple:

1. Native adults in ABE are often blocked by math anxiety, due to past negative school experiences. They may feel uneasy in a test situation, especially at the start in ABE.
2. Weak readers and non-native adults may encounter language problems in a paper-and-pencil test that could affect their actual knowledge and skills on math.
3. Tasks that only ask for applying mathematical procedures, like doing algorithms, may give an incorrect impression of the actual mathematical knowledge and skills of adults, especially when it involves second language learners.

4. A placement test based on only collecting right/wrong scores does not provide qualitative insight into the mathematical procedures of adults.

From these negative experiences with paper-and-pencil tests we wanted to come to a way of testing that would be friendly for adults and include both quantitative and qualitative information. Also, in this test the starting points of RME should be visible. That means, in our interpretation of RME for ABE, that items should be related to real life situations and that people should be able to show their own knowledge and skills in a constructive way. That brought us to the next set of criteria for testing adults in ABE:

1. Adult students should be enabled to show the best they can.
When adults come back to school they often have developed a mix of school knowledge and real life knowledge. They may have forgotten lots of formal school math procedures and developed more own-invented informal procedures instead. On the other hand, many adults with little school education show insight into mathematical problems and may know more than what they ever learned in school, based on real life experiences. Therefore, tasks on ABE tests should not only ask for supposed school knowledge and skills, but should enable adults to show what they actually know and can do. *For that, a math test for adults should provide mathematical problems in contexts derived from real life situations that can be solved in different ways.*

2. Language in a placement test should not hamper the student from doing the math test.
Math contexts do not need to consist of only text. In real life situations contexts occur as "problem-situations" that can be embedded in or supported by visual representations. Such visualizations should be the essence of math contexts in the test. Text in the context itself should be restricted to a minimum. Only essential information should be given. Instruction text in the item questions should be worded in a consistent style, indicating particular tasks or types of questions always in the same style and with the same or similar words. Instructions should be written in short, simple, not complex sentences. In this way the language barrier can be kept as low as possible. During the actual test situation people should still feel free to ask for help if there is any language problem.

3. Adults, in particular second language learners, should have a chance to apply their own mathematical procedures and the algorithms they are used to.
In an international setting cultural differences should be taken into account. Such differences become clear in, for example, different notation systems, not only in the students' work, but also in the offered mathematical contexts. It is very difficult to create items for placement tests that offer cross-cultural possibilities. For example, text in contexts should be unambiguous, e.g., 1/5 can be pronounced as "one-fifth" or "one-over-five" or "one out of five." In an context that says "One-fifth of the students in High School are too heavy, what percent is that?" it would be better to use the fraction notation "1/5" instead of words, or make it visible in a graphic. This may prevent misunderstanding. Also, people from different countries may apply different algorithms. Therefore, in a placement test we should not ask students to do algorithms to conform to the host country's style. We should offer contexts in which students can apply their own algorithms.

4. The test should yield qualitative information about the adults' mathematical skills in order to enable teachers and program developers to set up adequate and well-tuned programs for ABE students.
If the students are asked to write down their computations in their copies of the placement test, this may provide a lot of qualitative information to teachers and program developers. What kinds of computations does the student show in the test? Is the student used to formal algorithms or does he apply informal computations? Is it based on insight? Does the student profit by graphics? Does the student use schemes or mental models? Does

the student understand the text in the context, in the item question? etc. Information acquired here should be the starting point in the math classes.[1]

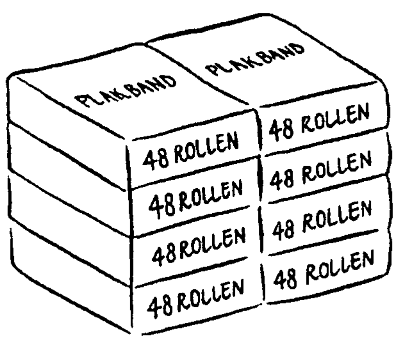
In 1992 a first experimental framework with accompanying placement test was published for ABE: the *Supermarket Strategy* (van Groenestijn et al., 1992, 2000). This test consists of 64 contexts, accompanied by a leaflet. The content is based on mathematical activities in the context of a supermarket, spread over different mathematical strands and levels. The test is based on oral interviews. The color leaflet and the contexts enable the interviewer to build up the interview in an informal way of a friendly talk with the interviewee about math topics related to their real life experiences. Guided by a session-flow procedure and a structured interview scheme, the interviewer is able to set a profile and determine the placement level in about 45 minutes to one hour. The interview yields a lot of qualitative information about the mathematical skills of the adult. Also, non-native speakers can be helped when they encounter language problems. This test showed teachers in ABE that testing adults could be done in a non-school-like way, which was an important step.

However, at the follow-up of this placement test, the elaboration of the *In Balance* student units, we were strongly advised to develop a new placement test, a paper-and-pencil test, due to time constraints in ABE institutions (van Groenestijn et al., 1994-2000). In this test the same principles were used as described above, but now the challenge was to develop items that could yield as much information on paper as in an oral interview. The text in the item contexts and item questions should be minimal, unambiguous, and consistent for similar items at different levels. A precondition for a paper-and-pencil test is that it looks attractive and challenging to adults to lessen math anxiety and blocks during the test session. People should be introduced to the test in the actual test situation, to become familiar with the setup and the layout.

4. Two Examples

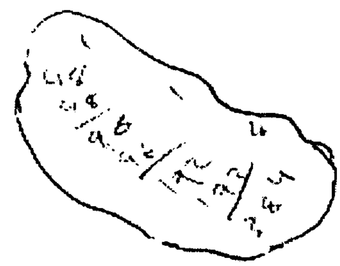
To give a brief impression of the type of items based on the criteria above, two examples are presented here. These items were part of the research described in the introduction. The first task is a multiplication context about tape rolls in boxes. The item question is:

How many tape rolls in total?

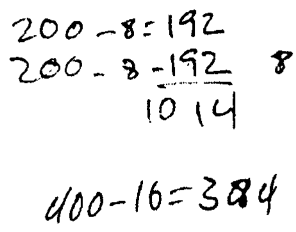


The graphic shows 8 boxes with the Dutch word "tape" on it. The text "48 rolls" indicates the content of each box. The text in the context and in the item question is minimal but essential. This context offers possibilities for formal and informal computations based on, for example, repeated addition, doubling, multiplication, smart computations by rounding up to 50, combining two boxes to 100-4, etc. A few students' computations show the following results:

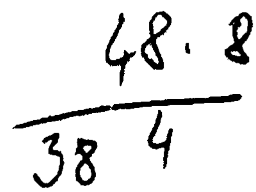
[1] Note: Here we come to the question whether the student should be allowed to use a calculator at the placement test or not. The use of a calculator is a study in its own and not part of this paper. I am all in favor of the use of calculators in ABE, though under certain conditions. However, regarding the placement test I advise not using the calculator in order to get clear what the student actually can do by himself. After the placement is done, we could ask the student to do one or more extra tasks, allowing him to use a calculator, or spend some time during the first group session for a few tasks with a calculator in order to see how the students deal with a calculator. Personally, I prefer the latter.



Student 1



Student 2



Student 3

Student 1 shows computations based on repeated doubling. By this action she shows her insight and her way of thinking. She can apply the addition algorithm, but probably not the multiplication algorithm. It is even unsure whether she knows how to multiply. Other items should give additional information.

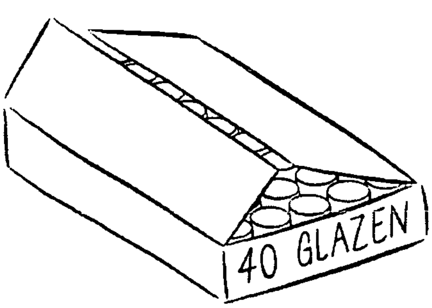
Student 2 starts in a smart way by using the number 200 for 4 boxes, minus 8. This student shows insight in the context, but then he applies a wrong addition algorithm. He adds 2 and 2, making 4. Then he adds 9 and 9, but he writes down 1 and keeps 8 instead of the other way. Finally he adds 1 and 1, plus 8 makes 10. (Total 1014) However, in the final notation below, probably done mentally, the student shows the correct answer (384).

Student 3 shows a correct multiplication algorithm, although it does not conform to the Dutch style.

For the record: only 53% of this student group got the correct answer to this item.

The second context shows a multiplication/division problem. The text says:

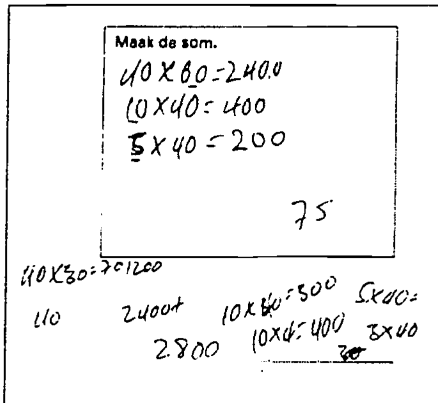
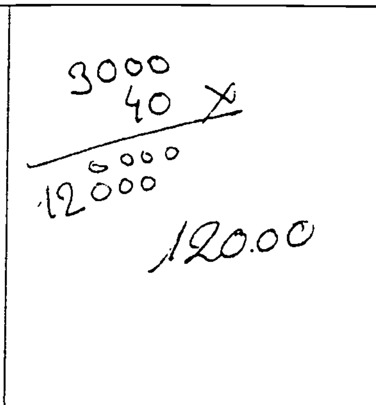
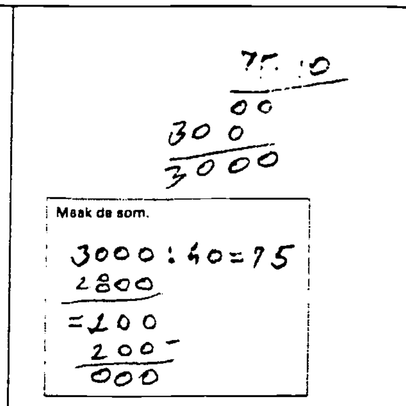
How many boxes?



A restaurant owner buys 3000 glasses.
The glasses are packed in boxes.
How many boxes should he buy?

The graphic only shows one box with the total "40 glasses" on it. It also shows the structure 8x5 in it. The instruction text is simple. The text on the box is minimal but essential to solve the problem.

This context offers many possibilities for solving the problem. A few examples:

		
Student 2	Student 4	Student 5

Student 2, the same student as in the previous example, starts by doing an estimate. Below the computation we see 40 x 30 = 1200 and below that, the number 2400. In the computation box we see 40 x 60 = 2400. Then we see in his scribbling 10 x 30 = 300 and 10 x 40 = 400 plus the number 2800. He adds in the computation box: 10 x 40 = 400. In the final step he adds another 5 x 40 = 200 and writes 75.

This student shows insight into the context problem and solves it by estimation and doing multiplication mentally, given his notations. The student probably does not have mastery of algorithms.

Student 4 does not understand the actual problem. He could read the text, as we checked afterwards. He shows a multiplication algorithm that does not fit in the context and with an incorrect answer. This is an example of "blind ciphering." This student showed more of such meaningless algorithms in his work. It may mean that he can do formal computations but is probably not used to solving context problems. Also, the point in the answer may indicate that he confuses this number with money or does not know exactly how to deal with commas and points that separate thousands or decimals in a number. In the Netherlands we use points for separating thousands, millions, etc. For the decimal point we use the comma, though the use of calculators may confuse people a lot.

Student 5 shows insight into the context problem. He can solve the problem by applying a correct long division and checks his answer by applying a multiplication. Again, this way of doing algorithms is not common in the Netherlands.

For the record: only 44% of this ABE student group got the right answer to this item.

5. Developing Placement Tests for Adults in ABE: A Challenge

The sample responses to the two items discussed above indicate that it is possible to construct a paper-and-pencil test in which ABE students can indeed show in a constructive way whether they understand a mathematical context and what kind of mathematical knowledge and skills they have acquired. The challenge with these items is that test developers cannot plan in advance that an item is meant for, e.g., "only" addition or multiplication or division. They can only indicate that it is meant for "basic operations." Such items enable ABE students to show their capacities on math, in these examples the four basic operations, but also their formal or informal strategies, or mental math. Test developers hence need to create a sufficiently broad set of items that can cover the grid of different skills according to curricula for ABE, taking into account the cross-linked nature of items as discussed in this paper. This way of testing may also provide additional information about people's ways of problem solving.

Information acquired from placement tests should provide directions for learning and teaching in ABE. Interesting conclusions can be drawn about people's ways of thinking and doing computations. For example, it may show that it is not necessary at all to learn (or to teach) algorithms in ABE when students are able to solve problems in more informal, but effective, alternative ways. Informal procedures, in combination with the sensible use of a calculator, may have as good results as formal procedures. Given the goals of ABE, at least in the Netherlands, this could have an important effect on math curricula in ABE.

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