THE MATHEMATICAL COMPETENCE OF ADULTS RETURNING TO LEARNING ON A UNIVERSITY FOUNDATION PROGRAMME: A SELECTIVE COMPARISON OF PERFORMANCE WITH THE CSMS STUDY

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This brief paper provides a snapshot of some of the mathematical competences of mature students on entry to a University Foundation Programme preparing students for a range of degree routes. As part of a pilot study, Foundation students were given a mathematics questionnaire containing some questions based on those used in the 1974-79 CSMS study (Hart, 1981) with the addition of confidence ratings. Whilst many of the results are as might be predicted, some results are perhaps more surprising. The purpose of this paper is to share some of these findings.

INTRODUCTION

As part of a larger piece of research into the influence of previous understanding on new learning, 'Building understanding on a Brownfield site', it was necessary to identify the 'mathematical understanding' of adults returning to learn. There is considerable debate amongst maths researchers about maths 'understanding' and the influence of situation in defining the maths itself, which is beyond the remit of this paper. However, since the purpose of the foundation learning is to prepare students for further study, it was considered appropriate to focus first on those elements of school mathematics likely to be used for this. Adults returning to learn are almost in the opposite situation from children, because they may be attempting to transfer real-life maths back into school maths rather than the other way round.

The Concepts in Secondary Mathematics and Science (CSMS) study (Hart, 1981) which took place in the late 1970s was an influential study in its time. Its detailed consideration of alternative mathematical strategies used by children formed the basis of future research, particularly into common misconceptions in maths (Swan, 2006). As a large scale study, it compared the facilities of questions for different age children and was able to suggest hierarchies for topics and problem types. It, therefore, also provided a rich source of well researched and tested questions for diagnostic use which were particularly appropriate to use in this research.

METHODOLOGY

The methodology used was adapted from Evans (2000) but with some differences, predominantly to minimise anxiety and try to reduce the impact of this on students' efficacy. Tutors skilled in working with adults with high anxiety levels administered questionnaires in the first maths session of the course. Written instructions were supplemented with verbal explanations and reassurance, and the option given for people to leave the room or hand in blank pages. Students labelled papers with

primary school and mother's first name, which allowed the potential to pair 'before' and 'after' scripts in the future, but ensured that only the students themselves could identify scripts. Anonymity was, therefore, transparent and did not rely on trust in others. People were encouraged to participate at their own level, which might include the writing of notes to relieve anxiety. Emphasis was placed on the extra value of responses from those who found some difficulty with maths.

Questionnaire Content

The first booklet contained preliminary questions on maths qualifications, time since studying maths and anxiety about future study and 34 maths questions, 13 of which were multiple choice. A second booklet contained a further 17 questions, mainly on algebra, but students were asked to only proceed to this if they had done as much as they could of the first booklet. It was hoped that this would increase the probability that the leaving of blanks represented an inability to answer a question rather than a strategic decision to spend limited time on later questions which were more easily recognised. Calculators were allowed in the second booklet but not the first.

The majority of the questions set were the same or similar to questions set in the CSMS study, but sometimes the numbers, wording, diagram or context was changed.

Students were asked to rate their confidence in each answer using the four categories: very confident, confident, not very confident and just guessed.

RESULTS AND ANALYSIS

Questionnaires were administered to 93 students (78 home/15 international) in 2006 and to 110 students (79 home/31 international) in 2007. It is only possible to discuss a few of the preliminary findings within the limitations of this paper and the analysis presented here has focused mainly on home students.

A score was allocated to each booklet (1 mark for a correct answer, 0.5 for a partially correct one). There was no clear correlation between this score and anxiety about maths study, maths qualifications and time since studying maths, possibly as a consequence of data unreliability and subjectivity in qualification ranking. However, it is of interest that whilst all students identifying themselves as, 'not at all anxious' gained high scores, some of those labelled as 'very anxious' also performed well.

Selection of Operations and Order of Division

The first multiple choice questions required students to select the operation to use for different word problems. Adults performed better than the CSMS children with the exception of the first question on chocolate bars. One explanation suggested for this, amongst others, is that answers might reflect a level of carelessness or instinct.

Problems with the order of division could be seen in the first question and the fifth which involved sharing students amongst tutors. In 2007, one student selected both division answers for both questions and four selected the division in the incorrect order for both questions. For the multiple choice question requiring an estimate for

40 ÷ 200, 46% adults divided the larger number by the smaller. This perhaps indicated an intuitive response with familiar numbers since the proportion who reversed the division was much smaller in the previous cohort which used the alternative question 72÷172

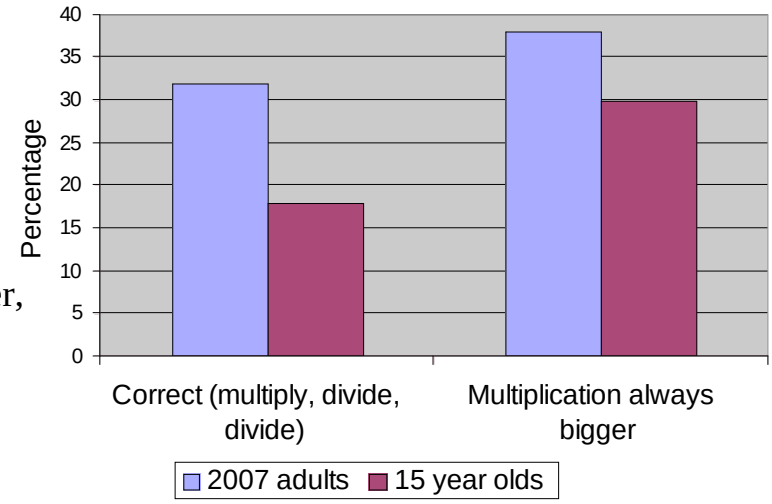
Multiplying always gives a bigger number and division a smaller

Three questions were asked about which calculation gave the bigger answer:

6 × 3 or 6 ÷3 8 × 0.4 or 8 ÷ 0.4 0.5 × 0.2 or 0.5 ÷ 0.2

In 2007, 99% of students correctly selected the first multiplication but only 32% correctly selected all three operations. Figure 1 shows that although a larger proportion of adults than children correctly selected all three, a larger proportion of adults also thought that multiplication was always bigger, indicating both a larger number of strong and a larger number of weak participants.

Figure1 :Percentages of Adults and Children selecting which is bigger multiplication or division.



Ratio and Proportion

Four questions were asked on snakes.

Three snakes are kept in captivity and fed on mice.
The number of mice they are given depends on their length.

A _____50 cm

B _____100 cm

C _____150 cm

a) If snake A is fed 2 mice

(i) How many would snake B get? (ii) How many would snake C get?

b) If snake B is fed 6 mice, how many would snake C get?

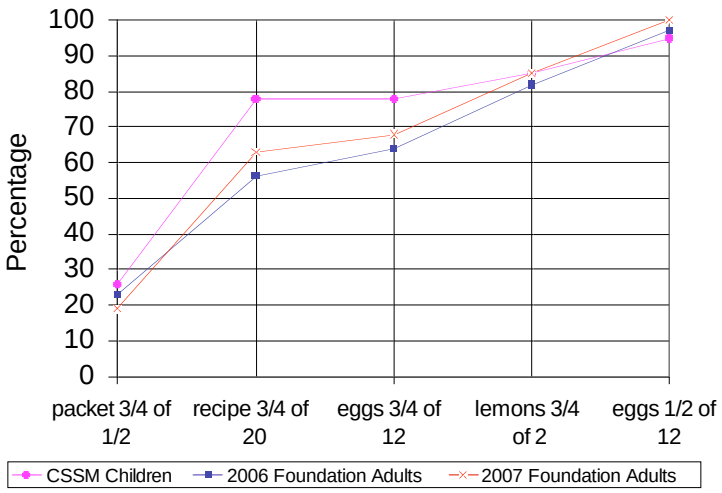
c) If snake C is fed 12 mice, how many would snake B get?

Correct answers for (a) could be obtained using the strategy ‘add on 2’. 8% of adults incorrectly extended this strategy to (b) and (c). Comparisons with the CSMS cohort again indicate that, although a higher proportion of adults gave correct answers (70% adults to 50% children), a higher proportion of adults also gave the weakest answers (9% adults to 7% children). 8% of adults correctly answered (b) requiring a

multiplication of 1.5 but incorrectly stated that 2/3 of 12 was 9 for (c). Similarly, 20% stated that 3/4 of 12 is 8 in a later question.

Questions were asked using proportions in a recipe. Figure 2 shows the results. The poorer response by adults might indicate a level of situating in real life and some estimating. One student quoted, 'one for the pot' and another pointed out that they would not calculate 3/4 of 1/2 a packet in real life but calculate the number of grams. In both the CSMS study and this one, the answer of 1/3 was the most common incorrect answer for 3/4 of 1/2 (27% of adults and 20% of children)

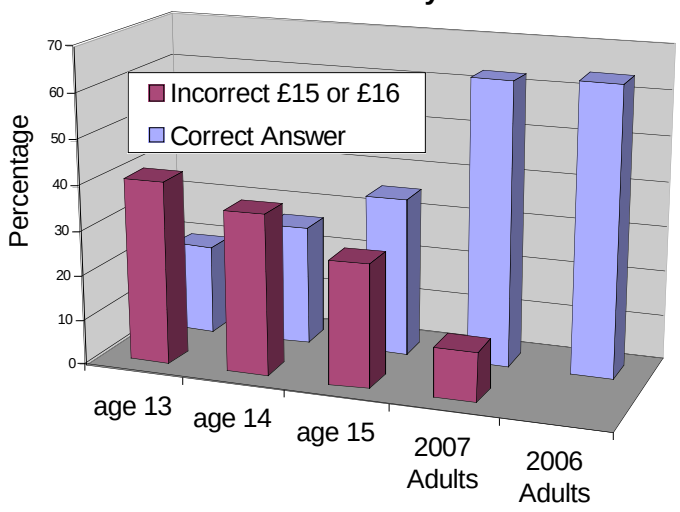
Figure 2:Percentages of Foundation Adults and CSMS Children correctly calculating Recipe Proportions



Percentage

Most students were able to give 10% and 25% as a fraction, although 3 students incorrectly identified 1/25 as 25%. The percentage question with the highest facility asked for the new cost of a £20 item after a 5% reduction (See Figure 3). If correct methods or '£1' were also included, the facility was even higher suggesting that skills may have improved with 'real life'. The most common incorrect answers for children were £15 and £16 which were found by children ignoring the £ and % signs. A small number of adults also did this.

Figure 3: Percentages of cohorts answering £20 reduced by 5%



For other types of percentage problems, adults performed less well than the children. Only 25% adults answered all the percentage questions correctly or used a correct method. Some adults used the same method whatever the problem type, succeeding where this was appropriate and failing where it was not. In contrast, many overseas students used the ratio method of $\frac{a}{b}=\frac{c}{d}$ to successfully answer all problem types.

The results for a question asking for 42 blue eyed mice as a percentage of the total 600 mice are given in Figure 4. The proportion of adults incorrectly selecting to divide by 100 and multiply is larger than the proportion of children who use this strategy.

Figure 4: Percentages of different answers for 'A out of B as a Percentage'

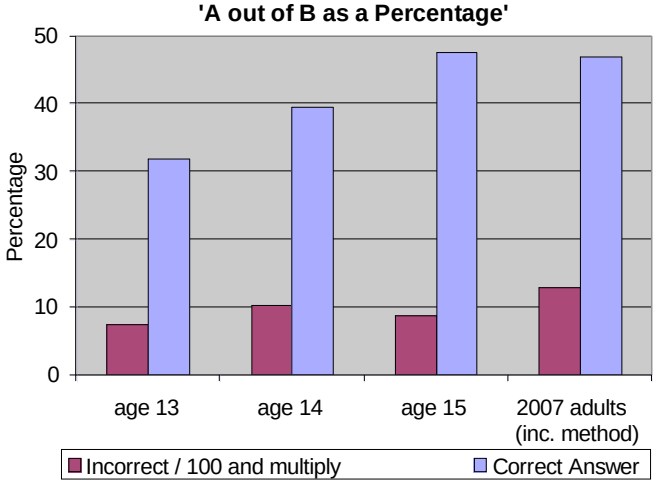
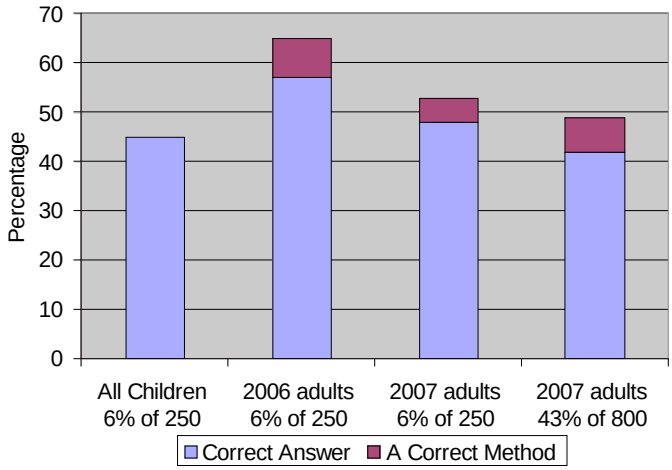


Figure 5:Percentages of Cohorts correctly finding A% of B



Results for questions finding A% of B are shown in Figure 5. In 2006, most successful adults built up 6% by finding 10%, then 5%, then 1%, This strategy was also common in the earlier reduction question and consolidated by a question requiring 15%. In 2007, the 15% question was replaced by one requiring 43% and it is possible that this caused more confusion in method selection. Adults who successfully found 6% of 250 could not always find 43% of 800 and vice versa.

Hierarchies

For the whole cohort, similar hierarchies to those identified in the CSMS study were identified. This was not the case for individual adults, particularly weaker students.

Student A, for example, has a GCSE grade C in maths and is 'not at all anxious'. He/she attempts every percentage question using the same method regardless of problem type but indicates confidence in the answers. He/she writes out complex methods for calculating ratios including the snake questions but is unable to work them out. He/she attempts to divide 7.75 by 10 using long division.

Student B, gives 10% and 25% as fractions and calculates the cost of an item after a 5% reduction but 'just guesses'. He/she answers place value questions correctly but misses out all other percentage problems. He/she copes with some ratio questions but sometimes reverts to subtraction strategies. Yet he or she also manages some quite complex algebra despite having last studied maths over 10 years ago with no qualifications and rating themselves as 'very anxious'.

SUMMARY OF CONCLUSIONS

The numbers used and hence the level of complexity used for both the foundation adults and CSMS children were sometimes different. Even when the numbers were

the same, the wording of the question and use of diagram or context was often different. CSMS children seemed to have been given a group of questions on one topic but adults were given questions on different topics jumbled together. Aside from the general subjectivity in classifying answers, comparisons were made from personal interpretations of the CSMS project book, not from CSMS raw data. There may have been some misinterpretations.

No formal qualifications are required for foundation entry and therefore the intake can vary considerable from year to year. For this reason, the original intention of the analysis was not to compare absolute levels for foundation students with the CSMS study but to identify differences in hierarchies which might indicate interaction between school learning and other processes. It was, therefore, surprising to identify how similar some of the results for the 2006 and 2007 cohorts were. The CSMS study used a stratified sample but the foundation sample appeared to have a large proportion of weaker students and a large proportion of stronger students with fewer in the middle. Whilst comparison of these results with those from the CSMS survey remains of interest, care must be taken to avoid extrapolating the findings too far.

Despite these issues, some useful conclusions can be drawn. Some adults appear to have the same misunderstandings and make the same common errors as children. What is not known is whether this is simply a continuation of ideas from childhood or whether people's ideas have reverted or been changed since leaving school.

Despite major differences between the ways that the participants were selected, the overall hierarchy of difficulty of questions remains similar for adults and children. . It is not clear how much individual hierarchies were considered in the original CSMS study, but for adults, the individual hierarchies can be rather different from the overall hierarchies. It is not known whether this reflects uneven memory retention, a return to naive strategies, a growth of 'adult common sense', awareness of real-life or an uneven usage of different skills since leaving school. Future interviews may help illuminate this as will further research.

If it were possible to design a longitudinal strand in future CSMS type studies this might give some valuable insights.

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