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ASSESSING EARLY MATHEMATICAL DEVELOPMENT IN ENGLAND AND SLOVENIA

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The work discussed here is part of an international study involving Dutch, Belgian, German, Greek, Finnish, Slovenian and English children. The project, co-ordinated by the University of Utrecht, employs the Utrecht Early Mathematical Competence Test. This paper looks at comparisons of performance between England, where children were in formal schooling throughout, and Slovenia, where they had not started formal schooling at the end of the year. Major contrasts include the following. English rather than Slovenian younger and older children within a cohort are more drawn towards the cohort's mean performance at any one time. English schools differ more than Slovenian nursery classes; but there is less variation within English groups than Slovenian groups. Children are more fixed in position within a cohort in England than they are in Slovenia. The relative emphasis on Piagetian developmental tasks compared with more arithmetical tasks differs between the two countries.

Background

A team at the University of Utrecht developed an instrument for monitoring the development of mathematical competence in children at around the start of schooling. See van der Rijt and van Luit (1998), van de Rijt, van Luit and Pennings (1999) and Godfrey and Aubrey (1999) for details.

There are vast differences between educational systems of England and Slovenia, not least in the early years. In England formal schooling officially starts at or around a child's fifth birthday, whereas in Slovenia children of five or six years remain in kindergartens. Slovenians would claim that their school classes as well as kindergarten groups are mixed ability and very similar in all institutions. The English would acknowledge that infant classes differ from one school to another, though classes within a single school usually have a similar range of ability.

Clearly this picture is oversimplified. What happens to children before the official start of formal schooling here may be quite structured. The introduction of Desirable Learning Goals and the foundation curriculum in England may create pressure towards formalisation. English infant teachers have, in the past, had a reputation for

an informal style of teaching. By contrast, Slovenian kindergartens with their obligatory school preparation programme which aims to make transition to primary school easier might be as formal as English infant classes.

Methodology

The research design involved in each country a sample of 100 children for each of the three parallel forms of the Utrecht Early Mathematical Competence Test administered over three testing cycles - February-March and June-July of reception year and February-March of Year One. The test and testing procedures are described elsewhere (Godfrey and Aubrey, 1999). In practice there were slight and unavoidable deviations in the testing schedules but both England and Slovenia were reasonably close to target. In England 21 different primary schools in a large south-east authority were used. In Slovenia 11 kindergarten groups participated.

Table 1 gives some indication of the sample attrition during the study as well as allowing comparison of ages. Godfrey and Aubrey (1999), looking at only the English data, suggested that the dependence of total test score on age was complicated by whether the results of the first, second or third testing cycle were examined. Test familiarity was provisionally rejected as an explanation of this. Here we use multilevel regression models to consider:

- whether the picture changes when account is taken of the Slovenian data (this could happen since multilevel models use all data in estimating the effects of age in each school and on each child); and
- whether the same patterns occurs in the Slovenian sample.

Table 1. Sample sizes and mean ages in months for each administration of the UEMCT in England and Slovenia.

	FIRST TEST		SECOND TEST		THIRD TEST	
	N	Age	N	Age	N	Age
ENGLAND	319	60.0	299	63.7	290	71.8
SLOVENIA	323	64.0	311	68.9	281	76.6

Results

i) Total Scores and the effects of age

The pattern found previously suggested that although at each testing cycle older children tended to do better, older children at a particluar age in the first testing cycle did not perform as well as at that age as younger children who attained that age only

in the second testing cycle and neither of these did as well as very young children who only reached that age in the third testing cycle. In other words progression over time was not apparently purely a matter of maturation. The whole cohort was advancing at a rate greater than that suggested by the difference between children of different ages at any one point in time. One interpretation of this is that schooling was moving pupils on faster than simple maturation would. Another is that average progress is at something like the rate of simple maturation but schooling tends to pull down the performance of older children and/or raise the achievement of younger children towards the cohort average. This ambiguity might be resolved by seeing how the Slovenian data affects the pattern.

The dependent variable is simply the score out of 40 gained by a child at one administration. The only explanatory variables were age, sex, country and whether the score arose from the first, second or third testing cycle. Age is taken as the deviation for the sample mean age of 67.3months. A constant terms refers to mean scores at that age. Sex was included as a fixed-effect explanatory variable throughout the exploratory analysis and at no point did its effect differ significantly from zero.

Regression of score on age reduced the variance at school/group level by 42.2% and a score level by 63.2%. Clearly much of the difference between scores for a single child will be explicable in terms of improvement with age. The impact on between-group variance is largely because the Slovene groups had older children than the English schools.

Table 2 indicates the mean scores and age coefficients that arise from allowing for different regression formulae at different times in each country. Where these agree exactly it is because the estimation of separate parameters proved to be unhelpful. It is clear that in the second model, which partitions the data all coefficients of age are markedly less than the 0.75 in the overall regression. The phenomenon previously noted in the English data is still clear. Cohorts make faster progress with age than would be expected if cohort progress and the superiority of older children were simply manifestations of the same rate of progress. In the Slovenian data the picture is rather different. The superiority of the Slovenian regression lines is consistent with the higher mean age of the cohort. However in the second testing cycle the Slovenian

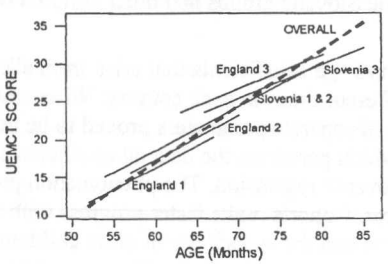
Table 2 Fixed for the overall model and for the model partitioning the data into countries and moments of testing.

	OVERALL MODEL	PARTITIONED MODEL					
		England			Slovenia		
Test		1	2	3	1	2	3
MEAN	22.5	20.5	21.6	25.4	22.7	22.7	24.2
AGE coefficient	0.74	0.58	0.58	0.45	0.58	0.58	0.45

regression line does not vary from the first. Taking just these two data sets it would be reasonable to deduce that the progress of the whole cohort is a manifestation of maturation or at least of the same process that gives an advantage to older children within the cohort. In the third testing cycle the younger Slovenian children make a jump similar to that seen in the English cohort. It is also notable that in the third testing cycle after a year at school the English regression line is superior to the final Slovenian regression line. This is consistent with other evidence that English children have an advantage in Mathematics by the time the Slovenians start school, although this advantage is soon lost (see Kavkler et al, 2000).

A final model allowed for variance structures to be different in the two countries. The variance attributable to variation between scores of an individual child is reduced by 15.0%. There is much more variance between children in Slovenia (39.5 compared with 24.33 in England). At school level the variance in England (7.98) is much greater than in Slovenia (2.40). This is strong evidence in support of the claim that Slovenian kindergarten classes are less varied and have a wider ability range. This sophisticated variance structure was highly significant ($\chi^2_6 = 94.2$, $p < .00005$).

Figure 1. Regression Lines: Overall and Partitioned



Stability of relative achievement levels.

As the original test constructors' interest had been in identifying early low-achieving sub-groups, these were a target for attention. Any definition of low achievement is arbitrary. This analysis looked collectively at all percentiles as possible cut off points between low and normal achievement. The analysis ignores the variance in scores due to the fact that some children have higher scores than others when the three testing cycles are combined. Analysis was carried out in terms of two variables constructed to show, for each percentile cut off point, what proportion of the variance is due to the fact that some children cross that percentile either moving upwards of

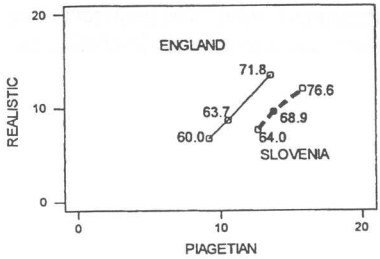
downwards between the first and third testing cycles (Progress) and what proportion is due to other changes (Disturbance).

Slovenia has particularly low levels of variance in Progress for percentiles around 20 to 25, but high levels of variance in Disturbance for percentiles between 15 and 30. In England exactly the reverse applies. In this country there is relatively more change between testing cycles one and three in which pupils count as low achievers than in which pupils count as high achievers. No particular interpretation is offered for this here.

Relative performance in Piagetian and Realistic questions.

The eight topics covered in the UEMCT are evenly divided between those derived from Piagetian theory (comparison, classification, correspondence and seriation) and those of more relevance to the overtly more arithmetical focus of the Realistical Mathematics Project (use of counting words, structured counting, resultative counting and general number knowledge).

FIGURE 2. Relative performance on Piagetian and Realistic Questions



Each topic includes 5 questions so the total marks for Piagetian questions and the total mark for Realistic questions are both 20. Figure three shows the mean total scores for each type of question in each testing cycle, annotated with the mean age of the cohorts at the time of each testing cycle. Age for age, English children appear to be more successful that Slovenian children in the arithmetical questions, but much less successful in the Piagetian questions. Even if the formal curriculum for the English 5 to 6 year old produces advanced development arithmetically, it is still necessary to explain the difference in Piagetian scores

Conclusion

The data examined here gives considerable support to the view that the different styles of education received by English and Slovenian children in the early years does produce different patterns in performance, as exemplified by scores in the UEMCT. The effect of cohort mean age as opposed to age is much more marked in England than Slovenia. Slovenian classes are wider in ability range and less segregated. Low achievers form a more stable group than high achievers in Slovenia, but the reverse is true in England. English children do better earlier on arithmetical questions, Slovenian children do better earlier on Piagetian questions.

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