Single or Combination Grades in Mathematics in the Early Years

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As part of the Early Numeracy Research Project, children's mathematical growth in 295 single grade and 275 combination classes in grades P – 2 was compared. Significant differences were found with negative effects for students in the upper grades of combination classes, though overall differences were not significant. Data also indicates that deliberate assignment of weaker students to the upper grade of a combination class as an exercise in homogeneity can have a negative effect on mathematical growth.

One decision many primary schools must make is how to organise their classes. This decision is often made taking a mixture of philosophy and expedience into account. In the early 1980's and 1990's multi-age groups were popular in the early years and were even mandated in some US states (Lodish, 1992). The rationale was one that aimed to optimize each child's opportunity to grow intellectually, socially and personally through interaction with both mixed and same age peers and involved approaches designed to meet individual needs rather than grade level needs (Surbeck, 1992). Sometimes though, the decision to have multigrade classes is to do with numbers and staffing and one "combination" class is created with more than one grade level, often with other grades remaining as a single grade level. At other times the decision is made for all classes at particular levels to be multigrade – for example grade 1and 2 multigrade classes or sometimes grades prep- 2 multigrade classes though the teachers involved may or may not embrace the philosophy of the planned multi-age classes. Mason and Burns (1997) refer to the multigrade classes created for expediency as combination classes to distinguish them from the multi-age or non-graded classes where there is a distinctive philosophy in both design and practice, and I will use this terminology in this paper.

A comparison of combination classes and single grade classes in a meta-analysis of 45 studies (Veenman, 1995) found no achievement differences and very small affective effects favouring combination classes. Further analysis on 51 studies, considering aspects such as country of origin as well showed no differences (Veenman, 1996). Nearly all studies of achievement differences included a component of mathematical achievement. Burns and Mason (1995) claimed a tendency to assign less problem children and more independent students, as well as more experienced teachers, to combination classes in schools where there are also single grades, at least in California where the study was based. This raises questions about the interpretation of research findings due to selection bias.

Teachers in combination grades tended to group the students according to grade and teach them as separate groups, while teachers in the single grades were more flexible in their approaches (Pratt & Treacey, 1986 in a study in WA at first and second grade level, and Mason & Good, 1997, in a study of mathematical instruction in the US with grades 1-6, reported in Mason & Burns, 1997). Teaching approaches within combination classes were to teach two separate curricula, especially in mathematics, but one group for most other curriculum areas.

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Analyses in most studies of combination versus single grade classes have shown either no significant difference in achievement in mathematics (as well as none in other areas), or slight effect sizes favouring the combination classes, but, as previously mentioned, selection bias was not considered in these studies. It is of interest though that the particular grade of the children has not also been a focus, particularly looking at the higher and lower grade levels in the combination classes.

Attitude studies have shown significant differences, with the higher grade level students showing the more negative attitudes towards the multiple groupings (Smith, 1993, grades 3-6). Few of the analyses of achievement differences between combination and single grade classes, though, seem to have considered the differences between the upper grade students and the lower grade students in the combination classes. Burns (1996, reported in Mason & Burns, 1997) found that the lower grade combination students, after controlling for ability and independence, scored significantly higher on standardised achievement tests (including mathematics) than the lower grade or single grade students (200 grades 3 through 6 classes). This is one of the few studies to consider this factor carefully.

Other research has focussed more on the setting or tracking of classes and has produced mixed findings with set or tracked classes sometimes being beneficial to the better students but usually detrimental to the weaker students (Gamoran & Berends, 1987). Even among the better students there were often detrimental effects (Boaler, Wiliam, & Brown, 2000). Teachers changed their practice when they believed their class was homogeneous and taught as if the students were identical, disadvantaging students at both ends of the spectrum. Sometimes with combination classes there has been a tendency to put the better children from the lower grade in with weaker children from the upper grade. This could lead to the teachers again thinking more of their class as being homogeneous. There have been very few studies that have specifically looked at mathematics during the first three years of school and considered the effect on children's mathematical learning of the schools' class assignment practices.

Method

As part of the Early Numeracy Research Project (ENRP) (Clarke, 2001) data was collected on the mathematical learning of over 10,000 students in grades Prep-2 over a three year period. The main student data base of the ENRP included information on the year level of the student and the teacher to whom the class had been assigned for mathematics as well as data on children's mathematical development in a number of different domains from the areas of Number, Measurement and Space. Within the project there were trial schools where there was full participation in all aspects of the project, and a set of reference schools where the project just collected data on student progress and classes.

Some of the classes were single grade classes but there were also many combination or multi-grade classes. The principal and coordinator in each school were asked what factors they considered when assigning students to classes and their assignment policy, particularly in reference to combination grades. To enable comparisons of student growth in different types of classes, a variable 'grade type' was added to the data base with the values single-grade, lower grade combination, middle grade combination and upper grade combination.

Since the scales for each child's mathematical development had previously been converted to interval scales (Horne & Rowley, 2001), ANOVAs were used for each of the

domains making a direct comparison between students in single and combination grades. This was followed by ANOVAs comparing the mathematical growth of students with different grade types both overall and in separate grade levels.

In a few classes children had been assigned to the upper grade level of a combination class because of previous lack of achievement. In one school, although they worked in P-2 classes for other subjects, for mathematics they effectively set the children with one teacher taking the preps and a few weak grade 1 students and the rest of the children being divided according to achievement. Where it was possible to identify such childrn, in any school, assigned due to lack of achievement, their growth in those classes was compared to the growth of children with a similar mathematical learning profile in other classes in the project schools.

Results

Within the trial schools, a variety of approaches was used for assigning students to classes. In most schools the classes were planned to be of mixed ability. There were some schools that had multigrade classes and others with single level classes. In some cases the multigrade classes were because of numbers, while in other schools the decision had been made to have all grade 1 and 2 classes as multigrade, or in two cases all grades as Prep-2 multigrade. While the original idea may have been multi-age classes or non-graded classes with a philosophical rationale, this evidence was not collected and the current practice tended to mean most of these classes could be regarded as combination classes. For this reason all will be considered as combination classes in this analysis. The main factors taken into account in the placing of children in class had been social interaction and behavioural factors. There were also a small number of schools who adjusted their classes for mathematics, so that the classes were closer to homogeneous, for example by placing "weaker" Grade 1 students with classes that consisted predominantly of Prep children. These children are discussed, following a consideration of combination and single grades. In both the 35 trial schools participating in the project and the 35 matched reference schools there were some classes which had a single year level (single) and some which had either two or three grade levels present in the one class (combination). There were 97, 104 and 94 single grade classes and 84, 96 and 95 combination classes in each of 1999, 2000 and 2001 respectively.

Table 1
ANOVA of Performance of Children According to Grade Type, 1999-2001.

	Number domains			All domains		
	df	*F*	*p*	*df*	*F*	*p*
1999	3, 5191	8.789	0.000	3, 3372	10.158	0.000
2000	3, 5315	24.169	0.000	3, 5279	31.502	0.000
2001	3, 5450	9.599	0.000	3, 4476	22.343	0.000

A comparison of the growth of children's mathematical understanding between single and combination grades shows no significant difference (using $p < 0.01$ because of the number of comparisons), either in the trial or reference schools or for any grade level. However when the *grade type* of particular children in the combination grade was

considered, differences emerged. When the position in the class was taken into account, there were significant differences in the growth in both the trial and reference schools. Table 1 shows the ANOVA results for the whole cohort using average growth across the number domains and average growth across all domains as the dependent variables, with grade type as the independent variable.

Table 2
Average Mean Growth According to Grade type (Single and Combination).

	Change number domains (growth points)*			Change all domains (growth points)*		
	1999	2000	2001	1999	2000	2001
single grade	0.86 ($n = 2623$)	0.96 ($n = 2794$)	0.97 ($n = 2861$)	0.83 ($n = 2129$)	0.80 ($n = 2772$)	0.84 ($n = 2817$)
lower grade combination	0.87 ($n = 1260$)	0.89 ($n = 1217$)	1.03 ($n = 1313$)	0.81 ($n = 1132$)	0.70 ($n = 1210$)	0.82 ($n = 1289$)
middle grade combination	0.81 ($n = 138$)	0.79 ($n = 145$)	0.93 ($n = 65$)	0.70 ($n = 108$)	0.66 ($n = 145$)	0.72 ($n = 65$)
upper grade combination	0.77 ($n = 1174$)	0.79 ($n = 1163$)	0.80 ($n = 1222$)	0.75 ($n = 1038$)	0.67 ($n = 1156$)	0.66 ($n = 1205$)

* the change figures here are expressed as an average growth within a domain in ENRP Growth Points

Whether growth in all domains together is considered, or just the number domains, the message is the same: There is a significant difference in performance. Table 2 provides a means of considering the direction and extent of these differences. It shows the mean growth for each of the years, 1999 to 2001, for the number domains and all domains, for the different positions within the grades.

Table 3
ANOVA Across Grade Levels Comparing Single Grades and Position in Combination Grades.

Grade		Change number domains			Change all domains		
		1999	2000	2001	1999	2000	2001
Prep	*F*	2.84	4.12	0.05	8.19	3.16	2.02
	df	1, 1801	1, 1811	1, 1813	1, 1150	1, 1799	1, 1388
	p	0.092	0.043	0.690	0.014	0.076	0.239
1	*F*	4.58	5.23	2.40	6.38	7.96	3.64
	df	3, 1761	3, 1753	3, 1837	3, 1129	3, 1743	3, 1387
	p	0.003	0.001	0.053	0.000	0.000	0.085
2	*F*	7.78	5.99	0.31	10.12	6.68	1.69
	df	2, 1624	2, 1746	2, 1795	2,1088	2, 1732	2, 1696
	p	0.000	0.003	0.504	0.002	0.001	0.465

From the analysis of variance, it is clear that the position of the year level within a combination class had a significant effect on growth of mathematical understanding. The table of means shows that it makes very little difference to the growth in understanding if the children are in a single grade or in the *lower* part of a combination grade but that the growth is significantly less if the children are in the *upper* part of a combination grade. Similar, but not quite as extensive differences are evident between single grades and the *middle* part of a combination grade.

Table 4
Mean Growth by Grade Level Comparing Grade Types

Grade		Change number domains (n)			Change all domains (n)		
		1999	2000	2001	1999	2000	2001
P	single grade	0.89	1.00	1.07	0.86	0.84	0.95
		(1454)	(1435)	(1425)	(1251)	(1424)	(1399)
	lower grade combination	0.84	0.93	1.08	0.78	0.80	0.90
		(349)	(378)	(393)	(297)	(377)	(387)
1	single grade	0.81	0.97	0.91	0.74	0.76	0.73
		(562)	(630)	(638)	(433)	(625)	(629)
	lower grade combination	0.91	0.88	1.02	0.83	0.66	0.80
		(854)	(784)	(853)	(792)	(779)	(836)
	middle grade combination	0.81	0.79	0.93	0.70	0.66	0.72
		(138)	(145)	(65)	(108)	(145)	(65)
	upper grade combination	0.79	0.86	0.82	0.72	0.71	0.64
		(211)	(198)	(287)	(166)	(198)	(278)
2	single grade	0.85	0.88	0.83	0.85	0.74	0.71
		(607)	(729)	(798)	(445)	(723)	(789)
	lower grade combination	0.59	0.85	0.78	0.57	0.71	0.75
		(57)	(55)	(67)	(43)	(54)	(66)
	upper grade combination	0.77	0.78	0.79	0.75	0.66	0.67
		(963)	(965)	(935)	(872)	(958)	(927)

Of course, such statistics simplify the situation and while they do indicate a cause for concern that is discussed below, they do not mean that being in the upper part of a combination grade always leads to lesser growth. Tables 3 and 4 show the ANOVA statistics and the mean growth respectively with the data split into grade levels. As expected, there is a very small difference in growth at the Prep level (though significant in 2000 for the number domains and in 1999 across all domains at the $p < 0.05$ level) since the comparison was between single grades and the lower part of combination grades. However in Grade 1 and 2 there was a significant difference in both of the first two years with any

disadvantage residing in being part of the upper grade level of a combination. In 2001 the difference in means was in the same direction but was not statistically significant.

The analysis assumed that no account of student understanding and performance is considered when assigning students to classes. However, there were a small number of classes where these were among the criteria in placing students in the combination class. This tended to happen particularly when a small number of high-attaining Grade 2 children were placed in a Grade 2/3 combination or when a small group of low-attaining Grade 1 or 2 students were placed with a lower grade level. In these latter cases, the teacher knew these children were considered to be weak, and the expectations of the teacher were more likely to be that these children would operate at a level commensurate with other children in the class. While these students could be identified, the sample size of only one or two classes is too small for any differences to be really considered statistically as the differences may be a teacher effect or class effect rather than the effect of the allocation. While little importance can be placed on the figures, a small group of students in Grade 2, who were taught with the Grade 1 students in 2000 because of their low achievement, were compared with other students in classes where achievement was not considered in class assignment. The comparison group was selected as all students with the same low profile of scores in the number domains at the start of the year.

Table 5
Mean Growth Comparing Low-Attaining Grade 2 Students Placed in a Lower Class to Others with the Same Profile.

	Mean growth (in growth points)	
	Students with same profiles	Students in combination class
Number domains	1.02 ($n = 311$)	0.58 ($n = 11$)
All domains	0.78 ($n = 306$)	0.43 ($n = 11$)

The data is shown in tables 5 and 6. The difference is significant ($p < .05$), but the number of students placed in classes because of their low achievement was small. This evidence indicates that such placements could be detrimental to children and should be avoided but it must be remembered that this is a small sample.

Table 6
ANOVA Comparing Grade 2 Students Placed in a Lower Class Because of Low Attainment to Others with the Same Profile.

	df	*F*	*p*
Number domains	2, 322	5.19	0.023
All domains	2, 317	5.84	0.016

A similar comparison of the 12 Grade 1 students who were placed in with Prep classes did not give the same result, but there was a difficulty in matching the profiles of the children. Within one school, they were clearly the lower-attaining students at the year level, but they had higher profiles than many other Grade 1 children in other schools, so the comparison sample was very large. The ANOVA showed no significance at the .05 level. The mean growth figures are shown in Table 7.

Table 7
Mean Growth Comparing Grade 1 Students Placed in a Lower Class Because of Low Ability to Others with the same Profile.

	Students with same profiles	Selected students
Number domains	0.94 ($n = 666$)	0.54 ($n = 12$)
All domains	0.73 ($n = 666$)	0.72 ($n = 12$)

It can be seen that these students improved less in the number domains but overall there was little difference, and the differences were not significant.

Discussion

These results differ from Veenman's (1996) meta-analysis but it should be noted that the early years were not a focus of the analysis and standardized achievement tests were used rather than the more strategies focussed interview assessment. While the implications of this data as presented are that combination classes are not as good for mathematical development of the students in the upper grade of a combination class as a single grade class, and have little or no advantage for those in the lower grade, there are other factors which need to be considered.

As mentioned earlier all of these grades were considered as combination classes but some may have had teachers who were committed to the idea of multi-age grades. If claims from multi-age advocates are true then the inclusion of possible multi-age philosophy classes as combination classes should have reduced the differences in favour of the combination classes. When classes were combination, although often in other subjects the students were taught as a group, there was a tendency for the teachers to separate the students by grade level or perceived ability level for mathematics. This was also indicated by Mason and Burns (1997). In many cases the multi-age philosophy does not appear to operate in the mathematics components of the program, though in this study there was no clear indication of whether the teachers were committed generally to a multi-age philosophy. This within class grouping is of interest and raises questions about homogeneity versus heterogeneity of within class groupings. Research on tracking and setting has shown possible detrimental effects and few positive gains (Boaler, Wiliam, & Brown, 2000; Gamoran & Berends, 1987; Linchevski & Kutscher, 1998). Homogeneous grouping within a class is a form of setting though with more flexibility possible.

While upper grade students overall showed lower growth, there were classrooms where this was not the case. For instance if grade 1 and 2 combination classes are considered there were some where the growth of grade 2 students was greater than that of grade 1 students while in other classes this situation was reversed. In 44 of the 86 combination classrooms in 2000, the growth of the students in the lower grade was greater than that of the upper grade students by at lest 0.1 growth point on average (in a few cases as high as 0.5 of a growth point). There were 14 classes, however, where this was reversed with differences greater than 0.1 growth points on average in favour of the upper grade level (and as high as 0.4).

The statistics indicate some aspects that need further consideration. Studies are needed of the characteristics of the teacher attitudes and beliefs, which enable strong growth across both grades of the combination class and of effective teaching approaches in combination

classes for both groups. We must find how to alter the current situation with combination classes tending to show weaker growth, particularly, when for reasons of expediency, combination classes will be with us for a while to come.

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