Behavior in large and small classes

Teachers' and Pupils' Behavior in Large and Small Classes:

A Systematic Observation Study of Pupils Aged 10/11 Years

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Abstract

This paper examines the effect of class size differences on teacher-pupil interactions, pupil engagement and pupil-pupil interaction. It extends previous research on younger pupils by using a more sophisticated form of data analysis that recognizes the hierarchical nature of observation data, and the confounding influence of other variables. The study used a time sampling method on a sample of 257 children in 16 small (25 or under) and 26 large (31 and over) year 6 classes (aged 10/11 years). In small classes there were more individualized task related contacts between teacher and pupils, and a more active role for pupils. These results confirmed those from earlier research on children aged 4/5 years. Against expectation, class size did not affect pupil on-task behavior or peer interaction. There was evidence of a moderating role for school subject, and a beneficial effect of teaching assistants.

Teachers' and Pupils' Behavior in Large and Small Classes:

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Research on teaching and pedagogy has shown a lack of interest in classroom contextual influences. There is an underlying assumption in many studies of a direct model, with teaching affecting pupils' achievements and learning in a causal way (Blatchford, Kutnick, Baines & Galton, 2004). Some academics and policy makers have also downplayed the importance of class size differences (Rivkin, Hanushek & Kain, 2000). But teachers do not meet pupils out of context, and class size, or the number of children in the classroom, can be seen as one contextual influence on classroom life, which plays a part in affecting the behavior of teachers and pupils. The conceptual roots of this view can be found in Bronfenbrenner (Bronfenbrenner, 1979) and the ecological psychology approach of Barker and Gump. The basic idea is that the classroom context has distinctive forces or 'signals', different to other contexts, which pull events and participants along with them (Kounin & Gump, 1974). Different aspects of the class environment, such as the number of pupils in a class, can exert distinct pressures on teachers and pupils. However, to date little is known about specific ways these pressures might work.

There has been much international debate about the educational consequences of class size differences. In the US, the debate has centred on the educational benefits and cost effectiveness of class size reduction initiatives, while in the UK the debate has been more about the negative effects of large classes. There is some agreement, drawing on experimental (e.g. Finn & Achilles, 1999) and naturalistic studies (Blatchford, Bassett, Goldstein & Martin, 2003), that smaller classes have

positive effects on pupil academic performance, if introduced immediately after school entry, that is, with the youngest children in school. However, it is now widely appreciated that attention needs to move to better understanding of the classroom processes that might be related to class size differences (Anderson, 2000; Finn & Achilles, 1999; Finn, Pannozzo & Achilles, 2003; Grissmer, 1999). Anderson (2000) has set out a comprehensive model of possible factors linking class size to student achievement, which includes greater knowledge of students, more instructional time, greater student engagement, and more 'in depth' treatment of content in smaller classes. Finn et al. (2003) conclude on the basis of their review that the research evidence supports two main conclusions: students in small classes in the elementary grades are more engaged in learning behaviors, and they display less disruptive behavior than do students in larger classes. They also conclude that effects on processes appear to fade out by later grades and that class size seems to affect student engagement more than teaching, though there is some evidence that teachers' interpersonal styles benefit from small class reductions. A large scale longitudinal study of class size and pupil adult ratio differences in English primary schools (the CSPAR project), using a multi-method approach, resulted in a data summary model of class size effects on classroom processes, with main areas being teaching and pupil behavior including pupil attentiveness and peer relations, and within class groupings (Blatchford, 2003a; Blatchford, Bassett, Goldstein & Martin, 2003). Finn et al. point to the need for studies that make use of strong data, such as that provided by systematic observations, in order to provide reliable evidence, and they identify the observational study by Blatchford (2003b) as one of the few studies of sufficient quality to be included in their review. This study, which was part of the CSPAR project just cited, found clear relationships between class size and teachers' interactions

with very young pupils in school, pupil classroom engagement and pupil-pupil interactions. It was, however, restricted to very young children in their first year of English primary schools (age 4/5 years).

In the UK, the policy context for an interest in class size differences has changed recently. In response to concerns about large classes the Government introduced a maximum of 30 to a class for children in the first three years of school (5 - 7 years). However, this has caused concern about class sizes over the rest of the primary school stage, that is, for pupils aged 7 – 11 years (called Key Stage 2), where no limits of any sort have been introduced. In 2004, official Government collected data showed that about a quarter of pupils in England were in classes with more than 31 pupils. There are concerns that class sizes of this magnitude will have a negative effect on teaching, pupil engagement in work, and pupil's relationships with each other. However, there have been no UK studies which have studied the effects of class size differences on teacher and pupil behavior at this stage. In this paper we seek to establish whether the effects of small class sizes found in the earlier study, in terms of increased individual attention, decreased levels of off task behavior, and increased rates of pupil-pupil interaction, are still evident at the end of the primary school stage (i.e., 11 years).

We also in this paper extend our earlier observation study, and the literature on class size effects on classroom processes, in two main ways. First, we examine the extent to which class size effects are affected by school subject, and, second, we examine in a systematic way the effect of extra adults in the classroom on teacher and pupil behavior. More details on these two are given below. The study also contributes by using a more sophisticated form of data analysis than the

previous study, in order to model the hierarchical, clustered nature of observation data, and the possibly confounding influence of other variables.

Three aspects of teacher and pupil behavior are considered in this study.

Teacher-Pupil Interactions

Class size can be positioned as one 'context' factor in Dunkin and Biddle's (1974) early seminal model of effects on teaching, but in general there has been little systematic research on how class size differences affect teaching behavior. On logical and common sense grounds it seems likely that the number of children in a class will increase the amount of time that teachers spend in procedural matters and, conversely, decrease the amount of time that can be spent on instruction and dealing with individual children. This expectation is consistent with teachers' views (Bennett, 1996; Pate-Bain, Achilles, Boy-Zaharias & McKenna, 1992, and some previous research (Glass, Cahen, Smith & Filby, 1982; Cooper, 1989). Achilles (1999) found in a systematic observation study of two schools matched on background factors, that teachers in small K- Grade-2 classes (about 14 students) engaged in more on task behavior over the year, while teachers in large classes (about 24 students) engaged in more off task over the year. However, Shapson, Wright, Eason and Fitzgerald (1980) found that results from systematic observations conflicted with teacher's own views; there were no statistically significant differences between class sizes for most teacher activities, and teachers did not alter the proportion of time spent interacting with the whole class, with groups or with individuals. There was, therefore, a gap between professional judgment and observational research findings. Several studies agree that the most important classroom process, affected by reduced pupil adult ratios and class size, is individualisation of teaching

(Molnar, Smith, Zahorik, Palmer, Halbach & Ehrle, 1999; Betts & Shkolnik, 1999). A recent multi-method study by NICHD Early Child Care Research Network (in press) summarises data collected by arguing that smaller first grade classrooms appear more child-centred than larger classes, and that larger classes become more structured. However, the curriculum for older pupils aged 10/11 years, at least in the UK, is itself much more structured, and the context for class size effects may therefore be different.

Results from the earlier CSPAR study of 4/5 year old pupils, showed that in small classes children were more likely to interact with their teachers, more one-to-one teaching took place, children were more often the focus of a teacher's attention, more teaching took place overall, and children more often attended to their teachers. These results showed that individual children in small classes received more interactions with their teachers of a task-related nature. The trend toward individualization in small classes did not seem indicative of a passive role for children; children in large classes spend less time actively interacting, either by responding or initiating contacts with the teacher. There was more interaction about classroom procedures (e.g., collecting materials, taking the register) in large classes. Overall, it was proposed that there was in smaller classes more likelihood of *teacher support for learning* (Blatchford, Moriarty, Edmonds & Martin, 2002). In the present study the aim was to establish if these effects of small classes on teacher-pupil interactions were still evident when pupils were 10/11 years of age.

It might be argued that one solution to the teacher's difficulties in contacting children in large classes would be to alter their approach so that there is more teaching to larger groups or to the whole class. There was no evidence from the CSPAR study that teaching to the whole class

increased in larger classes, but this result might have owed much to the perceived inappropriateness of whole class teaching with such young children. We expected teachers with larger Y6 classes to make more use of whole class teaching, while teachers with smaller classes would more use of individual settings and group teaching. We also wanted to see whether the more standardized curriculum and whole class teaching approaches, common with pupils aged 10-11 years, had affected the tendency for more individual attention and active interactions in smaller classes. Given the extra demands on teachers' time it was expected that there would be more waiting for the teacher in large classes, e.g., to answer a query, or provide materials.

Pupil Engagement and Off-Task Behavior

One main element of children's successful adjustment to school is likely to involve their attentiveness in class, e.g. as reflected in the extent of their attention to the teacher and to work. Many studies support the view that key aspects of educational success are engagement and active learning time, time on task or some equivalent term (e.g. Creemers, 1994). There is a good deal of evidence that these are major variables that affect pupils' achievement (Rowe, 1995).

Common sense and logic suggest that with more children in the class there will be more potential for distraction, and more possibility of being off task. Conversely in small classes there will be more opportunities to engage children and keep them on task. Finn and Achilles (1999) have argued for a connection between small classes and increased student engagement in learning. Cooper (1989) in his review found studies to support this view, but there are limitations in previous research because of the often informal designs and reliance on teacher reports (Finn et al., 2003). There are also limitations in the conceptualization of off task behavior, in that the

generic term may conflate separate forms of off task behavior, which may in turn be connected differently to class size differences. Off task behavior might take two main forms: an externalizing form in the sense of overtly disruptive behaviors and 'mucking about', or a more internalizing form in the sense of being disengaged and distracted from work. In the earlier CSPAR study, we found in the case of 4/5 year old pupils more off task behavior in larger classes, but especially more passive off task behavior - more disengagement - when working on their own. We predicted that there would continue to be for older pupils more off task behavior of both types in large classes, but because teachers are likely to sanction most obviously against more overt, externalizing forms, we predicted that the clearest effects of class size would again be on passive forms of off task behavior. We also predicted that there would be more child procedural behavior in large classes (e.g., in terms of talk about and collection of materials, taking the register).

Peer Relations In Class

There is a lot of evidence that children's early social behavior toward peers is an important predictor of later social and personal adjustment (Parker & Asher, 1987; Rubin, Bukowski & Parker, 1998). There is also a large literature on the value of collaborative or cooperative group work in classrooms (Galton, 1990), and naturalistic studies of children's interactions in classrooms, which include those with peers (Baines, Blatchford & Kutnick, 2003, Galton, Simon & Croll, 1980). However, as in the case of teacher pupil interactions and pupil on task behavior, there is little research on the effects of school contextual classroom factors like class size on peer relations.

It might be expected that in larger classes the increased pressure for space, and difficulties of

getting individual attention from the teacher, might increase the likelihood of interaction with peers, and there would be more negative and aggressive behaviors between children. This is supported by research on children at nursery level (Smith, McMillan, Kennedy & Ratcliffe, 1989; Smith & Connolly,1980) but other research with older pupils seems less clear. Shapson and others (1980) found no difference in conflicts between pupils.

Results from the CSPAR reception year study, showed that children in larger classes spent more time with each other, and this applied to all child-child categories, including interactions about work, about social matters, and also 'mucking about'. It was argued that pupils can compensate for reduced levels of interaction with teachers in large classes by interacting more with each other, and this might go some way to explaining why there was no support for the expectation that relations between children would be worse in large classes (Blatchford, Edmonds & Martin, 2003). Given the increasing importance of the peer group as children progress through middle childhood, it was predicted that the increase in peer interaction with larger classes would be more apparent in older children, aged 11 years.

As stated above, this paper extended previous research by also examining the effect of the presence of extra adults, and the role of school subject.

Presence of Adults in the Class

There is recognition that measures of class size and pupil adult ratios are different and need to be clearly identified in research (Finn & Achilles, 1999, Blatchford, Goldstein & Mortimore, 1998; Ehrenberg, Brewer, Gamoran & Willms, 2001). A class size of 15 may not be equivalent to a class size of 30 with two teachers or adults, because the social psychological processes at work can

be different; Finn et al. (2003) argue that there are distinct qualities of a small class that are lost when there are more children in a classroom, despite the presence of extra adults. There is also a problem that overall measures of the number of pupils, taken from the class register, and the number of adults may not necessarily adequately capture the number and type of adults in a class at any given moment. In England, at least, there can be a fair amount of movement in and out of classrooms by adults and pupils. For this reason, it is important to be able to record the presence of teachers and adults in the classroom on a moment-by-moment basis.

There has been a recent UK Government drive to increase the numbers of support staff in schools. The generic term used for paid support staff working in classrooms is 'teaching assistants' (or TAs), and there has been a large increase in their numbers. Studies that have assessed the effects of TAs on pupil academic outcomes have tended not to find positive effects (Blatchford, Russell, Bassett, Brown & Martin, 2004; Finn, Gerber, Farber & Achilles, 2000; Muijs & Reynolds, 2002). But one can conceive of the impact of TAs not just in terms of pupil learning and attainment, but also in relation to pupil and teacher behavior. Once again, there is only relatively anecdotal evidence, and in this study we wanted to measure in a systematic way whether the presence of TAs had an effect on interactions involving pupils and teachers in the same classrooms, and the extent of classroom engagement and attention to the teacher. We also wanted to see whether any influence of class size interacted with the presence of adults: for example, whether the presence of TA had a more marked effect in larger classes compared to small.

School Subject

There has been little research on the possible moderating effect of school subject on class size influences on classroom processes. Rice (1999), on the basis of a secondary analysis of teacher survey data, found that in math, as class size increased, less time was spent on small groups and individuals, innovative instructional practices, and whole group discussions, though increases in class sizes beyond 20 had little effect. There were no relationships between class size and instructional time allocation measures in science. In the earlier CSPAR study, with the youngest children in school, teaching methods and parts of the school day were not clearly delineated in terms of subject differences. However, by the end of the primary stage, when pupils are aged 10-11 years, there is a much clearer separation between subjects and a clearer apportioning of prescribed time, in terms of discrete 'lessons', to the three core subjects of maths, English and science. Different teaching approaches, appropriate for different subjects, have also developed by this time. Traditionally some subjects such as science and English have been taught using more discussion or practical based groups, while other subjects such as math have relied on individual work books or traditional teacher to whole class expositions. These differences in teaching approaches might be expected to be significant in any relationships between the number of pupils and teacher and pupil behavior. In England, national literacy and numeracy strategies have been introduced, with accompanying suggestions for teaching strategies and end of year assessment arrangements. This has raised concerns that other areas of the curriculum, such as history, geography and art might be affected. We wished to see whether there were any differences between school subjects in moderating any class size effects found.

Method of data collection: systematic classroom observation

One way to measure more reliably the extent to which class size differences are related to the type and nature of teacher pupil interactions and pupil work related behavior is through the use of systematic observation. This collects data in terms of categories previously defined on conceptual grounds and refined in pilot work. In contrast to other forms of data collection it builds up data on the basis of careful recording of on-going behavior (rather than, say, ratings or judgments). Criticisms of systematic observation have usually centered on validity issues (e.g. Delamont & Hamilton, 1986), but it can be a useful research tool when answering specific research questions where data are needed on relatively easily observed, high frequency behaviors (Croll, 1986; McIntyre & Macleod, 1986). This was the method used in the Shapson and others (1980) study which, though widely cited, is dated now.

There are difficulties but also potential advantages in the use of systematic observation, particularly with regard to its ability to capture the co-occurrence of behaviors at particular moments in time. The difficulties include the time consuming nature of data collection and processing which sometimes leads researchers to use total frequencies of behaviors as measures in analysis. This limits the ability to study relationships between variables and the ability to examine effects of class size on a given observation category, say teacher individual attention, controlling for the occurrence of another category, say the presence of a teaching assistant, or whether math or English is occurring, at the same moment in time. One advance of this paper over the earlier paper is that it measures the effect of other possible factors connected to, or which moderate, the effect of class size differences on classroom behavior.

There are also particular difficulties with observation data connected to the clustering of

behavior in time and within classrooms, and schools. The treatment of these difficulties requires a more sophisticated statistical analysis than has commonly been the case in research that has made use of systematic observation data. Multilevel statistical models are required, as the observations are not always independent of each other. More details are given in the methods section.

Method

The overall strategy in the CSPAR project was to employ a longitudinal research design, random selection of participating schools, and measurement of effects of naturally occurring differences in class size using measures carefully drawn up on the basis of previous research and pilot work. A naturalistic design is useful in addressing policy issues in that it is more 'authentic', and reflects adjustments and processes as they occur under normal circumstances. The CSPAR study had two aims, overall; it was set up to examine connections between: a) size of class and pupils' progress, and b) size of class and classroom processes, such as teacher and pupil behavior, within class grouping practices, teacher self perceptions, assessment and record keeping. The study followed a large cohort of pupils (see Blatchford, Bassett, Goldstein & Martin, 2003, for full details of the sample and summary of research findings from the main project).

In this paper we report on a sub-sample of children in small (25 or under) and large (31 and over) year 6 classes (and sets – see below). Year 6 was the last year of the study, when the pupils were all aged 10 years at the beginning of the school year in September. This definition of small and large classes is different to the STAR project (which was about 17 and 24), and also the earlier CSPAR study with 4/5 year olds (20 or below and 30 and over), but better reflects the

distribution of class sizes in England for this age group. There are in fact very few classes of pupils at this age in England with as few as 17 pupils of this age group, and they are not typical. The methods and procedures were similar to the systematic observation study carried out when the pupils were in the first, reception year (4/5 year), as described in Blatchford, Edmonds, Moriarty and Martin (2002) and Blatchford (2003a, 2003b). Classes were selected on a random basis from class size information supplied by the school. However, the class size actually used in analysis was the number of children actually present during the time of observation - what we call the 'experienced' class size. In some cases this varied from the registered class size and in a few cases quite significantly, e.g., because a number of pupils were absent or elsewhere in the school. The class size could also vary from time to time during the day, for example, as pupils left for an errand, and so a record was kept of the class size for each observation point. It was more difficult to find small than large classes. There were 42 classes in all, 16 small and 26 large, according to the school registers.

In some year 5 and 6 classes in England children are now allocated to what are called in the UK 'sets', i.e., classes formed of pupils of similar ability, usually for the teaching of the core subjects of math, English and sometimes science. 'Setting' can be contrasted with the teaching of these subjects in registration classes – quite commonly in such an arrangement pupils are grouped by ability but this is within the normal class. The situation is complicated because for a given class of pupils the degree of setting can vary. In some schools, reorganization into ability based classes can be for the three core subjects and can take up the majority of the school day, while in others it is only for one curriculum area, usually math, and will only be for an hour or

so. To have restricted observations just to non-setted classes would have reduced our sample, and would have biased it to small schools, where setting is likely to be less common. We therefore built setting into the research design by comparing large and small classes, some of which were set and some of which were not. The same class of pupils can experience setted and unsetted classes in the same day, and in a few cases children can experience classes and sets of different sizes – large and small – for example, when they move to a set much smaller than their normal class size or when a number of pupils are out of the classroom for a time. In all, there were observations on pupils in 21 small classes, 20 large classes, 17 small sets and 9 large sets.

Sample of pupils: Teachers were asked to select 9 pupils, three from each ability range - low, medium and high. Six of these 'target' children were then chosen by the researcher, two from each ability band, one girl and one boy. If a child was absent for more than a day they were replaced by a 'reserve' drawn from the nine. In some cases there were observations on more than six children (for example, the originally selected child and the reserve) and there were 257 children in all, 128 girls and 129 boys, 83 low ability, 87 medium ability and 87 high ability.

Organisation of observations: The basic principle was to observe when classroom-based activities could have taken place. Observations were not conducted during parts of the day when all the pupils went out of the classroom. The aim was to observe each child over two days. Time available for observation could vary somewhat from day to day. Observations were conducted in blocks of ten-second time intervals, with gaps of ten seconds between observations to allow recording of what took place in the previous ten seconds. After each block of 10 observations, attention switched to the next pupil on the list. There were 22,312 observations in total, with an

average of 87 observations per child.

Observation categories: The schedule was similar to that used in the earlier study of 4/5 year olds (Blatchford, 2003b) and comprised categories that provided a description of time spent in different work settings (individual, pupil group, teacher led group, whole class), different school subject areas (English, mathematics, science and 'other', e.g., history, geography, RE), and a description of how children behaved when in three social 'modes' - with their teachers, with other children and when not interacting. Within each of these three 'modes' were categories that covered work, procedural, social and off task activity. The categories referred to the 'target' child; teachers and other children were observed only when they came into contact with them. The schedule employed a form of predominant activity sampling with those behaviors selected within sets of behaviors (e.g., social modes) which occurred for the longest period within the ten-second interval. In order to examine the effect of class size, selected categories were chosen on conceptual grounds and on the basis of relatively high frequency of occurrence. Brief definitions of these categories are as follows:

School Subject

At the time of the observation the child was engaged in one of: mathematics, English, science or 'other' subjects (which would include geography, history, art, Religious Education, music, technology).

Work Context

Individual context: the child is working on his/her own; the work is not group based (though the child could be seated in a group) or teacher led. Group context: the child is in a group working

together, but not led by the teacher. Whole class context: teacher-led whole class settings where the target child is involved.

Teacher/pupil interaction

Teacher to child talk.

Adult Teach. Adult behavior directly concerned with the substantive content of subject knowledge, i.e. communicating concepts, facts or ideas by explaining, informing, demonstrating, questioning, suggesting. Adult on task: as Adult Teach plus contacts concerning the organization and preparation of children's task activities but not their substantive content.

Child 'Audience' vs.'Focus'. Child is focus: target child is the focus of the teacher's attention, and this could be in the context of one-to-one, group or whole class sessions, e.g., the target is asked a question about addition in the course of a session in which the teacher is addressing the whole class. These were coded separately as 'short', i.e., not for the whole ten second interval, and 'long', i.e., contact continued through the whole ten second period – for example, a question from the teacher was followed by an answer from the child and a further probe or comment from the teacher. This therefore gives some measure of extended or sustained interactions between child and teacher. Child is audience: another child is the focus of the teacher's attention in the group or class involving target child, or teacher interacts to same extent with all children.

Child to Teacher Interaction

Child to teacher - attend/listen. The child simply listens to the teacher during the interval and does not interact by responding or initiating.

Child on task to teacher. All child behaviors in contact with teacher that are concerned with work.

Child off task to teacher. Child behavior when in contact with the teacher obviously inappropriate or unrelated to situation (e.g. not attending).

Waiting for interaction with the teacher. The target waits for the teacher.

Pupil-Pupil Interactions

Target and child on task. All contacts with other children that are concerned with work and allocated tasks.

Target to child off task. Behavior with other children that is deliberately off-task; it would include mucking about and fooling around and times the target child is aggressive (verbally or physically) towards other child(ren). It would not include times when children spoke about non-work activities, if this was not deemed unacceptable by the teacher (this would have been coded 'social').

Individual Behavior/Not Interacting

Individual on task. Target child is involved in own work activity.

Individual off task (active). Target child focuses on something other than task in hand.

Individual off task (passive). Target child is disengaged during task activity, for example, daydreaming.

Computed Categories

Child on task. Total on task behaviors, i.e., behaviors related to the substantive nature of allocated work or preparation for the work across the three social modes, i.e. child to teacher on

task, target and child on task, and individual on task.

Child off task. Total off task behaviors, i.e., all off-task behaviors in the three social modes, i.e., child to teacher off task, target to child off task, and individual off task (active and passive).

Child procedure. Total child procedure behaviors, i.e., all target behaviors related to classroom management and organization of classroom routine, in the three social modes, i.e., child to adult procedure/routine, target to child procedure/routine, and individual procedure/routine.

Active interaction with teacher. The sum of the three child to teacher categories where the child's role was an active and not a passive (i.e., attends/listens) one, i.e., the child initiates, responds or sustains interactions with the teacher. Any target and child interaction: the sum of all the pupil-pupil categories, i.e., all task, social, procedure, and off task behaviors in contact with other children.

Other Information

At the time of each observation (i.e., each ten second time interval) a note was made of the number of children in the classroom; the term 'class size' therefore describes the number of pupils in the classroom at the time, whether in class or sets (what we have called the 'experienced' class size), rather than a notional number on the register. For each observation a note was also made of any extra adults in the classroom; 'extra adults' referred in almost all cases to paid teaching assistants (TAs). A note was also made of whether the observations took place when the class was setted or was the normal registration class and, further, whether the set comprised low, medium or high ability pupils. The gender and ability level of target pupils was also noted.

Observers. There were four observers. They were all experienced researchers who were

familiar with working in schools, and able to explain the research and put teachers and pupils at their ease. The basic aim was to avoid passing judgments, and to use the schedule as intended. All observers had initial training in which they were provided with an observation manual of categories, conventions and procedures, as well as tips acquired during previous use. Conventions were discussed and there was work on videotapes, accompanied by periodic checks of accuracy and understanding of how to use categories. This was followed by at least a day's observation in a class not involved in the study, and then a follow up training session to discuss field visits and iron out difficulties.

Reliability checks. Reliability coefficients for the main sets of mutually exclusive categories were high. Setting, subject, teacher-child 'social setting', 'child role', 'teacher content', child to teacher 'child contribution', 'child content' and' not interacting' all had reliability coefficients (kappa) greater than 0.80. Kappa for child-child content was 0.77.

Statistical methods and analysis. As described above, a feature of the analysis of the observation data was the way that it was conducted with the 10-second observation interval as the unit of analysis. This allows a greater accuracy and flexibility than simple, but more commonly used, total frequencies of behaviors for each pupil. The observation variables took the form of binary variables, in the sense of each either being performed, or not being performed, during one time interval.

A further feature of this observation study is that there is a hierarchical structure to the data, which is summarized in Figure 1.

INSERT FIGURE 1 ABOUT HERE

A consequence of the hierarchical structure is that it is likely that observations from pupils in the same class will be more similar than observations from pupils in different classes. Similarly, observations from the same pupil are more likely to be similar than observations from different pupils. Therefore, the observations cannot be regarded as independent of each, and so multilevel statistical methods (Goldstein, 1995) are required to allow for the non-independence of the data. Failure to allow for the structure of the data can lead to misleading parameter estimates, and also an exaggeration of the significance of the results (Paterson & Goldstein, 1991).

Four level multilevel models were used for the analysis, with the levels described in Figure 1. As all outcome variables were binary in nature, logistic regression models were used to examine the effects of the various explanatory variables upon the outcomes.

Let y_{ikjl} be the observed binary response (0, 1) of observation i from group of observations j, from pupil k in class l, and let the probability of a particular outcome being observed be denoted by π_{ijkl}, where $\pi_{ijkl} = [Pr(y_{ikjl})=1]$.

The basic form of the regression equation used in the analysis for a single explanatory variable x is given by:

$$\text{logit}(\pi_{ijkl}) = \beta_0 + \beta_1.x_{ijkl} + u_l^{(4)} + u_{kl}^{(3)} + u_{jkl}^{(2)}$$

where $u_l^{(4)}$ is the random effect at the class level, $u_{kl}^{(3)}$ the random effect at the pupil level, and $u_{jkl}^{(2)}$ is the random effect the observation group level. All random effects are assumed to be normally distributed as follows:

$$u_l^{(4)} \sim N(0, \Omega_l^{(4)}) , \quad u_{kl}^{(3)} \sim N(0, \Omega_{kl}^{(3)}) , \quad u_{jkl}^{(2)} \sim N(0, \Omega_{jkl}^{(2)})$$

The regression models were fitted using the MLwiN software package (Goldstein, Rasbash, Plewis, Draper, Browne, Yang, Woodhouse & Healy, 1998)

The exception to this basic form of the regression model was for the work contexts (individual, group, whole class). Within each group of observations, the pupils were always performing the same type of work. Therefore data for these variables were analyzed at the group level with one observation per group, and hence three-level multilevel models were used.

The initial set of analyses examined the differences between small and large classes without any adjustments for possible confounding factors.

Secondly, the effect of class size and several other explanatory factors thought likely to influence the observation outcomes were examined jointly. The aim was to estimate the effect of class size difference, controlling for the effects of the other explanatory factors. A summary of the other measures included in the analysis is given in Table 1. A backwards selection approach was performed to retain only the significant variables for each outcome, although class size was left in all models, as the effect of this variable was the main focus of the analysis. Possible interactions between class size and the other factors in Table 1 were also examined, to see if the effect of class size on the outcome varied for different levels of the other factors. Where significant interactions were found, the results are reported separately for each subgroup. Main effects for the presence of TAs are included in tables below, when they were statistically significant.

INSERT TABLE 1 ABOUT HERE

Results

The results of the statistical analyses examining the effects of the number of pupils in the class on each of the main observation categories are summarized in Table 2. The summary statistics reported are the effect sizes of the odds of each outcome occurring for a child in a large class relative to a child in a small class. No other possible explanatory variables, other than class size, are considered at this stage. An odds ratio above 1 suggests the outcome is more likely in a large class, whilst an odds ratio below 1 suggests that the outcome is more likely in a small class. Also given are 95% confidence intervals for each odds ratio, and a p-value indicating the significance of each result.

INSERT TABLE 2 ABOUT HERE

There were some clear differences between small and large classes. Two allied behaviors were more common in large classes: child to teacher listen/attend and child is audience. The first category denotes times when the child's contribution to interactions with the teacher is passive; they are simply listening to her. Child audience refers to times when they are not the focus of the teacher, i.e., they are not singled out by the teacher, either on a one to one basis or in a group or whole class situation. Both therefore describe a passive role in contact with the teacher and this is more likely in larger classes.

Conversely, in smaller classes pupils had a more active role in contact with the teacher. This was seen in the greater likelihood of active forms of behavior in contact with the teacher, i.e., initiating and responding to them and sustained contact with them.

There is also a greater likelihood in a small class of the child being the focus of a teacher's attention – and this is evident in terms of both short and long focus, as well as the two

added together.

It can also be seen that pupils experience more teaching in small classes, in the strict sense of contacts involving the substantive content of a subject (i.e., adult teach), in small classes, compared to large.

Interestingly, although teaching is more common in small classes, there was slight evidence that times when the teacher was addressing the whole class (which could cover all types of contact, including procedure/routine) were more likely in large classes.

Also of interest are the results that showed no differences between large and small classes. Against expectation there were no differences in the on task and off task categories, procedural behavior, and waiting for the teacher.

The results in Table 2 consider class size as the only explanatory variable in relation to observation variables. We now need to examine effects of class size while taking into account other possible explanatory factors. The effect of the presence of adults is also examined as a main effect because of the interest in this variable. Possible interactions between class size and the other factors in Table 1 were examined, to see if the effect of class size on the outcome varied for different levels of the other factor. Where significant interactions were found, the effects are reported separately for each subgroup.

Work Context

Results concerning effects of class size and adults on the three work context categories are shown in Table 3.

INSERT TABLE 3 ABOUT HERE

There was no sign that class size affected the amount of time pupils worked individually. The effect of the number of pupils on the other two work contexts varied by subject. Groups were more common for large numbers of pupils for science, but conversely less common with large numbers of pupils for other subjects. Whole class contexts were more common for other subjects when there were a large number of pupils compared to a small number, but there were no differences for the three remaining subjects.

The effect of the presence of TAs on each of the three work contexts varied by subject. There was more individual context for math with an adult present, but no difference for the other three subjects. There was more group context for English with an extra adult present, but less group context for other subjects with the presence of an adult. There was less whole class context with an adult present for math and English, but no difference for science or other subjects.

Teacher – Pupil Interactions

Results for adult teach and adult on task are presented in Table 4.

INSERT TABLE 4 ABOUT HERE

For both categories of teacher talk to pupils, the effect of the number of pupils varied by subject. There was less adult teach and adult on task in large compared to small classes in math. No differences were found for the three other subjects.

For adult teach, there was an effect of extra adults in the classroom. This varied by subject; the presence of a TA increased adult teach in science, but decreased it in English.

Child Audience and Focus

The connections between class size and child audience and child focus are shown in Table 5.

INSERT TABLE 5 ABOUT HERE

Child audience referred to times when the teacher addressed another pupil or all pupils together. A large number of pupils resulted in more child audience in math, science and other subjects, but there was no difference between numbers of pupils for English.

There was a significant effect of having a TA in the classroom, with the odds of child audience being halved when a TA was present.

The category focus was coded whenever the target pupil was the subject of a teacher's attention. There was more of this individual attention from teachers in small classes for math, science and other subjects, but no difference for English.

There was a noticeable effect of the presence of a TA in the classroom for total focus, with the odds being over 50% higher when a TA was present.

The results for focus short and focus long, when analyzed separately (not presented here) were less clear. They again pointed to less individualized attention with larger numbers of children, though this was affected by both subject and whether in classes or sets.

Child to Teacher Interactions

The results for child to teacher interactions are seen in Table 6.

INSERT TABLE 6 ABOUT HERE

A small class size and presence of a TA increased active interaction with the teacher (that is, the total of all initiations, responses and sustained interactions with the teacher).

The number of pupils did not influence waiting for interaction with the teacher (nor did the presence of a TA).

The effect of the number of pupils on child to teacher attend/listen was found to vary by set type. There was more attend/listen in large classes than small classes, but no significant results for either of the two types of sets.

Pupil to Pupil Interactions

Table 7 shows connections between class size and pupil-pupil on and off task behavior and all pupil-pupil activity.

INSERT TABLE 7 ABOUT HERE

Class size was not related to pupil-pupil on or off task behavior, but did play some role for the total of all pupil-pupil interactions. In a large class pupil-pupil interaction decreased in math and other subjects, but there was no difference between large and small classes for English and science.

The presence of a TA in the classroom influenced pupil-pupil on task behavior, with the effect found to vary by subject. There was more pupil-pupil on task behavior when there was a TA present in English, but no evidence of an effect for the remaining subjects. There was no effect of TA presence on pupil-pupil off task behavior. There was less total pupil-pupil interaction with a TA present for other subjects, but no evidence of an effect for math, English and science.

Not Interacting Behavior

Table 8 shows factors influencing individual on and off task behavior.

INSERT TABLE 8 ABOUT HERE

Table 8 shows that the number of pupils did not have an effect on individual on or off task measures.

There were signs that the presence of a TA increased the occurrences of individual on task, and decreased the occurrence of off-task behavior. No effect was found when active and passive off task behavior were examined separately, but this could be due to the reduced number of occurrences of each separate behavior type.

Total On and Off Task Behavior

Table 9 shows the results for pupil on and off task behavior summed across the three different social modes.

INSERT TABLE 9 ABOUT HERE

The results showed that there was no effect of the number of pupils on total child on task behavior.

The effect of TAs on on-task behavior varied by subject; there was more on task when there were extra adults for ‘other’ but no effect for the other three subjects.

There was less total off task behavior with extra adults present compared to when extra adults were not present. The effect of number of pupils on off task behavior was found to vary by subject, with more off task behavior for large numbers compared to small numbers for other subjects, but no evidence of a difference for the three remaining subjects.

We need to ask if there are any other factors that might be connected to whether a pupil is in a small or large class, which might have affected the observation results. The most obvious

possibility is that the allocation of pupils to classes is non-random, for example, that children with more difficulties at school are more likely to be found in small classes. In order to assess this possibility we compared small and large classes and found that pupils in small classes did indeed have lower attainment scores compared to pupils in large classes. In addition, small classes contained a greater proportion of pupils eligible for free school meals and with special needs. Analysis of relations with the observation variables, however, showed that these three variables, that is, pupil attainment, free school meals and special needs status, were not found to influence the observation outcomes. We can conclude, therefore, that results comparing small and large classes is not affected by any differences in pupil characteristics between class sizes.

Discussion

It is acknowledged that there are difficulties in drawing causal inferences from data in this study. The logic of the naturalistic design makes it impossible to be absolutely sure about causal direction. However, we have sought to control for possibly confounding and interacting variables, when examining associations between class size and classroom behavior, and the results of the analyses suggest that, even after allowing for the effects of other variables, there were significant effects of both the number of pupils in the classroom and the presence of extra adults or TAs in the classroom on some of the observation categories. With many observation categories, however, there was a tendency for main effects of class size to be moderated by the school subject within which observations took place.

Work Context

There were three work context categories – individual activity, groups or whole class.

There was no evidence that the amount of individual work was affected by class size. It was found that teachers in larger classes tended to use more groups, but for science only. Teachers do not therefore seem to organize the pupils in terms of more work in groups in response to having large classes in the two main subjects of math and English. It is not possible to give a precise explanation for this but there are two main possibilities: first, there is evidence that teachers' pedagogical approaches to these subjects do not recognize the value of group work (Blatchford, Kutnick, Baines & Galton, 2003); and second, it may also be that the curriculum in these two subjects is too constrained in terms of content and reliance on whole class teaching to allow for more work in groups. Moreover, science teaching in the UK has traditionally been more likely to involve work in groups, e.g., to conduct experiments and practical tasks, and teachers with large classes may be more likely to rely on this approach. This raises questions about whether teachers with large classes could make more use of groups in math and English. We return to this point below.

As expected, there was more whole class teaching in larger classes, but this was only for 'other' subjects, such as geography, history, music and arts activities. One explanation for why teachers with larger classes do not rely on more whole class teaching in the three main core subjects may be that constraints of the curriculum result in teaching methods that are less flexible and, therefore, less affected by the number of pupils. Teachers do, however, have more flexibility about the teaching and coverage of other non-core subjects in the curriculum and teaching may therefore be more likely to be adapted when faced with large numbers of pupils. There are already concerns that the stress on the three core subjects of math, English and science

is tending to squeeze time spent in other areas of the curriculum. It looks as though teachers in larger classes are also adapting their teaching in other subjects to use more whole class sessions. Other evidence from teachers themselves suggests that they do not always feel whole class teaching is the best way to teach these subjects (Blatchford, Russell, Bassett, Brown & Martin, in preparation).

Pupil is Individual vs. One of the Crowd

In these Y6 classrooms there was little individualized, or one-to-one, contact between teachers and pupils. Overall, there was a heavy reliance on whole class teaching and individual work. But the results were clear in showing an effect of class size on individual attention that did take place. In small classes there was more chance that pupils would be the focus of a teacher's attention. Conversely, in a large class there was more chance that a pupil would be in an 'audience' mode, that is, listening to the teacher address all pupils equally or another pupil. Small classes therefore seem to allow more individual attention, while in large classes children are more likely to be one of the crowd. This reinforces results from the earlier reception study (Blatchford, 2003b) and extends results to pupils at the end of the primary stage (10/11 years).

There were indications that this main effect on individual attention was modified in some ways by school subject. There was significantly more child as audience when there were a large number of pupils for math, science and other, but no difference between class sizes for English. In addition, there was significantly less adult focus when there was a large number of pupils in the same three subjects, but again there were no differences between sizes for English. This suggests that the general effects of class size on individualized attention, just cited, are found in

all subjects but English. The impression gained by observers in this study was that this is because English is the most discussion based subject; even in teacher to whole class sessions, the teacher tends to set up individual work by discussing and going through a topic with all in the class, and the dialogue is less likely to rely on questioning of individual pupils.

Active vs. Passive Interaction with the Teacher

For the most part, pupils, when in contact with their teachers, tend to be in the passive mode of listening to them. When considering active interaction that does take place, however, there was a greater likelihood of it in small classes. Pupils in small classes were more likely to initiate interactions, respond to the teacher, or sustain dialogue with the teacher into the next time interval. This result is consistent with results on much younger children. Conversely, in larger classes there is more listening and attending to the teacher. This behavior is in a sense on task behavior, but is a passive form of it. It seems that this trend is most obvious in classes rather than sets (i.e., when classes were reorganized by same ability). The number of pupils was not found to influence the occurrences of waiting for interaction with the teacher.

Amount of Teaching

Class size also affected the overall amount of teaching. There was more teacher to pupil talk in smaller classes that is directly concerned with the substantive content of subject knowledge, communicating concepts, facts or ideas etc., (‘adult teach’). This is line with Achilles’ (1999) results. However, for both types of teacher talk (‘adult teach’ and ‘adult on task’), the effect of the number of pupils varied by subject. There was significantly more teaching overall in small compared to large classes in math, but no differences for the other three subjects. It is not possible to test

exactly the reasons for this finding but observers' impressions were that teachers felt more able to extend their introductory explanations and demonstrations of procedures in small classes because they know that it will take less time to move around and monitor individual work. Such introductions are more typical of math compared to other subjects. In other words, teachers in large and small classes may balance differently whole class introductions and support for individual work.

Student Engagement in Class: On and Off Task Behavior

The results were clear in showing that there were no main effects of class size difference on any of the individual or total on or off task categories. Pupils in small and large classes spent the same amount of time on and off task. This was against expectation and contrary to results from the earlier CSPAR study of children aged 4/5 years. The only qualification to this overall trend was that there were signs of more total off task behavior in larger classes in 'other' subjects (not math, English or science). One explanation of this main finding may be that the prescribed curriculum in these three subjects means that there is little opportunity for work related behavior by pupils to vary according to the number of pupils.

Pupil-Pupil Interaction

The number of pupils in the classroom did not influence the occurrence of pupil-pupil on and off task behavior, but did affect the overall amount of pupil-pupil interaction. This effect was found to vary by subject, with evidence that in small classes there was more interaction between pupils in math, and other subjects, but there was no difference between numbers for English and science. What is clear is that against expectation there is no evidence that that there is more interaction between pupils in large classes. This is another result that differs from that found in the earlier

CSPAR study of 4/5 year olds. It is likely that this result, as with other results, owes much to the strong pressure on pupils to accord to particular curriculum and work demands, which leaves little time for interactions with peers.

Effect of Extra Adults

We have seen that the extra adult in these classrooms was almost always a paid teaching assistant (TA). One clear finding to emerge from the study was the beneficial effect of having a TA in the classroom. To date the evidence about the impact of support staff has tended to be in terms of the limited effects they have on student academic outcomes. The present observation study, however, found that their presence in classrooms had effects, not on interactions with pupils in which they were involved themselves, but rather on interactions between the teacher and pupils in the same classroom.

The effect of TAs in the classroom on teacher and pupil behavior was for the most part independent of a class size effect. The clearest results concerned the effect of a TA's presence on individual attention by the teacher. With a TA in the classroom, pupils were more likely to be the focus of a teacher's attention and less likely to be in an 'audience' mode. So it seems that both small classes, and the presence of a TA, increase the possibility of individualized attention for pupils, and these two factors are independent of each other. An allied effect of the presence of TAs was in terms of increasing occurrences of pupils' active interaction with the teacher.

The presence of a TA was also found to significantly increase the occurrence of individual on task behavior, and significantly decrease off-task behavior. No effect was found when active and passive off task behavior were examined separately, but this could be due to the

reduced number of occurrences of each separate behavior type. The presence of a TA also decreased the total amount of pupil off task behavior. These results indicate that a TA in the classroom can facilitate individual on task activity, and inhibit the overall amount of off task behavior. The evidence from this study, therefore, is that TAs can have an *indirect* effect on pupil learning, in the sense that their presence benefits interactions between the teacher and pupils.

It is not possible to exactly explain this effect. It might be that the presence of the TA encourages pupils to contribute more, or it could be that by taking over responsibility for some pupils, there are more opportunities for the rest of the class to be involved in interactions with the teacher. In this study it was not possible to collect detailed information on interactions between TAs and pupils, as the bulk of recorded interactions were between teachers and pupils. Further research, based on close attention to interactions between teachers, TAs and individual pupils is needed in order to better understand the classroom dynamics involved, and conceptualise more precisely the pedagogical contribution of TAs in relation to teachers.

General Models of Class Size in Relation to Classroom Processes

In general, therefore, the findings from the present study support the view that small classes lead to more individualized task related contacts between teacher and pupils - where pupils are less one of the crowd - and a more active role for pupils in interactions with their teachers. Interestingly, these findings are at variance with Finn et al.'s (2003) conclusion that class size affects student engagement more than teaching behavior. In the present study there was no effect of class size on student on or off task behavior, and this was also at variance with

the earlier English CSPAR study involving pupils aged 4/5 years. If the age of student is important in terms of reducing class size effects, as claimed by Finn et al., it seems that it affects student on task behavior more than teacher pupil interaction. The present study shows that effects of class size on teacher pupil interactions are still evident at 10/11 years and, putting these results together with the earlier study of pupils aged 4/5 years, suggests that this is a stable and robust finding across the primary stage (4-11 years).

This paper has reported findings from an observational study of pupil and teacher behavior, and as such cannot address the full coverage of effects contained in general models of class size effects put forward by Anderson (2000), Blatchford (2003a) and Finn et al. (2003). These models include dimensions such as greater knowledge of pupils and in depth treatment of the curriculum content that cannot be addressed through systematic observation. Connections between class size and other classroom processes have been found in other components of the overall research program, and are reported elsewhere (Blatchford, Bassett, Goldstein & Martin, 2003).

This paper is also limited in providing evidence based on the quantity of teaching behaviors. It was not designed to measure the quality of teaching in a systematic way, but there were a number of suggestions, from the questionnaires and case studies also carried out in the overall study, concerning ways in which class size could affect the quality and effectiveness of teaching. These were similar to qualitative results from the earlier CSPAR study (Blatchford, Moriarty, Edmonds & Martin, 2002). In smaller classes it can be easier for teachers to spot problems and give feedback, set individual targets for pupils, and be more flexible in the use of

different styles of teaching.

This study shows that two other factors would need to be added to general models of effects on classroom processes. The first is the presence of extra adults, as discussed above. Another, as we have seen, is the need to consider ways in which relationships between class size and teacher and pupil behavior can be moderated by the school subject. One direction for future research would be to identify more precisely ways in which class size is significant in relation to particular school subjects, and factors that might explain any differences found.

Class Size and Pedagogy

As well as considering the context provided by the curriculum, when interpreting effects of class size, the overall class size study suggests that one also needs to consider teachers' pedagogical beliefs. We have found from case studies in classrooms, and teacher responses to questionnaires about the effects of class size, that teachers in these English schools have a strong belief in the value of addressing the individual needs of pupils, but that this is at variance with curriculum and assessment demands, as we have argued above. This creates considerable tension for some teachers. Teachers' pedagogical views can also conflict with pressures arising from the classroom context, especially large numbers of children. There is an inevitable tension for teachers because of their belief that learning is best served by maximizing individual attention to pupils and by the tradition of supporting work to be done individually by pupils. This creates considerable professional concern and is exacerbated when they are allocated larger class sizes.

We suggest that one way of addressing this conflict is to do more in teacher training and professional development to consider more strategic linkages between the curriculum, pedagogy

and classroom contexts. More could be done to encourage better use of classroom contexts to help teachers make the most of class sizes of different sizes. In the case of large classes it would be important to develop strategies to maximize the opportunities for individual support. In the case of small classes, it is important to ensure that the opportunities afforded teachers are taken up. There is evidence that teachers do not always change their teaching approaches when faced with smaller classes (Evertson & Randolph, 1989).

But we also argue that an alternative solution would be to make more strategic use of a third context for learning, to offset the heavy reliance on teacher-led sessions and individual work – that is, more use of more group work in the sense of pupils learning together with a deliberate attempt to *minimize* the teacher's input. With appropriate training for teachers and pupils this can have benefits for pupil learning and can also help the teacher, especially those with large numbers of pupils, in terms of maximizing their time with other pupils, and encouraging independence in learning (Blatchford, Kutnick, Baines & Galton, 2003). It would also help teachers lucky enough to have small classes: as Betts and Shkolnik (1999) found, teachers could make better use of small classes if they did not reduce group instruction.

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Table 1

Explanatory Variables

Variable	Reference category	Explanation
Number of pupils	Small numbers (25 or less)	Effect of large numbers in class (i.e., 30 or more) relative to small numbers
Extra adults/TAs	No extra adult/TA	Effect of extra adults/TA relative to none
Sets	Classes	Effect of low ability or med/hi ability sets to classes
Ability	Medium ability	Effect of low or high ability pupils to medium ability
Sex	Girls	Effect of boys relative to girls
Subject	Math	Effect of each subject compare to Math

Table 2

The effect of number of pupils on pupil and teacher behavior

Outcome Observation variable	Large/small number of pupils Odds Ratio (95% CI)	P-value
Work context		
Individual context	0.85 (0.69, 1.05)	0.14
Group context	0.92 (0.62, 1.37)	0.68
Whole class context	1.21 (0.98, 1.48)	0.07
Teacher-pupil interaction		
Adult teach	0.63 (0.44, 0.83)	0.001
Adult on task	0.73 (0.50, 1.06)	0.10
Child audience vs. focus		
Child audience	1.92 (1.37, 2.68)	<0.001
Child focus (short & long)	0.46 (0.32, 0.65)	<0.001
Child focus (short)	0.57 (0.41, 0.79)	<0.001
Child focus (long)	0.49 (0.32, 0.75)	0.001
Child to teacher interaction		
Active interaction with teacher	0.69 (0.53,0.91)	0.009
Child to teacher attend/listen	1.35 (1.08, 1.70)	0.009

Table 2 (Continued)

Outcome Observation variable	Large/small number of pupils Odds Ratio (95% CI)	P-value
Waiting for teacher	0.94 (0.66, 1.33)	0.72
Target to teacher on task	0.96 (0.73, 1.25)	0.74
Target to teacher off task	1.00 (0.73, 1.35)	1.00
Pupil-pupil interaction		
Target to child on task	0.82 (0.60, 1.12)	0.21
Target to child off task (act. & pass.)	1.00 (0.68, 1.47)	1.00
All target to child activity	0.83 (0.67, 1.03)	0.10
Not interacting/individual behavior		
Individual on task	0.82 (0.60, 1.12)	0.21
Individual off task (active & passive)	1.21 (0.86, 1.71)	0.28
Individual off task (active)	0.92 (0.40, 2.16)	0.86
Individual off task (passive)	1.20 (0.85, 1.70)	0.30
Computed categories		
Total child on task	0.91 (0.73, 1.14)	0.42
Total child off task	1.11 (0.86, 1.43)	0.43
Total child procedure	1.20 (0.72, 2.01)	0.48

Table 3

Class size and individual, group and whole class work contexts

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Individual Context	Number of pupils	-	0.85 (0.69, 1.04)	0.11
	TAs/Extra adults	Math	1.62 (1.13, 2.33)	0.009
		English	1.10 (0.79, 1.54)	0.57
		Science	1.51 (0.73, 3.15)	0.27
		Other	1.08 (0.66, 1.76)	0.76
Group context	Number of pupils	Math	0.47 (0.19, 1.14)	0.10
		English	1.37 (0.78, 2.42)	0.27
		Science	15.9 (2.25, 112)	0.006
		Other	0.30 (0.13, 0.72)	0.007
	TAs/Extra adults	Math	0.89 (0.36, 2.00)	0.78
		English	2.10 (1.24, 3.85)	0.007
		Science	1.08 (0.26, 4.53)	0.92
		Other	0.17 (0.04, 0.73)	0.02

Table 3 *(Continued)*

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Whole class context	Number of pupils	Math	0.96 (0.67, 1.36)	0.72
		English	1.17 (0.86, 1.59)	0.31
		Science	0.83 (0.47, 1.45)	0.51
		Other	2.14 (1.39, 3.30)	<0.001
	TAs/Extra adults	Math	0.59 (0.41, 0.85)	0.005
		English	0.68 (0.48, 0.97)	0.03
		Science	1.48 (0.73, 3.01)	0.28
		Other	1.39 (0.85, 2.29)	0.19

Note: significance levels for main effects can vary from those in Table 2 because of the increased number of explanatory variables in the models.

Table 4

Class size and Teacher to child talk: amount of teaching

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Adult teach	Number of pupils	Math	0.34 (0.20, 0.57)	<0.001
		English	1.15 (0.75, 1.76)	0.53
		Science	0.58 (0.25, 1.37)	0.22
		Other	0.68 (0.40, 1.13)	0.13
	TAs/Extra adults	Math	0.78 (0.465, 1.31	0.35
		English	0.65 (0.42, 1.00)	0.05
		Science	8.72 (1.97, 38.7)	0.004
		Other	0.93 (0.53, 1.65)	0.81
Adult on task	Number of pupils	Math	0.47 (0.27, 0.83)	0.009
		English	1.43 (0.89, 2.29)	0.14
		Science	0.72 (0.35, 1.57)	0.41
		Other	1.19 (0.72, 1.97)	0.50

Table 5

Class size and child audience and focus

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Child audience	Number of pupils	Math	3.10 (1.94, 4.95)	<0.001
		English	1.13 (0.75, 1.70)	0.55
		Science	3.00 (1.53, 5.87)	0.001
		Other	2.62 (1.54, 4.47)	<0.001
	TAs/Extra adults	-	0.54 (0.41, 0.70)	<0.001
Child focus (short and long)	Number of pupils	Math	0.29 (0.16, 0.50)	<0.001
		English	0.89 (0.48, 1.63)	0.62
		Science	0.15 (0.07, 0.35)	<0.001
		Other	0.33 (0.18, 0.58)	<0.001
	TAs/Extra adults	-	1.68 (1.24, 2.27)	<0.001

Table 6

Class size and child to teacher interaction categories

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Active interact.	Number of pupils	-	0.68 (0.52, 0.90)	0.006
with teacher	TAs/extra adults	-	1.50 (1.15, 1.97)	0.003
Waiting for	Number of pupils	-	0.89 (0.63, 1.21)	0.51
int. with teacher				
Child to teacher	Number of pupils	Classes	1.53 (1.18, 1.98)	0.001
attend/listen		Low ability sets	0.25 (0.04, 1.42)	0.12
		Med/high sets	0.66 (0.32, 1.33)	0.24

Table 7

Class size and pupil-pupil interactions

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Target to child on task	Number of pupils	-	0.79 (0.58, 1.09)	0.15
	TAs/Extra adults	Math	1.04 (0.69, 1.57)	0.84
		English	1.89 (1.31, 2.75)	<0.001
		Science	0.81 (0.39, 1.69)	0.58
		Other	0.87 (0.53, 1.42)	0.57
Target to child off task	Number of pupils	-	1.01 (0.68, 1.48)	0.97
Total target to child interaction	Number of pupils	Math	0.67 (0.49, 0.92)	0.01
		English	1.10 (0.85, 1.44)	0.51
		Science	0.72 (0.47, 1.11)	0.13
		Other	0.72 (0.52, 1.00)	0.05
	TAs/Extra adults	Math	1.08 (0.82, 4.21)	0.60
		English	1.07 (0.83, 1.37)	0.60
		Science	1.06 (0.65, 1.75)	0.81

Table 7 *(Continued)*

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
		Other	0.58 (0.41,0.81)	0.002

Table 8

Class size and individual (not interacting) on and off task behavior

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Individual on task	Number of pupils	-	0.88 (0.65, 1.20)	0.42
	TAs/Extra adults	-	1.36 (0.99, 1.87)	0.06
Individual off task -	Number pupils	-	1.13 (0.80, 1.59)	0.50
active & passive	TAs/Extra adults	-	0.72 (0.50, 1.03)	0.07
Individual off task - active	Number of pupils	-	0.51 (0.22, 1.19)	0.12
Individual off task - passive	Number of pupils	-	1.18 (0.84, 1.66)	0.35

Table 9

Class size and total on and off task behavior

Outcome	Explanatory var.	Subgroup	OR (95% CI)	P-value
Total child on task	Number of pupils	-	0.93 (0.74, 1.16)	0.52
	TAs/Extra adults	Math	0.88 (0.66, 1.19)	0.41
		English	1.25 (0.95, 1.65)	0.11
		Science	0.87 (0.51, 1.50)	0.62
		Other	1.70 (1.81, 2.45)	0.005
Total child off task	Number of pupils	Math	0.77 (0.53, 1.11)	0.16
		English	1.16 (0.84, 1.60)	0.37
		Science	1.40 (0.83, 2.37)	0.20
		Other	1.69 (1.13, 2.51)	0.01
	TAs/Extra adults	-	0.79 (0.64, 0.98)	0.03

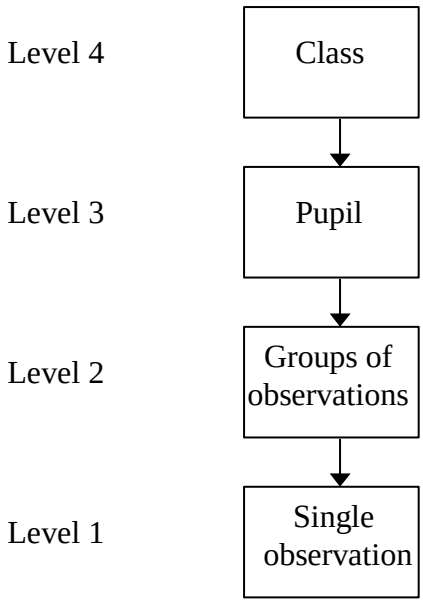

Figure 1. Structure of the data