Title page

Full Title
School lunch and learning behaviour in primary schools: an intervention study

Short running title
School lunch and learning behaviour

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Conflict of interest
The authors disclose no conflict of interest.
Abstract

Background/Objectives: In addition to the nutritional benefits of healthier school food, anecdotes describe improvements in children’s behaviour and educational outcomes when school food or the school dining room environment is improved. This study hypothesised that a school food and dining room intervention would improve pupils’ learning-related classroom behaviour.

Subjects/Methods: A controlled intervention trial involving six primary schools matched in triplets and randomly assigned to a 12 week intervention (promotion of healthier school food at lunchtime and changes in the school dining environment) or 12 week waitlisted control group. Study outcome was learning-related behaviours measured in a random sample of 146 pupils in years 3-5.

Results: On-task and off-task behaviours were observed and used as proxy measures for concentration and disengagement (disruption) respectively. Teacher-pupil on-task engagement was 3.4 times more likely in the intervention schools compared with the control schools (adjusted model OR=3.40 (95% CI: 1.56, 7.36), p=0.009). However, on-task pupil-pupil behaviour was less likely in the intervention group (adjusted model OR=0.45 (95% CI: 0.28, 0.70), p<0.001). Similarly, off-task pupil-pupil behaviour was more likely in the intervention group than in the control group in both the unadjusted model (OR=2.18 (95% CI: 1.52, 3.13), p<0.001) and the adjusted model (OR=2.28 (95% CI: 1.25, 4.17), p=0.007).

Conclusions: This study offers some support for the hypothesis that a school food and dining room intervention can have a positive impact on pupils’ alertness. However, if raised alertness is not channelled and supervised, it may result in increased off-task behaviour when pupils are working together.

Keywords
School lunch, behaviour, learning, primary school, UK, intervention study
## Introduction

Food provided by schools at lunch and other times of the day has the potential to support children’s nutrition, growth and development (School Meals Review Panel, 2005). The re-introduction of standards (School meals review panel 2005, Statutory Instrument 2000 No. 1777, Statutory Instrument 2006 No. 2381, Statutory Instrument 2007 No. 2359) and Government investment in school food in England aims to facilitate food consumption and nutrient intake in keeping with Government healthy eating guidelines.

Anecdotes from teachers and parents describe improvements in children’s concentration, behaviour, learning and academic performance when healthier school food is introduced. Additionally, best practice guidance promotes improvements in the school dining environment to support children’s behaviour, well being and learning (School Meals Review Panel, 2005).

These wider benefits of improved school food are not well supported by existing evidence. Studies exploring the benefits of school food generally lack clear and objective behavioural and educational endpoints; have been carried out in populations not generalisable to the wider school community; or have focused on the role of single foods, nutrient or meals in mediating educational improvements, but not addressed the way in which nutrition interventions themselves alter the environment in which children’s behaviour is being evaluated, nor the potential interactions between nutritional and environmental interventions (Ells et al, 2008).

Only two studies cited in the University of Teeside review (Ells et al, 2008) explored school lunches and educational outcomes (Dunifon & Kowaleski-Jones, 2002, Gietzen & Vermeersh 1980). Neither explored the impact of better eating at lunchtime on classroom learning behaviour. A recent study (Belot & James, 2009) comparing the impact of a campaign to improve school lunches in the London Borough of Greenwich against seven similar ‘control’ boroughs (i.e. no campaign) showed better average academic achievement scores at age 11 in English and Science and reduced authorised absenteeism. There were no direct measures of learning behaviour.

In the present study, it was hypothesised that providing and promoting healthier school food at lunch time and improving the school dining room environment (e.g. physical setting,
lunchtime routine or lunchtime behaviour management) would result in improvements in pupils’ learning-related behaviour in the classroom after lunch.

Methods

Study design

A 12-week controlled trial involving six primary schools in Sheffield, England, matched in triplets (see Figure 1) with school pairs randomly assigned to one of three treatment groups:

- **Nutrition first (NF):** introduction and promotion of healthier school food at lunchtime over six weeks followed by changes in the school dining environment
- **Environment first (EF):** changes in the school dining environment over six weeks followed by the introduction and promotion of healthier school food at lunchtime
- **Control:** wait-listed schools in which there was no intervention for 12 weeks. Control schools were then provided with intervention support.

The primary study outcome was the learning-related behaviour of a randomly selected group of pupils in the post-lunch period. This was assessed by trained observers in the classroom setting.

Treatment order (nutrition first versus environment first) was randomly allocated within the design to assess their independent effects. In practice, however, the two intervention components were undertaken simultaneously (not sequentially), so analysis of their independent effects was not possible. The results have therefore been analysed as a single (multi-component) intervention at the end of 12 weeks rather than by phase of intervention delivery.

The study was approved by the University of Sheffield Research and Ethics Committee.

Study schools

Sheffield primary schools within a 10 mile radius of the School Food Trust office willing to undertaking a dining room intervention in Spring term 2007 were invited to participate. Interested schools were screened (Figure 1), with six schools selected by researchers in order to achieve three pairs of schools best matched for; baseline food provision (i.e. toward the interim food-based standards, Statutory Instrument 2006 No. 2381) and the dining environment indicating room for improvement, type of catering provider, school roll, free
school meal eligibility, Healthy School status and school meal take up. The three pairs of schools were then randomly assigned to study group.

**Study intervention**
The intervention comprised both nutrition and dining room components which together facilitated improvements in the provision, promotion and consumption of school food and to the dining room environment. The intervention was designed to be representative of the dining room recommendations promoted in current guidelines (North Yorkshire Business and Education Partnership, 2004) and was based on a checklist designed to assess the quality of the dining room environment. To achieve a standardised intervention, a framework was used to enable schools to implement a tailored and flexible intervention underpinned by a consistent process, content themes and timeline. Food provision was assessed against Government standards and the take up of school meals was also recorded. Intervention components were categorised in five themes under two headings; ‘nutritional characteristics’ (food provision and food promotion) and ‘environmental characteristics’ (dining space, lunchtime management and good relations) (Figure 1).

**Pupil sample**
Schools nominated one year four class (in one school the nominated class was a combined year 3/4 class, with two study pupils in year three) and one year five class to be observed. Parents and pupils in the study classes were sent a study information sheet and asked to participate. Within each school, 24 pupils were randomly selected via random number generation (stratified for year level, gender, attainment level and whether they were registered as taking a school meal or packed lunch; and excluding those declining participation (2%) or children with acute or chronic illness based on school records). Packed lunch pupils were included because they were potentially influenced by the interventions.

**Data collection**

**School and pupil characteristics**
Demographic information was collected at baseline (attainment level, gender, birth date, ethnicity, English as an additional language, usual type of lunch eaten (i.e. school lunch or packed lunch), free school meal registration and special needs status). Attainments were derived by converting Qualifications and Curriculum Authority (QCA) Maths national
optional test score from 2005/2006 academic year into high, middle and low ability levels (upper 25%, middle 50, lower 25%) based on the national summary of results from QCA 2005 (http://www.qca.org.uk/qca_8792.aspx).

Food and dining room environment
A 91-item checklist was developed for the study by reviewing the literature to identify factors that shape the school lunch dining service. The checklist had four sections; an interview conducted with the head teacher and head caterer, a menu checker (for compliance with standards), a pre-service observation checklist and a during-service observation checklist. Nutritional characteristics covered; food provision (compliance with the food based standards for school lunch 2006 and 2008, cooking practices and variety), menu promotion (price, menu visibility/accessibility, dining room rules/contingencies, taster sessions, parent/pupil involvement, links with packed lunches and incentives). Environmental characteristics included aspects of the dining space (appearance, layout, blockage points), lunchtime management (management of space and pupil numbers, noise levels and behaviour management) and good relations (staff training, presence, involvement and value as well as pupil ownership of the lunch service). Questions relating to either school lunch provision or school dining room were summed for nutritional and environmental sub-scores. These were totalled for the final dining room checklist score. Responses were scored with a higher score indicative of a positive dining room environment.

Systematic classroom observation
Systematic observation (SO) (Blatchford et al, 2006) provided a direct measure of pupil learning-related behaviours in the classroom without reliance on pupil or teacher reported behaviour. SO builds up data by recording, in real time, the incidence of clearly defined low inference behaviours.

Observation categories
The observation schedule was modified from Blatchford et al, 2006. It comprised categories that provided a description of time spent in different work settings (Individual, Pupil-pupil interaction, Adult led group, Whole Class, Pupil Plenary, Other), teaching topic, and social modes (interacting with their teachers, interacting with other children, not interacting). Within each of these three social modes were mutually exclusive categories that covered engagement in work, procedural, social and off-task activity. Observation categories addressed learning
behaviours of interest to the research question, looking at pupil concentration (being ‘on-task’), disengagement/disruption (‘off-task’) and pupil mood.

Organisation of Observations
Observations of each ‘target’ child were collected over five minutes in ten 30-second blocks: 10 seconds for observers to ‘tune in’ to the target’s behaviour, 10 seconds to observe behaviour, and 10 seconds to record what took place during the observation period. After each block of ten observations, observer attention switched to the next pupil. Each observer collected observations on 12 selected ‘target’ pupils over approximately one hour in the same classroom on five consecutive days. The order in which pupils were observed differed each day.

Fieldworkers and training
Six observers were recruited from the National Centre for Social Research (NatCen), an independent UK social research institute. Over two days of training, observers focused on how to use the behavioural codes, the sampling framework and schedule. Observers practised coding (with periodic checks of accuracy and category understanding) using classroom video tape footage, followed by in-class observations. Weekly support sessions were held to discuss field visits. A retraining session was held prior to follow up visits. Observers were blinded to school study group allocation.

Fieldworker reliability checks
Initial training, inter-coder reliability coefficients for the main sets of mutually exclusive categories were good to high with Kappa coefficients ranging from 0.65 – 0.98. Reliability coefficients for the recalibration session were fair to good ranging from 0.48 – 0.87. For the ratings of observed mood, however, Kappa was low (0.23). Observed mood was not therefore included in the analytical model.

Data analysis
Data were entered in to a spreadsheet by two experienced personnel using pre-specified ranges. Five percent of cases were checked for errors and found to be within acceptable limits (less than 5% errors) and a range of validation and logical checking techniques were used to detect and remove any errors that remained. Data was imported into SPSS (SPSS Inc, Chicago, 2006) and MLWin (Goldstein, 1998) for analysis.
Multilevel statistical analysis of the systematic observation data, was undertaken appropriate for a cluster randomised trial, (Goldstein, 1995; Paterson & Goldstein, 1991). The 10-second observation interval was the unit of analysis with observation outcomes at each time point recorded as binary variables (present or absent). As a result, multilevel logistic regression was used for all analyses. Two-level models were used with individual observations nested within pupils. Observations in intervention (NF and EF combined) and control schools were compared at baseline and 12 weeks.

The model included terms for treatment group (Intervention vs. Control), visit (baseline vs. follow up), and a two-way interaction (treatment group by visit). The interaction term was of primary interest, showing whether differences in behaviours between visits varied significantly between intervention and control groups. An examination of a three-way interaction between visit, intervention and lunch type showed that results did not vary by lunch type (school lunch versus packed lunch on the day of observation), so analyses are reported only for the two way interaction effects. Two analytical models were assessed. Model 1 examined the effect of the intervention on behaviours, accounting only for differences between schools (unadjusted model). Model 2 included potentially confounding class and pupil characteristics in the analysis: class size, presence of additional adults in the classroom (yes/no), English as an additional language (EAL), free school meal eligibility (FSM), gender, special educational need (SEN) status, ethnicity (White British or ‘other’) and lunch type (school lunch or packed lunch) (adjusted model). These multi level logistic regression models were fitted using MLwiN software (Goldstein et al, 1998).

Statistics are reported as odds ratios (OR), confidence interval, and p value. An OR above 1.0 shows that the outcome is more likely in the intervention pupils than the control pupils; OR less than 1.0 shows that the outcome is less likely in the intervention pupils than the control pupils.

Results
Sample characteristics at school and pupil level are shown in Table 1. There were 96 year 3-5 pupils in the intervention schools (47 nutrition-first, 49 environment-first) and 50 year 4 and 5 pupils in the control schools; 72 girls and 74 boys; and 67 low attainment, 53 medium attainment and 9 high attainment pupils (data for the remaining 17 pupils were not available).
Gender and attainment levels were balanced across intervention and control schools. Other characteristics were similar between schools, except for FSM eligibility which was lower in the control schools (7.3%) than in the intervention schools (23.6% and 27%, NF and EF schools, respectively).

Class characteristics
Classes were of similar size (NF, 25.6; EF, 25.8; Control, 24.9), and of mixed ability. Two thirds of classes had a female teacher, 16% had another teacher, and 16% SEN teacher/support staff. The number of additional adults varied across the treatment conditions (means across all observations were: NF = 0.16, EF = 0.68, Control = 0.75), adjusted for in analytical Model 2.

Observations
A total of 17,306 observations were collected across the two time points and allowed for an analysis of reasonable power. At baseline, 5702, 10-second observations were collected in the intervention schools and 2941 in the control schools. At 12 weeks, 5811 and 2852 observations were collected, respectively. On average, 63.6 observations were collected for each ‘target’ pupil at each time point. Allowing for missing values, data for 132 pupils with observations at both baseline and week 12 have been included in Model 2.

Learning behaviours
On-task and off-task behaviours were observed and used as proxy measures for concentration and disengagement (disruption), respectively (Table 2). Total levels of on-task behaviour were high at around 80% in both intervention and control schools at baseline and post-intervention. Conversely, total levels of off-task were low, between 9.7% and 15.4%. The changes in on-task and off-task behaviours between baseline and 12 weeks, by intervention group and social-mode, are shown in Figures 2 and 3, respectively. The odds ratios for the three social modes (‘individual’, ‘pupil-pupil’ ‘teacher-pupil’) as well as for the total on-task and off-task behaviours observed are shown in Table 3.

In the unadjusted model (Model 1), there were no statistically significant time-treatment interactions for total on-task or off-task behaviours (Table 3). Thus, there was no statistically significant effect of the intervention on pupils’ behaviour that was consistent across all social-modes. There were, however, significant interactions between treatment and time for specific
social-modes in both the unadjusted model and the adjusted models. Consistent with the hypothesis, teacher-pupil on-task engagement in the hour after lunch was 3.4 times more likely in the intervention schools compared with the control schools in the adjusted model (OR=3.40 (95% CI: 1.56, 7.36), p=0.009), but not in the unadjusted model. Contrary to expectations, however, on-task pupil-pupil behaviour was less likely in the intervention group compared with the control group in both the unadjusted model (OR=0.72 (95% CI: 0.54, 0.95), p=0.02) and the adjusted model (OR=0.45 (95% CI: 0.28, 0.70), p<0.001). Similarly, off-task pupil-pupil behaviour was more likely in the intervention group than in the control group in both the unadjusted model (OR=2.18 (95% CI: 1.52, 3.13), p<0.001) and the adjusted model (OR=2.28 (95% CI: 1.25, 4.17), p=0.007).

Food and environment
A 2.2% increase in the percentage take-up of school meals was observed at the end of the study, although this change occurred in both control and intervention schools. Intervention schools met, on average, 18 of 19 Government food-based standards for school lunch at the start of the study which was maintained throughout along with improvements to food presentation, choice, quality and promotion. Control schools met on average 17 standards at the start of the study and 16.5 at the end. Environmental changes were implemented by schools according to their tailored intervention plan. Over the study intervention school’s implemented the following changes; newsletters to parents about school meals, behaviour management training for dining room supervisors, sticker schemes for pupils tasting new foods or eating fruit or vegetables, dining room displays and school assemblies on healthy eating, introduction of dining room rules, tasting sessions, promotion of menus at parents evening and via mail outs. Some schools also staggered lunchtime to reduce queuing, introduced music in to the dining room, changed the layout of chairs and tables, introduced ‘grab and go’ school lunches and involved pupils in the dining service. Planned changes to the dining room were reviewed during the intervention period and modified depending on their ongoing success. The precision of the instrument for assessing the dining room environment was valuable in deciding on which interventions were appropriate but was not adequate to show how the dining room environment changed over time when administered pre and post intervention. The impact of changes to the food and environment on children’s nutritional intakes are reported elsewhere.

Discussion
The key finding suggested by these results is that a school food and dining room intervention was followed by an increase in levels of alertness (concentration/engagement) among pupils in the hour after lunch, but that the expression of this raised alertness was different in the individual, pupil-pupil, and teacher-pupil social modes. Although the odds ratios were statistically significant only for the teacher-pupil on-task and the pupil-pupil on-task and off-task analyses, the general trends observed in Figures 2 and 3 are consistent with an overall pattern of raised alertness in the intervention schools.

A high proportion of the OR for the pupil-teacher on-task findings is likely to be explained by the decrease in on-task pupil-teacher behaviour observed in the control schools compared with the intervention schools. This is reflected in part in the wide confidence intervals for the OR.

The lower levels of concentration (and higher levels of disengagement) evident during the pupil-pupil social mode may be explained in a number of ways:

- *Poorly defined peer interactive activities.* Pupil-pupil interaction is the least easily controlled by an adult (Baines *et al.*, 2003, Bennett *et al.*, 1984, Galton *et al.*, 1999, Galton *et al.*, 1980) (teacher-pupil is the most controlled). If a reduction in levels of on-task behaviour was to be expected, it is in this context where it would most likely be observed.

- *Disruption due to the intervention implementation.* Interventions often take time to have a positive impact and may cause a disruption before a positive effect becomes evident (Blatchford *et al.*, 2005). Classroom observations were made directly following the final stages of the intervention implementation, and the results could therefore reflect pupils' immediate response rather than the final impact of change.

- *Changes in alertness.* Lower levels of on-task behaviour in the pupil-pupil social-mode may be attributable to greater levels of alertness post-intervention with a greater need to interact. Teachers may not have catered sufficiently to these changes (Baines *et al.*, 2003, Hastings & Schweiso, 1995).

This greater need to interact could also be expected in the individual (working alone) mode, but this was not observed here. Rather, differences between baseline and post intervention in the individual setting, although small and not statistically significant (and potentially lacking in power), are consistent with the suggestion that pupils in the intervention group are more
alert and more likely to be on-task and less likely to be off-task compared with the pupils in the control group.

The present study examined the impact of changes in lunchtime school food provision on education-related behavioural outcomes, and its strength is the direct measures of learning-related behaviours in the classroom setting rather than indirect evidence such as attendance, exclusions, etc.

The study has limitations. It focused on 146 randomly selected pupils in six primary schools in one city, with schools selected by researchers based on their willingness and capacity to implement the study intervention. There is no reason to suspect, however, that the schools or pupils are very different from other primary schools and pupils in England. The matching of schools between study groups, pupil selection stratified for a number of characteristics, relatively large number of observations (over 17,000), the careful training and monitoring of the fieldworkers, and the 12 week intervention all support the study’s generalisability to other motivated schools. While free school meal eligibility at the school level was matched, lack of pupil level data for sample selection stratified for free school meal eligibility resulted in higher eligibility in the intervention than control schools.

Any study of this kind is subject to the Hawthorne effect (short-term changes in behaviour resulting from an intervention \textit{per se} rather than specific intervention). A second control group with some form of intervention exposure, not related to school, and a longer-term follow up would be necessary to determine a sustainable impact. The Greenwich study (Belot & James, 2009) found changes persisting after one year, supporting the interpretation of a real effect. While attempts were made to measure the impact the food and dining room intervention, this was limited due to a lack of relevant and valid assessment tools. Although the dining room check list tool was useful to assess the initial quality of the dining room environment and inform intervention development, the tool was not sensitive to be able to show any differences in environment at follow up, despite numerous changes in each school. This tool could be refined to more effectively monitor change.

Some observers may have held an understanding of the behavioural categories not consistent with training. Data were, therefore, compared to observations collected on pupils in Years 4-6 as part of the SPRinG and class size projects (Blatchford \textit{et al.}, 2005, Baines \textit{et al.}, 2008).
Comparisons can only be considered indicative since the present study included a limited numbers of classes observed by a small number of observers. Differences were seen in relation to setting: teacher-pupil and pupil-pupil interactions. The SPRinG/Class size data on the pupil-pupil variables showed higher levels of on-task (74% on-task in present data set compared with 56%) and lower levels of off-task. Observations in the present study were collected by a single set of observers who each worked in at least three schools (including at least one intervention and one control school), therefore, it could reasonably be assumed that any biases in observation were balanced across all schools.

Finally, because of the relatively short timescale and the inability to separate the nutrition and environment phases, it was not possible to resolve whether a nutrition-only or a nutrition-first intervention would differ from an environment-only or an environment-first intervention.

On balance, the present study offers some support for the hypothesis that a dining room intervention that changes both food provision and environment can have a positive impact on pupils’ alertness, particularly during interactions between teacher and pupil which represent the majority of classroom experiences in primary schools. The findings also suggest that if that raised alertness is not appropriately channelled and adequately supervised, it may result in increased off-task behaviour when pupils are working together.

**Acknowledgements**
The authors would like to thank the staff and pupils of the Sheffield primary schools who participated in the study and all the organisations and individuals who contributed to its design and implementation: the Sheffield Healthy Schools Team, Sheffield PCT, Chartwells, Chaucer Catering, Sheffield Children and Young People’s Directorate, Sheffield local authority and the National Centre for Social Research (NatCen). In addition, the authors would like to thank Claire Storey and Pauline Ashfield-Watt, both of the School Food Trust, for their help in revising the manuscript.
References


• North Yorkshire Business & Education Partnership, Business & Education South Yorkshire. 2004). The Dining Room Environment Project. Food in Schools Programme (DfES, DH).


Table Legends

Table 1.
1 Special education needs
2 Free school meals
*based on 151 pupils
** from information reported by school

Table 2.
* There is the possibility of the co-occurrence of Teacher-Pupil and Pupil-Pupil contexts (i.e. these 2 contexts are not mutually exclusive). This situation is on the whole a relatively rare occurrence but may happen, for example, when a teacher is leading a reading group, when the teacher is talking to the class while a student is simultaneously talking to another student and so on. The total number of off task and not-off task in the two sections of the table are not the same because ‘not on task’ includes various ‘off task’ variables PLUS other variables (in this study procedure, social and other).

Table 3. Occurrence of On-task and Off-task behaviour overall and for each social mode separately for the Nutrition first and Environment first intervention groups combined relative to the Control group.
* Unadjusted: differences between intervention and control groups
** Adjusted: differences between intervention and control groups, adjusted for class size (number of pupils), presence of additional adults in the classroom (yes/no), EAL, FSM, Gender, SEN status, Ethnicity (White British or other ethnic group) and Lunch type (school lunch or packed lunch).

Figure 1 Study flow of school recruitment, intervention content and data collection timing

Figure 2 Percentage of on-task behaviour at baseline and 12 weeks, by intervention group and setting.

Figure 3 Percentage of off-task behaviour at baseline and 12 weeks, by intervention group and setting.
Table 1. School and pupil characteristics, by intervention group

<table>
<thead>
<tr>
<th></th>
<th>School roll (January 2007)</th>
<th>White British</th>
<th>English as first language</th>
<th>SEN(^1) plan</th>
<th>School meal take up</th>
<th>Pupils eligible for FSM(^2)</th>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>mean</td>
<td>Sd</td>
<td>%</td>
<td>%</td>
<td>%</td>
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<td></td>
</tr>
<tr>
<td>Nutrition-first</td>
<td>2</td>
<td>402</td>
<td>60</td>
<td>16.0**</td>
<td>98.0</td>
<td>29.7</td>
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<tr>
<td>Environment-first</td>
<td>2</td>
<td>471</td>
<td>264</td>
<td>6.3**</td>
<td>98.6</td>
<td>31.4</td>
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<tr>
<td>Control</td>
<td>2</td>
<td>433</td>
<td>66</td>
<td>3.3**</td>
<td>98.5</td>
<td>29.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6</td>
<td>435</td>
<td>128</td>
<td>8.5**</td>
<td>98.4</td>
<td>30.2</td>
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<tr>
<td>Nutrition-first</td>
<td>47</td>
<td>-</td>
<td>-</td>
<td>93.5</td>
<td>95.7</td>
<td>29.8*</td>
</tr>
<tr>
<td>Environment-first</td>
<td>49</td>
<td>-</td>
<td>-</td>
<td>86.3</td>
<td>98.0</td>
<td>28.3*</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>91.8</td>
<td>98.0</td>
<td>27.5*</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>-</td>
<td>-</td>
<td>90.4</td>
<td>97.3</td>
<td>28.5*</td>
</tr>
</tbody>
</table>
**Table 2.** Number of observations* and percentage of time spent in specified activities, by intervention group, at baseline and post-intervention (week 12).

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post-intervention</th>
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<tr>
<td></td>
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<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Intervention</td>
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<td></td>
<td>n  %</td>
<td>n  %</td>
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<td></td>
<td>n  %</td>
<td>n  %</td>
</tr>
<tr>
<td>On-task behaviour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual On-task</td>
<td>840  79.1</td>
<td>1187  80.3</td>
</tr>
<tr>
<td>Not on-task</td>
<td>222  20.9</td>
<td>291  19.7</td>
</tr>
<tr>
<td>Pupil-pupil On-task</td>
<td>955  79.0</td>
<td>1122  72.3</td>
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<tr>
<td>Not on-task</td>
<td>254  21.0</td>
<td>430  27.7</td>
</tr>
<tr>
<td>Teacher- pupil On-task</td>
<td>577  86.1</td>
<td>2241  83.9</td>
</tr>
<tr>
<td>Not on-task</td>
<td>93   13.9</td>
<td>431  16.1</td>
</tr>
<tr>
<td>Total On-task</td>
<td>2372 80.7</td>
<td>4550 79.8</td>
</tr>
<tr>
<td>Not on-task</td>
<td>569  19.3</td>
<td>1152 20.2</td>
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<tr>
<td>Off-task behaviour</td>
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<td></td>
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<tr>
<td>Individual Off-task</td>
<td>140  13.2</td>
<td>209  14.1</td>
</tr>
<tr>
<td>Not off-task</td>
<td>922  86.8</td>
<td>1269 85.9</td>
</tr>
<tr>
<td>Pupil-pupil Off-task</td>
<td>113  9.3</td>
<td>239  15.4</td>
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<tr>
<td>Not off-task</td>
<td>1096 90.7</td>
<td>1313 84.6</td>
</tr>
<tr>
<td>Teacher- pupil Off-task</td>
<td>32   4.8</td>
<td>211  7.9</td>
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<tr>
<td>Not off-task</td>
<td>638  95.2</td>
<td>2461 92.1</td>
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<tr>
<td>Total Off-task</td>
<td>285  9.7</td>
<td>659 11.6</td>
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<tr>
<td>Not off-task</td>
<td>2656 90.3</td>
<td>5043 88.4</td>
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</tbody>
</table>

*Note: *Observations are the number of times each activity was observed.
**Table 3.** Occurrence of On-task and Off-task behaviour overall and for each social mode separately for the Nutrition first and Environment first intervention groups combined relative to the Control group.

<table>
<thead>
<tr>
<th>Total on-task</th>
<th>Total off-task</th>
<th>Individual On-task</th>
<th>Individual Off-task</th>
<th>Pupil-Pupil On-task</th>
<th>Pupil-Pupil Off-task</th>
<th>Teacher-Pupil On-task</th>
<th>Teacher-Pupil Off-task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-task behaviour (Concentration)</strong></td>
<td><strong>Off-task behaviour (Disengagement)</strong></td>
<td><strong>Model 1 – Unadjusted</strong></td>
<td><strong>Model 2 – Adjusted</strong></td>
<td><strong>95% CI</strong></td>
<td><strong>Odds Ratio</strong></td>
<td><strong>Model 1 – Unadjusted</strong></td>
<td><strong>Model 2 – Adjusted</strong></td>
</tr>
<tr>
<td>Model 1 – Unadjusted</td>
<td>1.14</td>
<td>0.96, 1.39</td>
<td>0.15</td>
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<td>0.87, 1.49</td>
<td>0.86</td>
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<tr>
<td><strong>Individual On-task</strong></td>
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<tr>
<td>Model 1 – Unadjusted</td>
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<td>0.94, 1.74</td>
<td>0.14</td>
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<td>1.34</td>
<td>0.74, 1.83</td>
<td>0.27</td>
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<tr>
<td><strong>Pupil-Pupil On-task</strong></td>
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<td>&lt;0.001</td>
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<td>Model 1 – Unadjusted</td>
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<td>Model 2 – Adjusted</td>
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<td>1.56, 7.36</td>
<td>0.009</td>
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<td><strong>Total off-task</strong></td>
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<td>0.74, 1.19</td>
<td>0.31</td>
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<td><strong>Individual Off-task</strong></td>
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<td>0.84</td>
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<tr>
<td>Model 2 – Adjusted</td>
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<td>0.37, 1.35</td>
<td>0.29</td>
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<td><strong>Pupil-Pupil Off-task</strong></td>
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<tr>
<td>Model 1 – Unadjusted</td>
<td>2.18</td>
<td>1.52, 3.13</td>
<td>&lt;0.001</td>
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<td>0.35, 3.45</td>
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</tbody>
</table>
Figure 1

100 Sheffield primary schools contacted

18 schools screened for study inclusion

Capacity for school food and dining room improvement:
1) food on offer at lunchtime assessed against School Food Trust menu checker
2) school food promotion to pupils assessed using the study dining environment checklist
3) need for dining room or lunchtime management improvement assessed using the dining environment checklist
4) able to commit to the study protocol and timelines.

Ability to match study school characteristics:
Type of catering provision
Number of pupils on the school roll
Percentage of pupils entitled to free school meals
Healthy School status
Participation in the Social and Emotional Aspects of Learning (SEAL) program
School lunch take up (the percentage of pupils having meals provided by the school caterer)

6 schools selected for study participation

Baseline data collection 22 January to 9 February 2007 (prior to intervention delivery).
Baseline observations: school pupil characteristics and systematic classroom observations

Intervention period January to May 2007

**Nutrition intervention**
- food provision: menu changes to meet the interim food-based standards, packed lunch style
- school meal, healthy cooking practices
- food promotion: displaying menu for pupils, ensuring vegetables offered on pupils plate, rewards or incentives such as praise or stickers for healthy eating.

**Dining environment intervention**
- dining space: table and chair arrangement, decorating, noise reduction
- lunchtime management: dining room rules, lunchtime duration, queuing
- good relations: school meal and packed lunch pupils able to eat together, staff behaviour
- management training, school ownership and pride in school dining room

**Wait listed control**

Post intervention systematic classroom observations 8-25 May 2007
Figure 3.

The graph shows the percentage changes over time for different groups: Control Individual, Control Pupil-pupil, Control Teacher-pupil, Intervention Individual, Intervention Pupil-pupil, and Intervention Teacher-pupil. The x-axis represents Baseline and Visit 3, while the y-axis represents percentage. The data indicates an increasing trend in percentage for all groups from Baseline to Visit 3.