

Student and school-level belonging and commitment and student smoking, drinking and misbehaviour

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Abstract

Objectives: It has been suggested that students are healthier in schools where more students are committed to school. Previous research has examined this only using a proxy measure of value-added education (a measure of whether school-level attendance and attainment are higher than predicted by students' social profile), finding associations with smoking tobacco, use of alcohol and illicit drugs, and violence. These findings do not provide direct insights into the associations between school-level aggregate student commitment and health behaviours, and may simply reflect the proxy measure being residually confounded by unmeasured student characteristics. We examined the previously used proxy measure of value-added education, as well as direct measures at the level of the school and the student of lack of student commitment to school to see if these were associated with students' self-reported smoking tobacco, alcohol use and school misbehaviour.

Design

Cross-sectional survey.

Setting

Forty schools in south-east England.

Methods

Multi-level analyses.

Results: There were associations between school- and student-level measures of lack of commitment to school and tobacco smoking, alcohol use and school misbehaviour outcomes, but the proxy measure of school-level commitment, value-added education, was not associated with these outcomes. A sensitivity analysis focused only on violent aspects of school misbehaviour found an identical pattern of associations to that found for the measure of misbehaviour.

Conclusion: Our study provides the first direct evidence in support of the Theory of Human Functioning and School Organisation.

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Keywords: Adolescents, schools, smoking, alcohol, misbehaviour, young people

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Introduction

As well as being sites for health promotion interventions, schools and education operate as social determinants of health (Viner et al., 2012). It is well established from previous studies that at the individual level, lack of commitment to school or education is associated with risk behaviours and poorer health (Fletcher et al., 2008; Resnick et al., 1997). However, individual-level analyses cannot determine whether such associations reflect deficits in schools' ability to engage students or students' prior dispositions. To address this, more recent research has examined school-level health effects (Bonell et al., 2013b; West et al., 2004; Fletcher et al., 2008). These studies examine whether school-level factors affect student health behaviours independently of individual characteristics.

Much of this research has focused on Markham and Aveyard's Theory of Human Functioning and School Organisation, (Markham and Aveyard, 2003) which, according to a recent systematic review of theories, provides the most comprehensive account of how schools might shape student health behaviours (Bonell et al., 2013a). The theory suggests that schools may enable students to develop the critical reasoning and positive sense of affiliation necessary to avoid health risk behaviours (Markham, 2015) if they ensure students are committed to school, in terms of engagement with learning and sense of belonging to a pastoral community (Markham and Aveyard, 2003). The theory predicts that such effects will be greatest for risk behaviours that are associated with deviance from conventional social norms promoted by schools.

A systematic review of multi-level studies of the effects of school-level factors on student health outcomes (Bonell et al., 2013b) found consistent evidence from cross-sectional (Aveyard et al., 2004; Bisset et al., 2007) and longitudinal studies (Markham et al., 2008; Tobler et al., 2011) of US middle schools and UK secondary schools that students attending schools with high 'value added education' (VAE) have lower rates of smoking, drinking and drug use. One of these studies also reports an association between this measure of VAE and reduced violence (Tobler et al., 2011). In these studies, VAE is intended as a school-level measure indicating the extent to which student academic attainment and attendance are better than would be predicted according to their socio-demographic profile, intended to function as a proxy for the extent to which schools ensure students are committed to learning and the school community.

Selection bias arising from more health-oriented families sending their children to better schools is unlikely because parents of students in these studies could access data on gross but not value-added attainment and attendance, there being no correlation between gross and value-added attainment. Reverse causality is unlikely even in the cross-sectional studies because assessment of VAE drew on data on recent not current students. However, a key weakness is that these studies provide only indirect evidence on the Theory of Human Functioning and School Organisation, relying on a proxy measure of commitment. The relatively small associations between high VAE and lower risk behaviours may reflect confounding by unmeasured student characteristics. Furthermore, existing studies do not

examine mediators and shed little light on mechanisms of how value-added education might be associated with health outcomes (Bonell et al., 2013b).

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This paper aims to contribute to the literature regarding school effects on student risk behaviours by assessing the associations with student risk behaviours not only of school-level VAE but of direct measures of student lack of commitment to learning and to the school community, operating at both the level of the individual student and the school. Use of these direct measures aligns more clearly with Markham and Aveyard's theory and provides more confidence that any associations found are not merely the result of a proxy measure failing to account for all student socio-demographic characteristics. The research questions were

1. Is school-level VAE associated with reduced student self-reported smoking, drinking alcohol and school misbehaviour?
2. Is self-reported student lack of commitment to learning and to the school community operating at the school and student levels associated with student smoking, drinking and school misbehaviour?
3. Are any associations found between low VAE and risk behaviours mediated by school- or student-level lack of commitment to learning and the school community?

As well as smoking and alcohol, our analyses examined school misbehaviour using an established measure. School misbehaviour is not a health risk behaviour but since it represents behaviours contravening school norms, the Theory of Human Functioning and School Organisation would predict that it would be greater in schools with lower VAE and lack of student commitment. Some of the items within this scale focus on violent aspects of misbehaviour and sensitivity analyses examine whether these are subject to the same patterns of association as the main measure.

Methods

Sample and surveys

Our analysis followed STROBE guidance (von Elm et al., 2007) and draws on data from 40 secondary schools in south-east England (table 1) participating in the 'INCLUSIVE' trial being conducted from 2014 to 2017 of restorative practice to reduce bullying and aggression (Bonell et al., 2014a). Recruitment targeted state secondary schools within one hour's train journey from central London not judged by the national school inspectors as 'inadequate'. Sample size calculation, recruitment and data collection are described elsewhere (Bonell et al., 2014a). Survey data reported here were collected at trial baseline (2014) before allocation or intervention targeting all students at the end of year 7 (age 11/12 years). Students gave written informed consent to participate. Parents were informed and could withdraw their children from the surveys. The study was approved by the Institute of Education (FCL 566) and the University College London (5248/001) ethics committees. The procedures followed were in accordance with the Declaration of Helsinki 1975, revised Hong Kong 1989.

[Table 1 about here]

Measures

VAE

As per previous studies, (Aveyard et al., 2004 ; Bisset et al., 2007 ; Markham et al., 2008 ; Tobler et al., 2011) administrative data on school attainment and absence rates were used to construct a continuous measure of VAE. Attainment rates were measured as five-year (2009-13) averages of the proportion of year-11 students (aged 15–16) passing at least five General Certificate of Secondary Education (GCSE) examinations graded A*–C (5A*–C). Absence rates were measured as five-year (2009-13) averages of proportion of half-days missed. The VAE measure was developed via a number of steps. First, we estimated two logistic regression models using school-level 5A*–C and absence rates as outcomes with the following socio-demographic exposures: proportion of students that were White; proportion of females; income deprivation affecting children index (IDACI); (Department for Education, 2015) proportion of students eligible for free school meals (FSM); proportion of students speaking English as an additional language (EAL); and proportion of students scoring ≥ 6 on the Family Affluence Scale (FAS) (Currie et al., 2008). Data on FSM, IDACI, EAL and proportion of female students were from government websites. Government collected data indicated that in our schools 34.93% of students were eligible for free school meals (range 3-79%), 22.24% of children in the area of the school lived in income deprived households (range 0 -69.82%), 33.27% of students spoke English as a second language (range 2.2-90%), and 53% of students were female. The proportion of students who were White students and data on the FAS were derived from student responses to our survey. Standardised residuals from each model represent the difference between observed attainment and absence rates and those predicted based upon student socio-demographic profile at each school. These showed that schools with better than expected attainment also had better attendance ($r=-0.36$). We then undertook a principal components analysis of residuals from each model, which identified a single factor explaining 68.1% of variance with factor loadings of +0.71 for attainment and -0.71 for attendance residuals. This continuous variable was termed 'VAE' and standardised so that +1 represented schools with performance one standard deviation (SD) above average and -1 indicated schools with one SD below average.

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Student lack of commitment to learning and to the school community

These continuous variables were respectively assessed by the 4-item 'commitment to academic values' and the 8-item 'sense of belonging' subscales of the Beyond Blue School Climate Questionnaire (BBSCQ) (table 2). This scale was developed in Australia (Sawyer et al., 2010) using items from the Gatehouse, (Bond et al., 2004) Quality of School Life, (Epstein and McPartland, 1976) Patterns of Adaptive Learning, (Roeser et al., 1996) Manitoba School Improvement Survey (Earl and Lee, 1998) and Psychological Sense of School Membership (Goodenow, 1993) questionnaires. Cronbach's alphas for the lack of belonging and academic commitment sub-scales of 0.85 and 0.82 were reported for a sample of similar age (personal communication Lyndal Bond 21 July 2011).

[Table 2 about here]

Outcomes

For outcomes, we used self-report single-item binary measures of ever having smoked and ever having drunk alcohol previously used in the Ripple trial (Stephenson et al., 2008). We measured school misbehaviour in the last three months using a continuous measure derived from an amended 13-item version of the Edinburgh Study of Youth Transitions and Crime (ESYTC) school misbehaviour subscale (table 2), (Bonell et al., 2015; Smith, 2006) adding three items piloted in a previous study designed to examine threats, hitting/kicking and getting into fights (Bonell et al., 2015; Smith, 2006). The total score was a summed frequency of school misbehaviour. The Cronbach's alpha among a sample of similar age was 0.847 (Bonell et al., 2015).

Analysis

The analysis was performed in several steps, all using Stata version 13.1 (StataCorp, 2013). Missing data were handled by list-wise deletion.

Step 1: Selecting appropriate models and calculating intra-class correlation coefficients

Multi-level logistic regression analyses were used for the smoking and alcohol outcomes. The ESYTC measure of school misbehaviour was zero-inflated; 42% of responses were at zero and the remainder of responses declined in frequency with increasing magnitude. The variance was much larger than the mean indicating over-dispersion. Therefore for the ESYTC we used multi-level negative binomial regression and presented the results in the exponentiated form, as incidence rate ratios (IRR). To interpret IRR, the expected count is multiplied by a factor of the IRR value when the independent variable increases by one unit.

The intra-class correlation coefficient (ICC) measures the degree of within-cluster similarity between individuals for a variable. If all observations within schools are independent of one another, the ICC will be 0. If all the observations within schools are exactly the same, the ICC will be 1. ICCs for smoking and alcohol were calculated in intercept-only models using the following formula:

$$ICC = \frac{\text{var}(u_0)}{[\text{var}(u_0) + \pi^2/3]}$$

Where $\text{var}(u_0)$ is the level 2 (school) residual variance, and $\pi^2/3$ (which is equal to 3.29) is by assumption the variance of the level 1 (student) residuals.

To calculate the ICCs for school misbehaviour, we calculated the design effect using the following formula:

$$Deff = 1 + (m-1)ICC$$

Where Deff is the design effect, and m is the average number of observations per cluster (school).

We rearranged the formula in the following way to obtain an estimate of the ICC with our estimate design effect:

$$ICC = \frac{Deff}{1 + (m-1)}$$

Step 2: Estimating associations between VAE and student outcomes

We undertook multi-level analysis estimating associations between VAE and the three outcomes in unadjusted and adjusted analyses. We adjusted for school-level size (divided by 100 so that coefficients were expressed per 100 student increase), IDACI and FSM, as well as student-level sex, ethnicity, family structure (student report of the adults they live with dichotomized into single parent/two parent households), household employment (student report of whether any adults in the household were in paid work or not), and housing tenure (student responses to whether their house or flat was rented from the Council/housing association, rented from a landlord, owned by their family, other, or whether they didn't know).

Step 3: Estimating associations between lack of academic commitment and sense of belonging with student risk behaviours

We used the same method as above to examine the unadjusted and adjusted associations between our outcomes and lack of student-report belonging and commitment at both the school and student levels. We analysed school-level and student-level separately.

Step 4: Mediation analysis

Dependent upon the findings from steps 2 and 3, we aimed to assess whether our measures of lack of belonging and academic commitment at the student or school level mediated the association between low VAE and risk behaviours. The possibility of co-linearity between the measures of VAE and school- and student-level lack of belonging and academic commitment was assessed by examining correlations. However, as described in the results section, there was no association between VAE and smoking, alcohol, or school misbehaviour

Step 5: Estimating school- and student-level measures of lack of commitment and belonging simultaneously

We included both student- and school-level lack of belonging and academic commitment in the same model to examine whether the between-school and within-school associations were independent. For these models, student-level variables were cluster-mean-centred.

As well as considering the individual coefficients, we also formally tested the null hypothesis that the school-level and student-level coefficients for lack of belonging and academic commitment (separately) were equal using the post-estimation command "lincom". We used lincom to perform two tailed t-tests of the coefficients for the school-level mean of lack of belonging minus the coefficient for the cluster-mean-centred student-level lack of belonging, and the same for lack of academic commitment (Rabe-Hesketh and Skrondal, 2005). Furthermore, we used likelihood ratio tests to ascertain whether including both the school-level and student-level values of lack of belonging and academic commitment resulted in improvements in model fit, compared to models including only the student level. This would enable us to determine if lack of belonging and academic commitment appear to be important at both the school and the student level or merely the latter.

Where both school-level and student-level lack of belonging or academic commitment were significantly associated with the risk behaviours, we tested cross-level

interactions between these measures, to test whether high overall school levels of lack of belonging and academic commitment were associated with more risk behaviours for students having or lacking an individual sense of belonging or commitment to academic values.

Results

Of eligible students, 6667 (93.6%) completed questionnaires. Of these: 6474 (97%) reported on ever smoking; 6414 (96%) reported on ever drinking alcohol; and 6265 (94%) responded to school misbehaviour scale items. Overall 5.4% of students had ever tried smoking and 13.7% had ever drunk alcohol. The mean misbehaviour score was 2.82 (SD 4.81). These outcomes varied considerably by school: 1.6 to 15.6% for smoking; 0-39% for having drunk alcohol and 1.07-5.74 for school misbehaviour. The ICCs for these outcomes were 0.071 for smoking, 0.168 for alcohol and 0.052 for school misbehaviour. The Cronbach's alpha values for the school misbehaviour ($\alpha=0.89$), lack of belonging ($\alpha=0.80$) and lack of academic commitment ($\alpha=0.74$) scales suggested high internal consistency. Descriptive statistics for all exposures and covariates are shown in table 3.

[Table 3 about here]

Correlations between school-level VAE and school-level lack of belonging ($r=-0.23$) and academic commitment ($r=0.21$), and school-level VAE and student-level lack of belonging ($r=-0.05$) and commitment ($r=-0.03$) were small. Correlations between student-level lack of belonging and academic commitment were moderate ($r=0.37$); those between school-level belonging and commitment were larger ($r=0.56$). School-level correlations were based on only 40 observations so this moderate correlation suggests a small number of observations whereby school-level lack of belonging and academic commitment were disparate.

The unadjusted relationships between the exposures of interest (VAE, lack of belonging and academic commitment) as well as the covariates with the risk behaviours are also shown in table 3. VAE was not significantly associated with any of the risk behaviours at the 5% level of significance; there was a suggestion of a possible association between high VAE and lower odds of ever having tried smoking. In adjusted models (table 4) VAE was not significantly associated with ever having tried smoking, ever having tried drinking or school misbehaviour.

[Table 4 about here]

However, the unadjusted relationships between school-level and student-level lack of belonging and commitment to academic values with smoking, alcohol and school misbehaviour were statistically significant. The adjusted relationship between student-level and school-level belonging and academic commitment and the risk behaviours were estimated separately (web appendixes 1 and 2). The coefficients were almost identical to the model in which school-level and student-level cluster-mean-centred lack of belonging and academic commitment were included in the same model adjusted for confounders (table 5), hence we only report the results of this model in the main text.

[Table 5 about here]

A lower sense of belonging at the student level was significantly associated with increased odds of ever having drunk alcohol, and school misbehaviour. Student-level lack of belonging was associated with increased odds of ever having tried smoking, but this association was not statistically significant. A lower academic commitment at the student level was associated with increased odds of ever having tried smoking, ever having drunk alcohol, and school misbehaviour. A lower school-level average of student belonging was associated with increased odds of students having ever drunk alcohol, but was not significantly associated with ever having tried smoking or school misbehaviour. A lower school-level average of student academic commitment was associated with increased odds of students having ever tried smoking and engaging in school misbehaviour. Lower levels of school-level academic commitment were associated with increased odds of student ever having drunk alcohol, but this was not statistically significant.

Likelihood ratio tests comparing the adjusted model (with both student- and school-level lack of belonging and academic commitment) to the adjusted model including only student-level lack of belonging and commitment to academic (web appendix 1) indicated small but significant improvements in model fit for smoking ($\chi^2(2)=8.24, p=0.02$), alcohol ($\chi^2(2)=7.49, p=0.02$) and school misbehaviour ($\chi^2(2)=6.60, p=0.04$). The significant coefficients for school- and student-level lack of academic commitment with ever having tried smoking and school misbehaviour, and school- and student-level belonging with ever having tried alcohol suggest independent associations for the between- and within-school associations of lack of academic commitment with smoking. However, tests of the equality of the school-level and student-level lack of belonging and academic commitment coefficients did not reach statistical significance.

Finally, we tested the interactions between school- and student-level lack of commitment for ever having tried smoking (OR=0.94, 95%CI 0.77,1.16) and school misbehaviour (IRR=1.03, 95%CI 0.94,1.14), and the interaction between school- and student-level lack of belonging for ever having drunk alcohol (OR=0.99, 95%CI 0.97,1.01). None of the interactions were significant.

Discussion

Summary of key findings

There was no evidence of an association between school-level VAE and any risk behaviours among students aged 11-12 years. Lower school-level student academic commitment was associated with increases in smoking and reporting school misbehaviour, and lower school-level belonging was associated with increases in use of alcohol. Students with lower academic commitment were more likely to report ever smoking, drinking alcohol or misbehaving. Students with lower belonging were more likely to report ever drinking alcohol and engaging in school misbehaviour. At both the school and student levels, lack of belonging and academic commitment were independently associated with smoking, alcohol and aggression. However, formal tests of interaction which aimed to assess whether these effects were independent did not reach statistical significance, probably because the sample of schools was insufficient.

Limitations

Our sample excluded schools poorly rated by school inspectors and this may have reduced the range of value-added among our school sample. Compared with English schools overall, our sample somewhat over-represented highly rated and high-achieving schools, slightly under-represented community and mixed-sex schools and had more students eligible for FSM. The measures for ever having tried smoking and drinking alcohol use could not distinguish regular smoking or drinking from experimentation. The Theory of Human Functioning and School Organisation would predict that reduced commitment to school would be associated with the former more than the latter because of its being an indicator of greater deviance from conventional norms. Use of measures of frequency was precluded by the low rates of this among students who were aged only 11-12 years. Nonetheless, early use ever of substances is a good marker of later harmful use (Lando et al., 1999; Viner and Taylor, 2007). Our study focused on students in their first year of secondary school; school effects may increase as they move through secondary school. The study was cross-sectional in nature so that causal directions cannot be inferred, particularly in analyses using our measures of belonging and academic commitment, which unlike our measure of VAE were derived from student self-reports. Thus, findings should be considered as hypothesis-refining rather than testing. Longitudinal research should assess these hypotheses. Our analysis used the ESYTC measure of school misbehaviour rather than a measure specifically of violence in contrast to previous research (Tobler et al., 2011). However, we conducted a sensitivity analysis which repeated all our analyses but focused on the violence only subset of items (fights in or outside class; purposefully damage school property; threaten a teacher; hit or kick a teacher; threaten a student; hit or kick a student; and get in a fight), finding that the pattern of associations is identical and point estimates very similar to that of the full ESYTC measure.

Implications for research and policy

Our finding of apparent protective effects of student belonging and academic commitment at the school levels though based on cross-sectional data is an important contribution to empirically assessing the Theory of Human Functioning and School Organisation, such associations having previously been examined at the individual (Resnick et al., 1997) but not school level studies (Bonell et al., 2013b). Our findings suggest that students' risk of early use of tobacco and alcohol and engagement in school misbehaviour may be affected not only by their own commitment to learning and the school community but also by aggregate levels among their peers as predicted by the theory.

Our finding of no protective association between VAE and reduced risk of health-compromising behaviours are not unprecedented. A study from Scotland, (Markham et al., 2012) too recent to be included in the systematic review cited earlier, found small associations between increased VAE and increased substance use, which were reduced by adjusting for other indicators of school ethos drawing on aggregate student self-reports. In the case of our study, it may be that as a result of recent government policy the English educational system has become even more focused on traditional academic attainment metrics. In consequence, there may be less of an association between the quality of education provided by a school and the broader social development of its students (Bonell et al., 2014b).

Our finding that lower school-level student academic commitment was associated with increases in smoking and reporting school misbehaviour but not with alcohol might be

explained by experimentation with alcohol being a more normative behaviour less influenced by processes of disengagement from learning, which fits with the Theory of Human Functioning and School Organisation's focus on more deviant behaviours (Markham and Aveyard, 2003). The association with school misbehaviour is unsurprising and consistent with this theory. Our finding that lower school-level belonging was associated with increases in use of alcohol but not with smoking or school misbehaviour is more puzzling. It may be that because these behaviours were relatively uncommon in our data they may have been more randomly distributed. Our finding that at the student level lower academic commitment and lower belonging were associated with self-reported drinking of alcohol and of misbehaviour is what we would expect from the theory.

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As well as the need to assess whether our findings are replicated in longitudinal analyses, further research is required to examine whether the school as an institution shapes student commitments to learning and the school community in ways which promote avoidance of health-compromising behaviours. Observational studies could assess which aspects of institutional structures or processes are associated with student commitment to school and health behaviours, but will always be subject to residual confounding. Another approach is experimental research on whether interventions aiming to modify the school institutional environment can reduce health-compromising behaviours and whether such effects are mediated by effects on student commitment to learning and the school community. Our ongoing trial of the effects of restorative practice on misbehaviour and bullying is an example, its theory of change being informed by the Theory of Human Functioning and School Organisation (Bonell et al., 2014a).

Conflict of interest

There are no conflicts of interests, including any financial, personal or other relationships with other people or organisations, which could inappropriately influence or be perceived to influence this work. The funder had no involvement in: study design; the collection, analysis, and interpretation of data; the writing of the report; or the decision to submit the manuscript for publication. No honoraria were involved in study authorship.

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Supplementary materials

The data on which this analysis draws were collected as part of a randomised controlled trial. They will be made available publically once approval for this has been given by the trial's data monitoring and ethics committee.

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Conflicts of interest statement

The authors declare that they have no conflicts of interest. The funder had no involvement in: study design; the collection, analysis, and interpretation of data; the writing of the report; or the decision to submit the manuscript for publication. No honoraria were involved in study authorship.

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Table 1: Characteristics of schools that participated in the study 2014-2017

Characteristic	Schools in study n (%)	Schools in England (%)
<i>Inspection rating</i>	Not yet inspected	1 (2.5)
	Requires improvement	4 (10)
	Good	24 (60)
	Outstanding	11 (27.5)
<i>Type</i>	Voluntary aided	4 (10)
	Foundation	6 (15)
	Academy	25 (62.5)
	Community	5 (12.5)
<i>Sex</i>	Boys only	3 (7.5)
	Girls only	7 (17.5)
	Mixed	30 (75)
<i>Free school meals</i>	0-20%	12 (30)
	21-40%	11 (27.5)
	41-60%	12 (30)
	61-80%	5 (12.5)
<i>Attainment (extent to which students do better in best 8 GCSE exams at age 16 than predicted based on attainment at entry age 11)</i>	Above average	24 (60)
	Below average	16 (40)

Table 2: Scales used for belonging, commitment and school misbehaviour

Question	Response options
Lack of sense of belonging (8 items Cronbach's alpha=0.80, ordinal alpha=0.83) "How much do you agree with the following statements?"	Higher scores = lower sense of belonging
I feel very different from most other students here	YES!!Totally agree!! (3)/Yes, I agree a bit(2)/ No, I don't really agree(1)/ NO! Totally disagree!! (0)
I can really be myself at this school	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Other students in this school take my opinions seriously	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
I am encouraged to express my own views in my class(es)	YES!!Totally agree!! (0)/Yes, I agree a bit (1)/ No, I don't really agree (2)/ NO! Totally disagree!! (3)
Most of the students in my class(es) enjoy being together	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Most of the students in my class(es) are kind and helpful	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Most other students accept me as I am	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
I feel I belong at this school	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Lack of commitment to academic values (4 items Cronbach's alpha=0.74, ordinal alpha = 0.84) "How much do you agree with the following statements?"	Higher scores = lower commitment
I try hard in school	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Doing well in school is important to me	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
Continuing or completing my education is important to me	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)
I feel like I am successful in this school	YES!!Totally agree!! (0)/Yes, I agree a bit(1)/ No, I don't really agree(2)/ NO! Totally disagree!!(3)

School misbehaviour (13 items; Cronbach's alpha=0.89, ordinal alpha=0.96) "During the last 3 months how often did you do these things at school?"	Higher scores = increased misbehaviour
Arrive late for classes	0=hardly ever or never; 1=less than once a week; 2=at least once a week; 3=most days
Fight in or outside the class	
Refuse to do homework or class work	
Be cheeky to a teacher	
Use bad or offensive language	
Wander around school during class time	
Threaten a teacher	
Hit/kick a teacher	
Cheat doing homework or tests Purposely damage or destroy things belonging to the school	
Threaten another student	
Hit/kick another student	
Get in a fight	

Table 3. Descriptive statistics and unadjusted relationships between exposures and outcomes, and covariates and outcomes

	Exposure prevalence/ mean (SD)	Ever tried smoking			Ever Drank alcohol			School misbehaviour		
		Prevalence of outcome by exposure category	Unadjusted OR(CI)	p	Prevalence of outcome by exposure category	Unadjusted OR(CI)	p	Mean of outcome by exposure category	Unadjusted IRR(CI)	p
School Level										
Value added	0.00(1.00)	0.85(0.70 - 1.02)		0.09	0.84(0.64 - 1.10)		0.20	0.94(0.83 - 1.07)		0.37
Lack of belonging	8.17(0.95)	1.45(1.21 - 1.74)		<0.001	1.35(1.03 - 1.76)		0.03	1.31(1.17 - 1.46)		<0.001
Lack of commitment	1.47(0.26)	3.48(1.86 - 6.51)		<0.001	3.80(1.49 - 9.73)		<0.01	2.01(1.28 - 3.15)		<0.01
School size	10.84(3.21)	0.93 (0.88 - 0.99)		<0.05	0.98(0.91 - 1.07)		0.71	0.98(0.94 - 1.02)		0.31
FSM	0.35(0.20)	2.09(0.80 - 5.50)		0.13	0.17(0.05 - 0.58)		<0.001	3.50(2.11 - 5.80)		<0.001
IDACI	0.25(0.20)	1.92(0.73 - 5.01)		0.19	0.26(0.07 - 0.94)		<0.05	3.69(2.26 - 6.01)		<0.001
EAL	0.33(0.25)	1.32(0.61 - 2.84)		0.48	0.07(0.03 - 13.72)		<0.001	2.13(1.35 - 3.47)		<0.01
Student Level										
Lack of belonging	8.07(4.40)	1.09(1.06 - 1.11)		<0.001	1.09(1.07 - 1.10)		<0.001	1.06(1.05 - 1.07)		<0.001
Lack of commitment	1.45(1.65)	1.43(1.36 - 1.51)		<0.001	1.34(1.29 - 1.40)		<0.001	1.39(1.36 - 1.43)		<0.001
Gender										
Male	47%	6.11%(5.26 - 6.97)			16.16%(14.83 - 17.48)			3.49(3.29 - 3.69)		
Female	53%	4.43%(3.79 - 5.13)		<0.05	11.59%(10.51 - 12.67)		<0.001	2.21(2.07 - 2.35)		<0.001
Ethnicity										
White British	40%	4.97%(4.13 - 5.82)			19.84%(18.28 - 21.38)			2.27(2.11 - 2.43)		

White Other	9%	5.3% (3.42 - 7.18)		13.94%(11.03 - 16.86)		2.90(2.50 - 3.31)	
Asian/ Asian British	25%	3.73%(2.91 - 4.77)		3.76%(2.93 - 4.82)		2.74(2.50 - 2.98)	
Black/Black British	14%	7.84%(6.23 - 9.83)		13.45%(11.32 - 15.91)		4.25(3.86 - 4.65)	
Mixed ethnicity	7%	6.98%(4.95 - 9.76)		16.78%(13.55 - 20.60)		3.01(2.57 - 3.46)	
Other (including Chinese)	6%	5.42%(3.52 - 8.26)	<0.001	11.47%(8.59 - 15.17)	<0.001	3.30(2.71 - 3.88)	<0.001
Family Affluence							
Low	3%	7.33%(3.60-11.06)		11.70%(7.06-16.33)		3.27(2.55-4.00)	
Medium	34%	5.49%(4.51-6.46)		10.92%(9.58-12.26)		3.25(3.02-3.48)	
High	63%	4.98%(4.30-5.64)	0.47	15.45%(14.32-16.58)	0.15	2.56(2.41-2.70)	<0.05
Household composition							
Single parent household	19%	8.69%(7.10-10.27)		18.64%(16.43 - 20.84)		4.09(3.74 - 4.44)	
Two parent household	81%	4.47%(3.91-5.03)	<0.001	12.65%(11.74 - 13.55)	<0.001	2.52 (2.40 - 2.65)	<0.001
Employment status of parents							
At least one parent in work	74%	7.34%(5.36 - 9.97)		13.91%(11.13 - 17.25)		3.58(3.07 - 4.10)	
Neither parent don't know	8% 18%	4.68%(4.11 - 5.32) 6.34%(5.07 - 7.91)	<0.05	14.57%(13.59 - 15.61) 10.61%(8.95 - 12.53)	0.08	2.58(2.45 - 2.71) 3.37(3.06 - 3.69)	<0.001
Housing tenure							
Rented from council/housing association	16%	6.93%(5.52 - 8.67)		13.94%(11.93 - 16.24)		3.65(3.30 - 4.00)	
Rented from landlord	12%	7.43%(5.77 - 9.52)		12.02%(9.89 - 14.54)		2.87(2.55 - 3.19)	
Owned by family/mortgage	42%	4.18%(3.49 - 5.01)		15.67%(14.33 - 17.10)		2.27(2.11 - 2.43)	
Other	2%	5.26%(2.37 - 11.26)		18.92%(12.64 - 27.33)		3.58(2.57 - 4.60)	
Don't know/not sure	29%	4.81%(3.91 - 5.90)	<0.001	11.27%(9.88 - 12.83)	0.11	3.02(2.79 - 3.25)	<0.001

Table 4. Adjusted relationship between VAE and outcomes

	Ever tried smoking		Ever Drank alcohol		School misbehaviour	
	OR(CI)	p	OR(CI)	p	IRR(CI)	p
School Level						
Value added	0.91(0.75 - 1.10)	0.32	0.88(0.74 - 1.04)	0.13	0.96(0.88 - 1.05)	0.39
School variance	0.19		0.21		0.06	
Observations	6,124		6,073		5,936	
Number of groups	40		40		40	
over-dispersion (log)					0.74(0.69 - 0.79)	0.00

Adjusted for school level covariates (school size, FSM, IDACI) and student level covariates (sex, ethnicity, household composition, parental work status and tenure). Full model presented in web appendix 3

Table 5. Adjusted relationship between School (between) and student (within) level belonging and outcomes

	Ever tried smoking		Ever drank alcohol		School misbehaviour	
	OR(95C.I)	p	OR(95C.I)	p	OR(95C.I)	p
School Level						
Lack of belonging	1.15(0.92 - 1.44)	0.23	1.30(1.04 - 1.61)	0.02	1.06(0.97 - 1.16)	0.21
Lack of commitment	2.79(1.33 - 5.86)	<0.01	1.70(0.82 - 3.52)	0.15	1.74(1.27 - 2.38)	<0.01
Student Level						
Lack of belonging	1.02(0.99 - 1.05)	0.13	1.05(1.03 - 1.07)	<0.001	1.01(1.01 - 1.02)	<0.01
Lack of commitment	1.39(1.31 - 1.47)	<0.001	1.29(1.23 - 1.35)	<0.001	1.36(1.32 - 1.39)	<0.001
Observations	6,059		6,010		5,877	
Number of groups	40		40		40	
School variance	0.10		0.16		0.03	
over-dispersion (log)					0.52	<0.001
Log likelihood	-1094.9167		-2110.9673		-11551.243	
Tests of equality of coefficients						
Lack of commitment	OR=2.01, z=1.84	0.07	OR=1.31, z=0.75	0.46	IRR=1.28, Z=1.55	0.12
Lack of belonging	OR=1.12, z=1.00	0.32	OR=1.24, z=1.90	0.06	IRR=1.04, z=0.94	0.35

Adjusted for school level covariates (school size, FSM, IDACI) and student level covariates (sex, ethnicity, household composition, parental work status and tenure). Full model presented in web appendix 4.