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INTERVENTION, EVALUATION, AND POLICY STUDIES

Impacts of the Mindset Teams Programme on Teacher Outcomes and Pupil Educational Attainment: Secondary Data Analysis

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ABSTRACT

We evaluated the impact of a growth mindset intervention on pre-specified teacher outcomes and pupil academic attainment and attendance. Delivered over 12 months, the Mindset Teams intervention provides teachers with formal and self-directed online learning, and an opportunity to implement evidence-based growth mindset practice in the classroom setting. The intervention aims to influence teacher practices to improve pupil resilience for learning and bring about positive impacts on pupil attainment and health outcomes. Impacts on teachers were explored through pre- and post-intervention survey data (570 and 301 respectively). Pupil attainment and attendance data from 1220 schools, 72 of which received the intervention, across years 2017–2021 (minus 2020), were analyzed using weighted mixed effects models, using a Difference-in-differences framework. Bayes factors were calculated as a measure of strength of evidence. Results suggest positive impacts of the intervention on teacher outcomes and indicate a moderate effect (+3% (95%CI +1%, +6%)) of programme delivery on writing attainment, but no evidence of effect for other outcomes. Findings highlight important issues for further research, specifically the need to explore programme impacts using pupil or classroom level data.

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Introduction

Schools play a pivotal role in shaping children's experiences and fundamentally shaping trajectories toward adult life (Martin et al., 2013). For instance, classroom practices are seen as critical in the development of mindsets which play a central role in children's motivation, self-regulation, achievement, and the development of social-emotional skills (Dweck, 1999).

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In recent decades, there has been a surge of social-psychological interventions attempting to influence pupils' beliefs about intelligence, also referred to as growth mindset. Those with a growth mindset believe that attributes and abilities are malleable and can be developed or improved, whereas a fixed mindset reflects the belief that these abilities are relatively stable or fixed. Within educational settings, pupils with a growth mindset may seek out challenging situations, while pupils with a fixed mindset may avoid situations in which they may fail or struggle (Blackwell et al., 2007). The role of growth mindset in supporting greater success or achievement is believed to occur through self-reinforcing cycles of motivation and learning-orientated behavior (Yeager et al., 2019). Mindset is therefore thought to be particularly important during childhood and adolescence, as this is considered a crucial period where the foundations of learning ability and skills are developed (Boylan et al., 2018; Burnette et al., 2013; Lam et al., 2023). With regards to inequalities, growth mindset might be of particular benefit to those from areas of higher deprivation or lower socioeconomic status (Claro et al., 2016; Destin et al., 2019).

Research on the use of growth mindset interventions in schools is largely limited to studies in the United States and secondary school settings (Yeager et al., 2019). In 2023, two systematic reviews and meta-analyses of growth mindset interventions were published (Burnette et al., 2023; Macnamara & Burgoyne, 2022). Macnamara and Burgoyne (2022) reviewed 63 studies examining the impacts of growth mindset interventions on pupils' academic achievement. Authors concluded that despite evidence of a small overall effect of growth mindset interventions on academic achievement, findings were limited by study design issues and publication bias. Burnette et al., (2023) reviewed 53 studies, with a key focus on intervention implementation. In total, 70% of studies were from the United States and most academic-based interventions were described as brief (involving a median of two 75-minute intervention sessions). Despite the large variation in effectiveness, the authors noted the positive effects on academic outcomes, mental health, and social functioning across studies.

To the best of our knowledge, only one review concerning growth mindset interventions among younger children has been published to date. In 2021, Savvides and Bond (2021) systematically reviewed growth mindset interventions in primary schools and concluded that evidence was limited, with 10 identified studies (three United Kingdom-based) including three unpublished studies. Of the 10 studies, authors reported that studies were predominantly exploratory and small scale, with only three studies including a follow-up measure. Since, only a few studies focusing on growth mindset interventions among 8–11-year-olds have emerged (Barroso et al., 2023; Foliano et al., 2019; Kaya & Karakoc, 2022). In the United States (Barroso et al., 2023) and Turkey (Kaya & Karakoc, 2022) small positive effects of growth mindset on mathematics attainment were found following the delivery of mathematics-based growth mindset intervention.

The importance of teacher-pupil relationships is demonstrated throughout the literature, with stronger relationships linked to greater academic achievement, self-efficacy, and motivation (Fabris et al., 2022; Longobardi et al., 2023). In line with the Developmental Systems Theory (Johnston, 2009), there is a belief that a teacher's mindset influences their growth mindset practices which in turn impacts pupils' mindsets. A recent study examining this notion among early adolescents across a 12-month period, showed that teachers with a growth mindset had a positive association with pupil growth mindset and conversely, teachers with a fixed mindset had a negative

association with pupil mindset (Mesler et al., 2021). Rissanen and Kuusisto (2023) also reported that secondary school teachers with a growth mindset were more likely to recognize and combat issues of social injustice and inequity compared to teachers with a fixed mindset (Rissanen & Kuusisto, 2023). A school-based United Kingdom (UK) growth mindset programme; Changing Mindsets (Foliano et al., 2019) was developed on the theory that improving teacher behavior and language (through a 1-day training event) would improve pupil mindset and as a result, lead to improvements in academic achievement among 10–11-year-olds. This programme was evaluated in 2019, with a randomized trial not finding impacts of Changing Mindsets on pupil attainment scores and the evaluation did not gather data on teacher outcomes, therefore the programme's influence on teacher improvements remains unknown. As such, teachers could play an important role for the outcome of school-based growth mindset interventions, yet the current evidence-base is lacking.

With the ever-increasing popularity of school-based growth mindset interventions there is a clear need to generate further evidence regarding potential impacts on younger pupils' attainment and to consider the role of teachers within this. Furthermore, studies to date have tended to evaluate single-site interventions which lack contextual considerations and yield limited insights for policy and practice.

To address this need, the current study evaluated the impact of a UK school-based growth mindset intervention, the Mindset Teams programme (Winning Scotland, n.d.), on teacher attitudes, awareness and knowledge and pupil academic attainment and attendance among primary schools.

Research Questions of the Current Study

This study draws on secondary data analyses to examine the impacts of the Mindset Teams programme in the primary school setting. The research questions underpinning this study are:

i. What are the impacts of the Mindset Teams training programme on teacher attitudes, knowledge, and beliefs toward growth mindset?
ii. Do pupils attending Mindset Teams schools have better educational attainment scores and attendance compared to non-Mindset Teams schools 1 year after programme implementation?
iii. What role, if any, do inequalities play in any observed programme impacts?

This study is part of a wider project which examined the impacts of the Mindset Teams programme and factors influencing the uptake, implementation, and sustainability of the programme (National Institute for Health & Care Research, 2023).

Method

Study Context and Target Population

This study concerned teachers and pupils in primary schools in Scotland, UK. Pupils aged 5–12 years attend primary school, with the Scottish national curriculum, the

Curriculum for Excellence (CfE), used throughout primary and secondary school years. The CfE comprises a broad general education, with a focus on four key domains in primary school; numeracy, reading, writing, and listening and talking. The Scottish Government collects data on achievement of each CfE domain in Primary 1 (ages 4–5), Primary 4 (ages 7–8) and Primary 7 (ages 10–11) for all publicly funded mainstream schools (Scottish Government, 2023). The proportion of pupils achieving the expected level in each domain is publicly available each year. In 2015, the Scottish Attainment Challenge (Education Scotland, 2023) was launched. Underpinned by the CfE, the Scottish Attainment Challenge focuses on closing the poverty-related attainment gap through targeted improvement activity in literacy, numeracy and health and wellbeing across Scotland.

Mindset Teams Programme

The Mindset Teams programme, developed by a charity, Winning Scotland, was first introduced within primary and secondary schools throughout Scotland in 2018, with participating schools typically located in areas of deprivation. The programme was designed to complement the aims of the Scottish Attainment Challenge (Education Scotland, 2023) by improving health and education outcomes for pupils. This outcome is realized through the training of teachers and improvements in pupils' resilience for learning.

The programme runs over a 12-month period and involves two 6-month elements: (i) an online training course for Mindset Teams within a school and (ii) the implementation of a school growth mindset project. A Mindset Team is typically comprised of a member of senior management (Mindset Leader) and at least two classroom teachers (Mindset Champions). The online course is designed to improve staff knowledge, beliefs and confidence around mindset and around change management in schools. A key part of the online training is to equip staff with the skills to incorporate growth mindset activities within the classroom and ultimately apply their learning through the implementation of a growth mindset project within the school. Over the course of the 12-months, members of the Mindset Team are supported through online one-to-one tutor support and access to a peer forum supported by Mindset Ambassadors (i.e., teachers previously completing the scheme).

Measures and Outcomes

Teacher Outcomes

Winning Scotland ask teachers to complete an online survey before and after completing the provision of the online Mindset Teams training. The survey includes 26 questions obtaining information on general background (e.g., job role, gender, number of years teaching), awareness of growth mindset, attitudes toward growth mindset and school delivery involvement in growth mindset. Completion of the pre-survey is a mandatory requirement as part of the training course.

An anonymized dataset of teacher survey responses gathered between 2018 and 2021 was provided by Winning Scotland to the study team. While all teachers were

asked to complete the survey at both time points, individual IDs were not systematically allocated, and thus individual-level changes cannot be analyzed. In the present study, survey responses are therefore described separately in the pre and post samples, with no formal analyses undertaken. We were interested in the 17 questions that describe attitudes and awareness toward learning on a 6-point Likert scale from 'Strongly Agree' to 'Strongly Disagree' (see Table S1 in the Online Supplementary Materials (OSM)). Reliability was estimated by Cronbach's alpha for these 17 questions, and was 0.65 (95%CI 0.61–0.67) indicating unsatisfactory reliability (Bland & Altman, 1997).

Pupil Outcomes

A list of primary schools participating in the Mindset Teams programme since 2018 was compiled by Winning Scotland. For each school, the following details were provided; school name, local authority, year of programme enrollment and school deprivation (Scottish Index of Multiple Deprivation) (Scottish Government, n.d.).

We obtained school-level data from the Scottish Government. The dataset included 2,056 schools with data spanning a 5-year period (2017 to 2021). Of the 103 schools participating in the Mindset Teams Programme during this period, 14 schools participated for only 1 year, 77 for 2 years, 2 for 3 years and 10 for 4 years. Due to the COVID-19 pandemic no attainment and attendance data were provided for the year 2020. The final dataset therefore consisted of all schools for which 4 years of data (2017, 2018, 2019, and 2021) were available. For analysis of the timeseries we only included schools with complete data for all 4 years, resulting in an analytic sample of 1,220 schools of which 72 participated in the Mindset Teams Programme; seven started in 2018, one in 2019, and 64 in 2021.

School-level outcomes of interest were the annual average attendance rate and the percentage of pupils achieving the expected level of CfE outcomes across four domains (described above). Average attendance rates were provided as percentages. CfE outcomes were reported in percentage deciles which, for the purpose of this study were converted to midpoint percentiles. Covariate data were available for average number of pupils (school size), school classification, school denomination, percentage of pupils with additional support, percentage of pupils with additional language, percentage of ethnic minorities, average class size, average full-time equivalent number of teacherst, percentage of female pupils and Scottish Index of Multiple Deprivation (SIMD). For some schools, data were not available for earlier years, and where this was the case for time-invariant variables (local authority, school classification, school denomination) data were imputed from later years.

Analytic Approach

All analyses were conducted in R software (version 4.2.1). Descriptive statistics (N and percentage) were calculated for teacher data. Pupil data were analyzed using weighted linear mixed effects models to estimate the ATT (Average Treatment Effects of Treated) of the Mindset Teams programme on the selected school-level outcomes. The parallel trends assumption was assessed prior to analyses. Differences in mean outcomes between intervention and control schools prior to the intervention (years 2017–2019) were

minimal (< 3%) indicating that this assumption was plausible. Propensity to receive the intervention at any point in the time period of the study was calculated for the year 2017 (prior to any school received the intervention), and models were weighted using Inverse Propensity Weighting (IPW). Propensity weights were calculated based on 2017 average number of pupils (school size), school classification, school denomination, percentage of pupils with additional support need recorded, percentage additional language, percentage ethnic minorities, average class size, average teacher FTE, percentage of female pupils and SIMD using the optimal full matching algorithm. To avoid single observation biasing the results, weights were truncated to 1% and 99% of the weights distribution (Chesnaye et al., 2022). The effect of the Mindset Teams programme (the intervention) was evaluated using a Difference-in-Differences (DiD) framework. For each school-year combination a 0/1 indicator variable signified whether a school received the Mindset programme intervention or not. Given that 89% of intervention schools started the programme in 2021, a staggered DiD was deemed not necessary (comparison of unweighted models DiD and staggered-DiD models using the R *did* package confirmed differences were negligible [data not shown]). Similarly, cluster-robust standard errors had minimal impact on results in unweighted models [data not shown]. The estimand of interest is the average effect of the Mindset Teams programme on any of the outcomes in the same year in schools participating in the programme. This was estimated by the conditional model estimate, provided with p-values and 95% confidence intervals using the Wald approximation. Repeated measurements were accounted for by inclusion of a random intercept per school. We conducted both a weighted unconditional analysis and a doubly robust analysis including all covariates used in the exposure model as main effects (Emsley et al., 2008). Inequalities were explored through interactions terms of covariate of interest and intervention. The model equation for the statistical model is shown in OSM Table S2.

BIC-derived Bayes factors were calculated for non-null findings to provide an indicate of the strength of evidence against the null (Jarosz & Wiley, 2014). In addition to the main analyses, we performed additional sensitivity analyses. We provide corresponding unweighted DiD analysis, analysis of the complete dataset ignoring missing data, and analysis of the complete dataset with missing data imputed using multiple imputation chained equations. The CfE outcome variables of interest were provided to the research team as decile groups from 0%-10% to 90%-100%, of which we used the midpoints as the results are more meaningfully interpretable. They should, however, be statistically analyzed using ordinal categories as the dependent variable. To support the primary analyses, we therefore also conducted weighted mixed effects ordinal regression analyses. Propensity score weighting was done using R packages *MatchIt* and *cobalt* (v 4.4.0). Statistical models were run using the *lme4, lmerTest*, and *ordinal* packages. Multiple imputations were done using the *mice* package.

Results

Study Sample

The teacher survey was completed by 570 teachers prior to attending the 6-month Mindset training course and 301 after completing the training. The distribution of

answers pre- and post-Mindset Teams course are shown for all 17 questions of interest in OSM Table S4.

An overview of the available school-level dataset is provided in Table 1. Missing data in the complete dataset of 2,056 schools ranges 6% to 25%. Distributions of covariates indicate that schools with missing data on key variables, and which were removed from these analyses resulting in an analytic sample of 1,220 schools, were not systematically different (at least for observables) compared to those with complete data; with only marginal differences between both sets, although relatively more non-intervention schools were excluded than intervention schools.

Programme Impact on Teacher Outcomes

Overall, analyses indicate a shift toward a higher appreciation that pupils can have different ways to get to answers than perhaps taught and that all pupils can improve regardless of their baseline skills or motivations. This is illustrated by four questions selected from the survey - 'There will always be some students who simply won't "get it" no matter what I do', 'Ability is something that people have a certain amount of and there isn't much they can do to change it', 'Some people have a knack for learning and some just don't', and 'Intellectual (or Mathematical) ability is something that remains relatively fixed throughout a person's life' – as illustrated in Figure 1. Figure 1 shows a higher proportion of survey respondents somewhat disagreeing, disagreeing, or strongly disagreeing with these statements after attending the Mindset Teams course (85%, 100%, 85%, and 96%, respectively) compared to before (54%, 57%, 42%, and 42%, respectively).

Pupil Outcomes among Programme and Non-Programme Schools

Propensity weights result in comparable populations with an Average Standardized Absolute Mean Distance (ASAM) of −0.0012, with all variables within the 10% difference Improvements are shown graphically in OSM Figure S1. Marginal estimates for each outcome and year for intervention and control schools are shown graphically in OSM Figure S2.

The quantitative results of the IPW models are shown in Table 2. These do not provide evidence (Bayes Factor (BF_{10}<0.01) that participating in the Mindset Teams programme was associate with changes in attendance rates (+0.08%, 95% Confidence Interval (95%CI) −0.18, +0.33; p-value 0.56). There was also little evidence of an association of the Mindset Teams programme with CfE outcomes Reading and Listening and Talking; associations for both included the null with Bayes factors of 0.07 and 0.08, respectively, strongly favoring the null hypothesis. Statistically significant increases were observed for CfE Numeracy (+2.3%, 95%CI 0.7, 4.5) and Writing (+3.4%, 95%CI 1.2, 5.7), but only for Writing a Bayes factor (BF_{10}=3.51) was observed, indicating moderate strength of evidence of an association. Following introduction of the Mindset Teams programme, participating schools have on average about a 3% (95%CI +1%, +6%) higher outcome compared to schools not in the programme. These doubly-robust results are comparable to IPW models

Table 1. Comparison of intervention and control schools in the full dataset and the complete dataset used in the study.

		Missing data	Intervention schools (%)	Control schools (%)	Intervention schools (%)	Control schools (%)
			Full dataset (2056)* Year 2017		Complete data set (1220; 59.3%) Year 2017	
	N		103	1953	72	1148
Classification	Accessible rural	6.0%	10	385	8	217
	Accessible small town		8	121	8	116
	Large urban		23	282	23	274
	Other urban		32	426	32	416
	Remote urban		5	340	1	80
	Remote small towns		0	48	0	45
Number of pupils		6.3%	272.2	185.5	291.5	241.7
School denomination	Non-denominational	6.0%	66	1476	60	1031
	Other		0	3	0	2
	Roman catholic		12	123	12	115
Pupils with additional support need recorded		6.2%	22.2	30.3	22.2	28.5
Pupils with English as an additional language		6.3%	6.8	8.9	6.9	8.7
Ethnic minority		7.1%	6.4	7.3	6.5	8.1
Class size		6.3%	22.7	20.8	23.2	23.1
FTE teachers		6.3%	17.4	12.1	18.6	15.4
Percentage girls			48.8	49.1	49.0%	48.9%
Scottish Index of Multiple Deprivation (Q1; most deprived)		7.1%	32.6	18.2	34.2	22.7
SIMD Q2			24.4	19.2	22.9	21.3
SIMD Q3			15.1	29.1	14.3	21.1
SIMD Q4			17.6	26.0	16.7	22.9
SIMD Q5 (least deprived)			16.1	15.5	16.4	18.9
Attendance rate		7.5%	93.1	94.1	93.1	93.7
CfE Listening and Talking		24.9%	83.7	82.7	83.6	82.7
CfE Numeracy		24.9%	77.6	77.6	75.4	75.6
CfE Reading		24.9%	76.9	77.2	77.4	77.2
CfE Writing		24.9%	71.6	71.4	71.0	71.5

*: numbers with missing data excluded.

without adjustment of additional covariates, indicating the weighting methodology successfully balanced the data with respect to the covariates. The results of the ordinal regression models are presented in Table 3 and support the results from Table 2. With a Bayes factor >100 these models provide strong support that the Mindset Teams programme had a positive effect on the CfE 'Writing' criterion, indicated that schools who participated in the Mindset Teams programme were 1.5 times (95%CI 1.0–2.5; p-value 0.08) more likely to be one decile category up compared to nonparticipating schools (or the same school prior to participation), while for CfE Reading, Numeracy and Listening and Talking there was little support for an association (BF_{10} ranging 0.02–0.06).

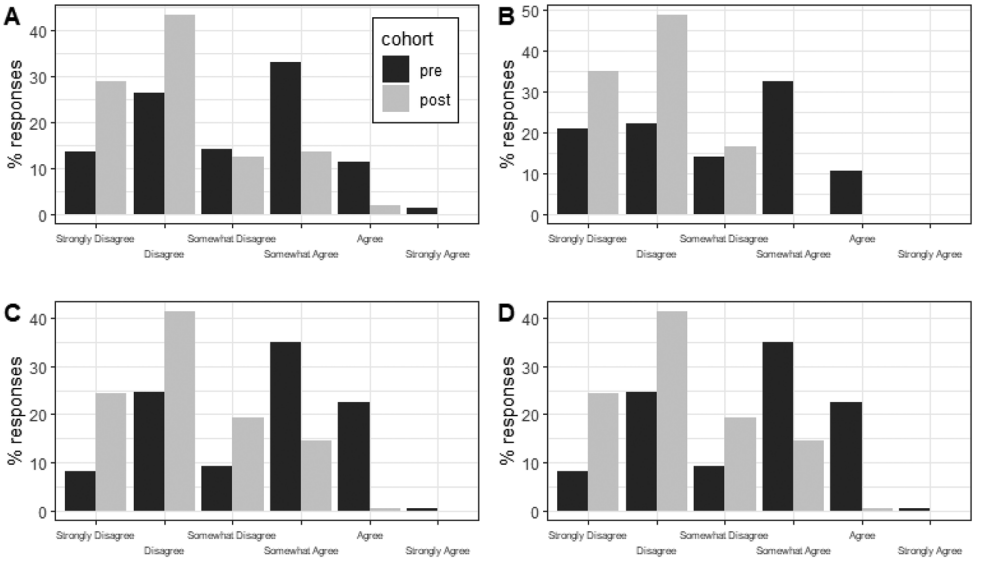

Figure 1. Teacher responses pre and post-Mindset training for exemplar questions (Full survey results in Online Supplement): (A) There will always be some students who simply won't 'get it' no matter what I do, (B) Ability is something that people have a certain amount of and there isn't much they can do to change it, (C) Some people have a knack for learning and some just don't, (D) Intellectual (or Mathematical) ability is something that remains relatively fixed throughout a person's life.

Table 2. Results of inverse propensity weighting models.

Outcome	IPW model conditional effect			IPW model (doubly robust) conditional effect			Bayes factor (BF_{10})
	ATT	95%CI	p-value	ATT	95%CI	p-value	
Attendance rates	−0.06	−0.20,0.32	0.66	0.08	−0.18, 0.33	0.56	0.006
CfE Writing	**3.49**	**1.19, 5.78**	**0.00**	**3.44**	**1.18, 5.70**	**0.00**	3.507
CfE Reading	1.17	−0.66, 3.19	0.25	1.14	−0.82, 3.11	0.25	0.069
CfE Numeracy	**2.45**	**0.41, 4.64**	**0.03**	**2.27**	**0.07, 4.46**	**0.04**	0.312
CfE Listening and Talking	1.41	−0.61, 3.44	0.17	1.24	−0.77,3.24	0.23	0.076

Bold values indicate significant values.

Table 3. Results of ordinal mixed effects models.

Outcome	IPW model (doubly robust) conditional effect (proportional odds ratio)			Bayes factor (BF_{10})
	ATT	95%CI	p-value	
Attendance rates	–	–	–	–
CfE Writing	**1.54**	**0.95, 2.48**	**0.079**	**108.1**
CfE Reading	1.06	0.68, 1.64	0.793	0.016
CfE Numeracy	1.12	0.73, 1.72	0.616	0.020
CfE Listening and Talking	1.29	0.78, 2.12	0.320	0.061

Bold values indicate significant values.

Role of Inequalities

The impact of inequalities is explored through interaction models and result presented in Table 4. The results largely confirm that attendance rates and CfE outcomes

are lower in schools in which inequalities are higher, independent of other factors in the models. There remains a statistically significant association between the Mindset Teams programme and the CfE Writing outcome with little evidence of a differential impact of the programme in schools with higher percentages of ethnic minorities, pupils requiring additional support, pupils from the most deprived areas, or schools with larger class sizes. However, some differential effects are observed.

Table 4. Results of interaction models assessing the impact of inequalities.

Outcome			IPW model (doubly robust) conditional effect	
	factor	ATT (95%CI)	factor (95%CI)	interaction (95%CI)
Attendance rates	>5% ethnic minorities	0.25 (-0.13, 0.63)	−0.00 (-0.01,0.01)	−0.02 (-0.06,0.01)
	% pupils with additional support >26.5%*	−1.54 (-0.45, 0.15)	0.04 (-0.10, 0.17)	**0.69 (0.19, 1.19)**
	>40% most deprived (SIMD 1 or 2)**	**0.87 (0.42, 1.32**)	**−1.36 (-1.50, −1.22)**	**−1.11 (-1.63, −0.58)**
	average class size >23.4	−0.32 (-0.69, 0.05)	−0.03 (-0.24, 0.18)	**0.71 (0.23, 1.19)**
CfE Writing	>5% ethnic minorities	**3.95 (1.42, 6.48)**	−0.20(-1.45, 1.05)	−2.25 (-7.17, 2.67)
	% pupils with additional support >26.5%*	**3.51 (0.81, 6.21)**	**−2.72 (-3.79, −1.64)**	−0.279 (-4.66, 4.12)
	>40% most deprived (SIMD 1 or 2)**	**4.04 (0.13, 7.95)**	**−5.80 (-6.86, −4.73)**	−0.68 (-5.27, 3.91)
	average class size >23.4	**4.41 (1.11, 7.71)**	**−2.72 (-4.38, −1.05)**	−1.67 (-5.88, 2.55)
CfE Reading	>5% ethnic minorities	1.18 (-1.01, 3.37)	**−1.24 (-2.33, −0.16)**	−0.30 (-4.58, 3.97)
	% pupils with additional support >26.5%*	1.22 (-1.13, 3.56)	**−1.91 (-2.84, −0.97)**	−0.27 (-4.08, 3.55)
	>40% most deprived (SIMD 1 or 2)**	0.65 (-2.74, 4.05)	**−5.17 (-6.09, −4.24)**	0.88 (-3.11, 4.87)
	average class size >23.4	1.73 (-1.14, 4.60)	**−1.81 (-3.25, −0.37)**	−1.01 (-4.67, 2.65)
CfE Numeracy	>5% ethnic minorities	2.81 (0.36, 5.26)	**−1.51 (-2.71, −0.31)**	−2.56 (-7.31, 2.19)
	% pupils with additional support >26.5%*	1.53 (-1.09, 4.14)	**−2.76 (-3.78, −1.74)**	2.14 (-2.11, 6.38)
	>40% most deprived (SIMD 1 or 2)**	3.13 (-0.65, 6.91)	**−4.55 (-5.56, −3.54)**	−1.04 (-4.46, 3.39)
	average class size >23.4	**3.02 (0.18, 6.22)**	**−1.57 (-3.15, −0.02)**	−1.30 (-5.38, 2.77)
CfE Listening and Talking	>5% ethnic minorities	1.64 (-0.60, 3.89)	**−1.38 (-2.46, −0.29)**	−1.91 (-6.21, 2.39)
	% pupils with additional support >26.5%*	0.69 (-1.69, 3.08)	**−1.57 (-2.46, −0.67)**	1.58 (-2.28, 5.44)
	>40% most deprived (SIMD 1 or 2)**	**4.21 (0.79, 7.64)**	**−4.20 (-5.08, −3.32)**	**−4.09 (-8.09, −0.09)**
	average class size >23.4	1.13 (-1.80, 4.05)	**−1.81 (-3.18, −0.44)**	0.21 (-3.49, 3.91)

*: median; **: median, and additional adjustment for SIMD categories not included. Bold values indicate significant values.

Following the introduction of the Mindset Teams programme attendance rates increased more in schools with higher percentages of pupils with additional support and larger class sizes, but decreased in the schools from the most deprived areas. A significant interaction was further observed indicating that the Mindset Teams programme did not have a measurable impact on the CfE Listening and Talking outcome in the schools from the most deprived areas but did for schools in areas of lower deprivation (-4%, 95%CI −8% to −0.1%). It is further relevant to observe that although interactions were mostly not statistically significant, point estimates were all in the same direction hinting that impacts may be smaller in disadvantages groups.

Results from sensitivity analyses are presented in OSM Table S3 and indicate qualitatively similar results for non-weighted models of the dataset with complete data (N = 1,220 schools) but not for the complete dataset after imputation of missing data (N = 2,056 schools). For the latter, there was no association with the CfE 'Writing' outcome, but surprisingly a statistically significant reduction in attendance rates in Mindset schools compared to control schools was observed.

Discussion

This study sought to examine the impact of the Mindset Teams programme on teacher attitudes, knowledge and beliefs and pupil educational attainment among primary schools in Scotland. To date systematic research on the implementation and impact of growth mindset interventions in the UK has been limited.

Programme Impacts on Teachers

The present study suggests several improvements in teacher knowledge, attitudes and beliefs toward growth mindset following completion of the 6-month online aspect of the training course. Similarly, Strahan et al. (2017) developed a programme whereby teachers were taught how to encourage growth mindset among pupils, and despite no evaluation of impacts, the study indicated improvements in children's understanding of growth mindset concepts and ways in which learning routines had been adapted. A recent Finnish-based study (Rissanen & Kuusisto, 2023) demonstrated key differences between teachers who had a growth mindset compared to peers with a fixed mindset, revealing those with a growth mindset as more likely to recognize social injustice and inequity among pupils. While the present study relied on teacher self-report data, findings are encouraging for the upscaling of an online delivery programme to support teachers to foster growth mindsets within the school setting.

Programme Impacts on Pupil Attendance and Attainment

School participation in the programme was not shown to impact school-level attendance rates. To the authors' knowledge, only one other study has examined the impact of a growth mindset intervention on student attendance (Brougham & Kashubeck-West, 2017). Among 14–15-year-olds, the study showed higher attendance rates in the

treatment group, yet the study was underpowered to detect any meaningful difference. In the present study it is important to highlight the high average attendance rates across schools. We are therefore unable to rule out a ceiling effect, with a small margin (<7%) for improvement in attendance rates across schools.

Within the present study, school participation in the programme was also not shown to impact school-level attainment scores in numeracy, reading, or listening and talking. These findings are in agreement with a randomized controlled trial, showing no impacts of the Changing Mindsets project on pupil attainment (i.e., Key stage 2 literacy, numeracy, reading, grammar, punctuation, and spelling) among 10–11-year-olds in England (Foliano et al., 2019). While acknowledging the short programme duration of eight weeks, Foliano et al. (2019) surmise that the absence of observed impacts might also be explained through the widespread use of growth mindset concepts. Their study revealed that over a third of comparison schools involved in the trial had reported teachers attending growth mindset training and a large proportion of comparison schools were familiar with growth mindset concepts. This information was not available on control schools within the present study.

We did observe a relatively small, but positive effect of implementation of the programme and average pupil writing scores with moderate strength of evidence. In line with previous studies claiming that mindset has enduring effects on educational attainment for at least one academic year (Gunderson et al., 2018; Park et al., 2016), we found a greater number of children within Mindset Teams schools achieving the expected writing attainment level compared to schools without the programme 1 year later. Considering that current analyses looked at average effects at the whole school-level, as opposed to pupil-level data, findings are somewhat encouraging, with the growth mindset project typically delivered within specific classes and thereafter cascaded across a school as the programme matures over time.

Wider studies exploring the impact of growth mindset interventions specifically on student writing attainment are scarce. Two studies exploring the impact of a growth mindset intervention on children's writing attainment have embedded growth mindset within an existing programme. For example, among 5–6-year-olds, Schrodt et al. (2019) reported improvements in writing motivation and performance following a writer's workshop framework. Conversely, Camacho et al., did not find any added improvements among middle school Portuguese students (mean age 11-years) using a Self-Regulated Strategy Development (SRSD) approach (Camacho et al., 2023). Given the differences in study populations, designs and intervention approaches, it is difficult to draw comparisons with the present study findings. Furthermore, given the lack of existing studies, we are unable to draw on wider literature to surmise why this intervention might specifically improve writing attainment and cannot rule out a chance finding.

While other studies have shown greater effect sizes on a range of attainment outcomes, such studies are typically focused on older children, are based in the United States and include a longer-term follow-up period (Destin et al., 2019; Yeager et al., 2019). As such, growth mindset interventions could be more beneficial for pupils when principles are taught over several years and for older children, whereby pupils are able to undertake self-directed learning. While the current study observed

a small average effect on writing attainment scores, Greenberg and Abenavoli (2017) emphasize the importance of not disregarding findings which show low average effects as a more targeted intervention could provide meaningful and replicable benefits at scale. It is further important to highlight wider studies (Broda et al., 2018; Claro et al., 2016; Paunesku et al., 2015) which have demonstrated differential effects of growth mindset interventions, with greater impacts shown among minoritized or lower achieving pupils compared to high-achieving pupils. In our analyses statistically significant differential effects in line with those observed elsewhere were only observed for listening and talking attainment, but not for any of the other outcomes.

Strengths and Limitations

This study draws on a large publicly available school-level dataset and benefits from robust analytical approach using doubly robust models, which have the benefit that inferences can be unbiased if either of the matching process is correctly specified or the outcome equation is correctly specified (or increased efficiency if both are correctly specified (Emsley et al., 2008). These analyses are further supported by several sensitivity analyses. There are however several limitations to this study. First, attainment data restricted all analyses to the school-level, consequently effects at the classroom level may be underestimated. Second, school-level data were only available in 10-percentage point groups and thus the observed ATT of about 3% for the writing attainment outcome is not an exact estimation from the distribution. However, additional ordinal regression supported the main findings. Third, we are unable to comment on the teaching practices within the control schools, a key factor which could impact on the current attainment findings. Fourth, we were unable to determine whether a Mindset Team school has continued to implement the programme following the first year of teacher training and school delivery. Fifth, we are unable to rule out the role of wider school-based programmes or confounding factors on the study outcomes. Sixth, the format of teacher survey data prevented any direct comparisons between teacher responses at pre- and post-timepoints.

Conclusion

The current findings bear some useful implications for the impacts of a growth mindset programme on teachers and pupils. Findings demonstrated positive impacts on teacher attributes and suggest potential impact on the writing attainment outcomes of around 3% (95%CI 1% to 6%) improvement on average, but not for other outcomes. Over time, it might be possible that greater impacts may be found as growth mindset principles become embedded throughout the whole school, for both the workforce and pupils. There was little evidence of differential impacts in disadvantages groups of the Mindset Teams programme. Our findings highlight important issues for further research, with a need to explore impacts of such programmes using pupil or classroom level data.

Open Research Statements

Study and Analysis Plan Registration

- There is no registration associated with this study. The study protocol is publicly available on the National Institute for Health and Care Research website: https://njl-admin.nihr.ac.uk/document/download/2037354

Data, Code, and Materials Transparency

- The data are available on the Open Science Framework: https://osf.io/7nmuy/. The materials and code associated with this study are not publicly available.

Design and Analysis Reporting Guidelines

- Not applicable.

Transparency Declaration

- The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Replication Statement

- This manuscript reports an original study.

Author Contributions

KM and SM were the co-principal investigators for the study. Fieldwork and analysis were undertaken by HR, KM and SG. KM led the development of this manuscript and wrote the first draft, with contributions from FdV and SG. FdV was responsible for all data analyses and reporting results. AB and GS contributed information on the Mindset Teams programme and enabled teacher survey data access. All authors contributed to revisions of the draft manuscript and read and approved the final manuscript.

Ethics Statement

Ethical approval was granted by Cardiff University's School of Social Sciences Research Ethics Committee (SREC/4280).

Disclosure Statement

AB and GS are members of the Mindset Teams programme team. All other authors declare no conflicts of interest.

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Data Availability Statement

The teacher survey data that support the findings of this study are available on request from the corresponding author. School attainment data are publicly available and accessible via Tableau Public.

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