Cambridge Assessment

The relationship between taking a formal music qualification and overall attainment at Key Stage 4

Research Report

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Introduction

There is a great deal of research which has looked at the relationship between learning a musical instrument (or participating in music education in some form) and children's social, emotional or cognitive development. Much of this research suggests a positive relationship between the two. However, there is very little research in this area in the context of academic achievement in England. This study seeks to address this gap by using national data to investigate whether having formal music tuition is associated with higher attainment at the end of Key Stage 4 (KS4). This is of particular importance currently because of a perception that music education in schools has been 'squeezed out' in recent years due to a focus on more 'academic' subjects (Daubney *et al. 2019*; ISM, 2018)

Previous research

There is large swathe of literature that suggests a positive relationship between participation in music and cognitive development (e.g. Southgate & Roscigno, 2009; Hille & Schupp, 2014; Yang, 2015; Hallam & Rogers, 2016; Guhn *et al.*, 2020). Furthermore, there is some evidence for the magnitude of the effect being greater for those with more music training (Hallam & Rogers, 2016; Guhn *et al.*, 2020). However, the evidence is not unanimous, with some studies finding no significant effect of music on cognitive ability (e.g. Schellenberg, 2011; Elpus, 2013).

A number of possible reasons have been suggested as the mechanism by which music participation might improve cognition and academic achievement. The first of these is via the concept of executive functions (EFs), which can be thought of as the ability to control and regulate thoughts and behaviours. Previous research has demonstrated that EFs are correlated with academic achievement (Best *et al.*, 2011). As described in Slevc *et al.* (2016), the three main EFs relate to inhibition (controlling behaviour), updating (monitoring information and adding it to or removing it from working memory) and switching (moving between tasks). All three EFs may be important in successfully performing music, particularly in a group (Slevc *et al.*, 2016; Guhn *et al*. 2020). Previous research has shown a positive relationship between participation in music and results of tests to assess all or some of these EFs (Nutley *et al.*, 2014; Moradzadeh *et al.*, 2015; Slevc *et al.*, 2016; Jaschke *et al.*, 2018).

Secondly, there may be a motivation or self-efficacy pathway, whereby students who practice a musical instrument on a regular basis take satisfaction in their mastery of skills and achievement of goals (Dege & Schwarzer, 2017; Guhn *et al.*, 2020). This may provide them with additional motivation in other areas of education, leading to improved performance elsewhere.

However, many of the studies that showed a positive relationship between music participation and academic achievement suffer from a substantial shortcoming, in that they were unable to infer the direction of causation. An entirely plausible scenario for the relationship is that students who are more motivated to do well academically are also more likely to learn an instrument. This was the hypothesis explored by Corrigal *et al.* (2013), who investigated whether demographic, cognitive and personality variables were predictive of the duration of music training amongst children and undergraduates. They found that some personality traits that are known to be associated with academic achievement (e.g. openness-to-experience and conscientiousness) were also significant predictors of duration of music training. In an additional model that predicted average school grade, they found that both personality traits and IQ were significant predictors, but duration of music training was not.

Another plausible explanation for the association between music and attainment is that students with more developed EFs may find music practice easier and therefore more rewarding, and thus be more likely to continue to learn an instrument (Slevc *et al.*, 2016).

There is very little research on the relationship between playing a musical instrument and attainment that uses data from England, and even less that focuses on secondary school students. Hallam & Rogers (2016) compared the performance at the end of KS4 of students who had played a musical instrument for at least the past three years with those who had not done so, in three secondary schools in England. They found that after accounting for prior attainment (results of KS2 tests), musicians outperformed non-musicians, and the size of this difference was greater for musicians with more musical experience (4-5 years) than for those with only 2-3 years of playing an instrument.

Playing a musical instrument was one of many different attitudes and behaviours that were found to influence GCSE attainment in a study by Chowdry *et al.* (2011). Their results showed a significant and positive (although very small) association between playing an instrument and GCSE results, after accounting for prior attainment, demographic and family background factors and attitudes towards school. However, this study was based on survey data, with students asked at age 14 whether or not they had played a musical instrument in the past 4 weeks (Chowdry *et al.*, 2009). Thus, it did not indicate students who had taken formal music lessons or undertaken a lot of music practice.

Thus, there is considerable evidence that learning a musical instrument is associated with higher academic achievement, but very little of it uses data from England. The research presented in this report has the advantage of using a very large dataset of students, which includes a large range of factors known to affect attainment, such as gender, deprivation, ethnicity, special needs and school type.

Music education in England

This study's focus on music is important because, for a number of years, there have been concerns about the decline in music education in England (e.g. Daubney *et al.*, 2019; ISM, 2018). A longitudinal survey of teachers found that in 2012/13 music in Key Stage 3 (KS3) was compulsory in 84% of schools. By 2018/19, this had fallen to 48% (Daubney & Mackrill, 2018). The authors of that study also reported a decline in the amount of time spent on music education in KS3. This was likely to be partly due to the increased occurrence of teaching GCSEs across three years, rather than two (ISM, 2018).

At Key Stage 4, the introduction of the EBacc accountability measure[1] may have had an impact on uptake of Music GCSE. In a survey undertaken by the University of Sussex (Daubney &

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[1] The EBacc (**E**nglish **Bacc**alaureate) is a school accountability measure designed to encourage uptake of core academic subjects (English, Maths, Sciences, History or Geography, and a language). Schools are measured on the percentage of pupils taking GCSEs in these subjects and their performance.

Mackrill, 2018), 59% of respondents claimed that the EBacc has had a negative impact on the provision and uptake of music in their school. Research by Cambridge Assessment (Gill, 2012; Carroll & Gill, 2018), however, showed only a very small decline between 2009/10 (the year prior to the introduction of the EBacc) and 2016/17 in the percentage of GCSE students taking Music GCSE (down from 7.4% in 2009/10 to 7.0% in 2016/17). Daubney & Mackrill (2018) also reported a fall in the percentage of schools offering GCSE music, with 18% of respondents saying that their school was not offering the subject at all.

Data and methods

The main source of data for this project was a KS4 extract of the National Pupil Database (NPD), which is administered by the Department for Education (DfE). The NPD includes examination results for all students in all qualifications and subjects in schools and colleges in England, as well as student and school background characteristics such as gender, ethnicity, level of income-related deprivation and school type. We requested the KS4 extract for the 2017/18 academic year, which included data on all students who finished KS4 in that year. The data also included each students' Key Stage 2 (KS2) test results, where available. KS2 tests are taken by students in year 6 (aged 11) in state schools.

Four different music qualifications were used to identify students who took part in formal music tuition prior to taking their KS4 exams. These are outlined in Table 1.

Table 1: Description of music qualifications used to identify music students.

Qualification	Description (including the amount of practical music involved)
GCSE Music[2]	Included assessment of performance on an instrument, both individually and as part of an ensemble (worth 30% of qualification). Options included DJ-ing and sequencing[3], with no indication in the data of which students took this option.
VRQ[4] Certificate in Performance for Music Practitioners	The focus of this qualification was on pop music. Two different versions were available ('Performance' and 'Technology & Composition'). The Performance version had a compulsory unit on 'Live Music Performance' and an optional unit 'Instrumental Study', both of which required a significant amount of practice in order to pass. No indication was given in the data of which version students took.
Graded Music (practical)	A way of formally assessing the achievements of those learning a musical instrument. Available at different levels (called 'grades'), from grade 1 to grade 8. There was no indication in the data of which instrument was learned.
Graded Music (theory)	Taken by students learning an instrument, covering areas such as notation, scales and composition. No practical performance required.

It is important to note that in each of these qualifications (apart from the graded music theory) students can be assessed on their vocal performance instead of on an instrument. Previous

[2] International GCSE was also counted in this category.
[3] Sequencing refers to computer controlled manipulation of a digitally created performance to generate a musical outcome
[4] Vocationally related qualification. These qualifications are designed to give students the knowledge and practical skills required for particular job roles.

research on the effect of musical tuition points towards less benefit from vocal learning than from learning an instrument (e.g. Guhn *et al.*, 2020). Unfortunately, there was no indication in the data of which instrument or voice students were being assessed for. Furthermore, there is apparently no recent data on how many students each year take an assessment for different instruments. However, data from 2009[5] showed that only around 9% of practical graded music exams taken though the ABRSM[6] exam board (the main board offering these qualifications) were for vocal performance. Therefore, we can probably assume that a large majority of the results in the NPD related to assessment of performance on an instrument, rather than for vocal performance. Additionally, for the GCSE and the VRQ, students could choose DJ-ing or sequencing as their 'instrument', and it is unclear whether the potential benefits of learning an instrument would also apply to this context. There was no way of determining from the data which students chose either of these options, but it was likely to be a small minority.

Many of those taking graded music exams had more than one result in the NPD for these qualifications, which was probably due to taking more than one grade in the same instrument. Where this happened, only the highest grade passed was kept. Students were then classified into those passing grade 4 and above and those only passing grades 1-3. This was because the grade passed gave an indication of how long students had been learning the instrument for, which was found in some previous research to be associated with academic achievement (Hallam & Rogers, 2016; Guhn *et al*, 2020).

We included the graded music theory qualification as an indication of music participation because it was very likely that those passing these qualifications (particularly in higher grades) would have learnt an instrument at some point. As with the practical graded music exams, students were classified into those passing grade 4 and above and those only passing grades 1-3. In fact, a large majority (around 75%) of passes for these exams were at grade 5.

One shortcoming with the data on music participation was the possibility of a large amount of missing data on students taking the graded music exams. According to private email communication from the main exam board offering these qualifications (ABRSM) there were an estimated 46,000 students who were expected to finish KS4 in 2016/17 and took at least one of these exams in the previous three years. This compares with around 6,000 students in the NPD for 2017/18. The ABRSM exam board sends data to the DfE on the results of exams taken by secondary school age children (so that they can be included in school performance tables). However, most students taking these exams will have been taught privately and entered by their teacher (i.e. not in a school) and ABRSM may not be aware of details such as the centre number or date of birth of the student. Where this information is missing, it would not be possible to match the student to a record in the NPD.

This missing data was a problem because it meant that some students were incorrectly classified in the data as not taking a graded music qualification. However, the number of these students was relatively low compared to the size of the whole cohort (around 500,000), so it was hoped that it would not have a big impact on the results.

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[5] See http://www.se22piano.co.uk/abrsm-music-exam-facts-and-figures/. The figures were apparently taken from the ABRSM website, but are no longer available from that source.

[6] Associated Board of the Royal Schools of Music

To measure performance at the end of KS4 the average points score (APS) per GCSE and equivalent qualification entry was used. This variable was already in the NPD, but an adjusted version of it was calculated after excluding any of the music qualifications in Table 1.
We were interested in the relationship between music participation (as indicated by the music qualifications detailed in Table 1) and the KS4 APS. However, many other factors have been shown to influence attainment at GCSE (e.g. Gill, 2018) which needed to be accounted for so that the effect of music participation could be isolated. These are outlined in Table 2.

Students with missing data for any of the variables in Table 2 were excluded. This meant removing students from independent schools, as these schools were not required to provide information to the DfE on their students' background, such as their ethnicity, EAL or SEN status. Additionally, about 30,000 students in state maintained schools who did not have KS2 results were also excluded. Finally, students attending special schools were also excluded.

Regression analyses

A statistical model was fitted to determine which factors were most important in predicting KS4 attainment. A multilevel model was used to account for the clustering of students within schools. The general form of the model was as follows:

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \cdots \beta_k x_{kij} + \mu_j + \varepsilon_{ij}$$

Where y_{ij} is the KS4 APS for student i in school j, x_{1ij} to x_{kij} are the independent variables, β_1 to, β_k are the regression coefficients, μ_j is a school effect (technically known as the Level 2 'random' effect) and ε_{ij} is the residual difference between a student's predicted and actual points score.

Each of the different music qualifications were included in the model as separate independent variables (equal to 1 if the student took the qualification and 0 otherwise). The possibility of including an independent variable indicating whether the student had taken any of the music qualifications was also considered. However, as over 92% of the students taking any music qualification took at least the GCSE, the size of the effect for such a variable would have been very similar to the effect for taking GCSE Music.

Additional models were also undertaken with either GCSE Maths grade or GCSE English grade as the outcome variable. The purpose of this was to investigate whether taking any of the music qualifications had a different effect on performance in different subjects. Maths and English were used in this analysis because they were compulsory subjects and were therefore taken by almost all students in the cohort. For English, students had a choice of taking GCSEs in either English Literature or English Language or both. Where students took both subjects, an average of their grade was used.

Table 2: Description of variables included in regression models.

Variable	**Description**
Prior attainment	KS2 average fine level, across Maths and Reading tests.
No. of qualifications taken	A count of the number of GCSE or equivalent qualifications taken. This was an attempt to partially account for a motivation effect on the likelihood of taking music, since more motivated students are probably likely to take more qualifications.
Gender	Male or Female
Ethnicity	The NPD categorised students into one of seven ethnic groups: White, Asian, Black, Chinese, Mixed, Other or Unknown. Chinese students were in a category of their own due to a well-known tendency to perform very well compared to other Asian students.
IDACI	A measure of deprivation commonly used in analyses of student performance is the Income Deprivation Affecting Children Index (IDACI). The IDACI measures the percentage of children in the area where the student lives who are in income-deprived families. Thus, it does not indicate for certain that the students themselves are income deprived.
Free School Meal (FSM) status	An additional indication of deprivation. Students were classified in the NPD by whether or not they had claimed free school meals in any of the past six years.
English as an additional language (EAL) status	The EAL classification in the NPD was into one of three categories: English, Other or Unclassified. It should be noted that the definition of EAL in the NPD only accounted for whether the student was exposed to an additional language in their home or community. It did not actually tell us their level of proficiency in English.
Special Educational Needs (SEN) status	Students with SEN were classified in the NPD into one of three categories: SEN support, Statement of SEN or Education, Health and Care Plan (EHCP). These categories are listed in order of the amount of extra support needed (low to high).
School type	In the NPD schools were classified into Comprehensive; Selective; Secondary Modern; Other Maintained; Independent; Sixth Form College; Other FE. For the present research, we restricted to students in Comprehensive, Selective or Secondary Modern schools.
School mean attainment	Previous research (e.g. Gill, 2018) has found that students of equivalent ability perform better in schools where the average attainment is higher. The school level measure was calculated by averaging the KS2 average fine level for all students (who were at the end of KS4)
School ‘gender’	Students were classified by the gender make-up of the school: Girls’, Boys’ or Mixed.

Results

After excluding the students with missing data there were 478,085 students in the dataset. Table 3 presents the number of students taking each of the music qualifications that were investigated in this research.

Table 3: Number and percentage of students taking music qualifications.

Qualification	No of students	% of cohort
GCSE Music	29,604	6.2
VRQ	926	0.2
Graded Music, grades 1-3	1,297	0.3
Graded Music, grades 4+	1,484	0.3
Music Theory, grades 1-3	126	<0.1
Music Theory, grades 4+	396	0.1
At least one	**32,070**	**6.7**

It is worth noting that a substantial proportion of these students took more than one of these qualifications. The numbers taking different combinations of the qualifications are shown in Table 4.

Table 4: Number and percentage of students taking different combinations of music qualifications.

Qualification of interest	Qualification of interest only	Qualification of interest combined with…					
		GCSE Music	**Graded music 1-3**	**Graded music 4+**	**Music theory 1-3**	**Music theory 4+**	**VRQ**
GCSE Music	28026 (94.7%)	-	377 (1.2%)	765 (2.6%)	82 (0.3%)	172 (0.6%)	44 (0.2%)
Graded music 1-3	897 (69.2%)	377 (29.1%)	-	0	<10	<10	<10
Graded music 4+	559 (37.7%)	765 (51.6%)	<10	-	0	32 (2.2%)	<10
Music theory 1-3	19 (15.1%)	82 (65.1%)	<10	0	-	0	<10
Music theory 4+	71 (17.9%)	172 (43.4%)	<10	32 (2.2%)	0	-	<10
VRQ	873 (94.3%)	44 (4.8%)	<10	<10	<10	<10	-

This shows that students taking GCSE Music were most likely to take no other music qualifications[7]. Of those taking graded music exams at grades 4+, over half combined this with

[7] Although, as described in the data section, there were probably a lot of missing graded music exams, some of which were likely to have been taken by students taking GCSE music as well.

either GCSE music (765). In contrast, it was rare for VRQ students to take any additional music qualifications. Additionally, there were a very small number of students (who are not shown in the table) who combined three of these qualifications. Of these, the largest number (116) took a combination of GCSE music, graded music exams at grades 4+ and music theory at grades 4+.

Table 5 compares the percentages of students in each category of the categorical background variables, between students without any music qualifications and those taking each of the available music qualifications. Table 6 compares the distributions of the continuous background variables, as well as the outcome variables.

These results show some substantial differences between non-music and music students. Those taking the graded music or music theory exams (particularly grades 4+) were, by far, the students with the highest levels of attainment (both current and prior), and the lowest levels of FSM, IDACI and SEN. Next highest attainment (and next lowest FSM, IDACI and SEN) was amongst the graded music / music theory students who only achieved grades 1-3, followed by the GCSE students, the non-music students and the VRQ students. Music students were also much more likely to be female than non-music students, particularly those taking the graded music / music theory exams. In terms of the types of school attended, graded music / music theory students were much more likely to attend selective schools (and single-sex schools) than non-music students, whilst VRQ students were more likely to attend comprehensive schools and mixed sex schools. Finally, music students tended to take more qualifications on average than non-music students, with the highest mean amongst graded music / music theory students (grades 4+).

The results of the regression modelling (with KS4 average points score as the dependent variable) are presented in Table 7. The results of three separate models are presented: an initial model including no predictor variables, to assess the amount of variance in the outcome variable between schools; a second model, including the predictors at the student level (including indicators of whether students took each of the music qualifications); and a final model including predictors at the school level. In each of these models, there were 478,079 students, nested in 3,144 schools. In all of these tables, an asterisk indicates statistical significance.

Table 5: Comparison of music and non-music students (categorical background variables, percentage within each category)

Variable		**No music quals *(n=446,015)***	**GCSE Music *(n=29,604)***	**VRQ *(n=926)***	**Graded music grades 1-3 *(n=1,297)***	**Graded music grades 4+ (*n=1,484*)**	**Music Theory grades 1-3 (*n=126*)**	**Music Theory grades 4+ (*n=396*)**
Gender	Female	49.1	55.5	56.5	61.2	59.0	53.2	60.6
	Male	50.9	44.5	43.5	38.8	41.0	46.8	39.4
Ethnicity	White	77.0	80.5	80.2	73.9	82.9	77.8	83.1
	Asian	10.7	4.7	5.5	11.8	5.7	8.7	6.8
	Black	5.0	5.7	5.7	4.8	2.1	8.7	1.3
	Chinese	0.3	0.8	0.1	1.0	1.7	0.0	1.5
	Mixed	4.5	6.0	6.4	6.1	5.9	4.0	4.6
	Other / Unclassified	2.4	2.3	2.1	2.4	1.8	0.8	2.8
FSM status	No	73.5	81.4	62.7	87.0	93.6	84.1	94.4
	Yes	26.5	18.6	37.3	13.0	6.4	15.9	5.6
EAL status	English	85.5	90.9	87.4	87.4	91.9	87.3	89.9
	Other	14.3	9.0	12.6	12.5	8.1	12.7	10.1
	Unclassified	0.1	0.1	0.0	0.2	0.1	0.0	0.0
SEN status	None	87.4	90.1	82.2	91.8	95.2	93.7	96.2
	SEN Support	10.7	8.7	15.6	6.7	4.5	5.6	3.3
	Statement	0.3	0.2	0.4	0.2	0.1	0.0	0.0
	EHCP	1.5	1.0	1.8	1.4	0.3	0.8	0.5
School type	Comprehensive	92.5	90.1	97.7	86.0	83.3	88.1	84.1
	Selective	4.2	7.6	0.0	12.5	16.0	4.8	14.9
	Secondary Modern	3.3	2.4	2.3	1.5	0.7	7.1	1.0
School gender	Mixed	89.7	86.3	98.2	78.9	79.3	89.7	80.3
	Boys	4.2	5.3	0.0	7.5	9.2	6.4	10.9
	Girls	6.1	8.4	1.8	13.7	11.6	4.0	8.8

Table 6: Comparison of music and non-music students (continuous background variables, mean and standard deviation)

Variable	**No music quals *(n=446,015)***		**GCSE Music *(n=29,604)***		**VRQ *(n=926)***		**Graded music grades 1-3 *(n=1,297)***		**Graded music grades 4+ (*n=1,484*)**		**Music Theory grades 1-3 (*n=126*)**		**Music Theory grades 4+ (*n=396*)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
No. of quals	8.42	1.59	9.04	1.33	8.48	1.32	9.22	1.40	10.05	1.34	9.28	1.30	10.09	1.39
IDACI score	0.20	0.14	0.17	0.13	0.24	0.14	0.15	0.12	0.13	0.12	0.17	0.13	0.12	0.11
KS2 mean fine grade	4.76	0.71	5.02	0.63	4.56	0.80	5.14	0.56	5.38	0.42	5.12	0.54	5.46	0.34
School mean KS2	4.77	0.24	4.85	0.26	4.58	0.21	4.92	0.29	4.99	0.31	4.80	0.25	4.98	0.30
KS4 APS	4.52	1.79	5.40	1.79	4.09	1.62	5.94	1.62	6.83	1.41	5.63	1.35	7.16	1.21
Average English GCSE grade	4.69	1.84	5.52	1.82	4.32	1.82	5.92	1.66	6.73	1.47	5.79	1.52	6.92	1.33
Maths GCSE grade	4.62	2.05	5.49	2.08	4.06	1.97	6.08	1.88	6.98	1.73	5.77	1.79	7.38	1.52

Table 7: Regression coefficients (outcome variable = KS4 APS, standard errors in brackets)

Fixed effects		**Model 1**	**Model 2**	**Model 3**
Intercept		4.515 (0.015)*	4.446 (0.037)*	4.712 (0.037)*
KS2 mean			1.231 (0.003)*	1.229 (0.003)*
No of quals			0.407 (0.001)*	0.406 (0.001)*
Gender	Female			
	Male		-0.464 (0.003)*	-0.463 (0.003)*
Ethnicity	White			
	Asian		0.155 (0.007)*	0.153 (0.007)*
	Black		0.087 (0.008)*	0.086 (0.008)*
	Chinese		0.456 (0.027)*	0.452 (0.027)*
	Mixed		0.053 (0.007)*	0.052 (0.007)*
	Other / Unclassified		0.104 (0.011)*	0.103 (0.011)*
IDACI score			-0.942 (0.014)*	-0.931 (0.014)*
FSM status	N			
	Y		-0.298 (0.004)*	-0.297 (0.004)*
EAL status	English			
	Other		0.286 (0.006)*	0.287 (0.006)*
	Unclassified		0.076 (0.042)	0.075 (0.042)
SEN status	None			
	SEN Support		-0.086 (0.005)*	-0.088 (0.005)*
	Statement		0.527 (0.026)*	0.524 (0.026)*
	EHCP		0.606 (0.013)*	0.603 (0.013)*
GCSE Music	No			
	Yes		0.178 (0.006)*	0.177 (0.006)*
Graded Music	No			
	Grades 1-3		0.282 (0.029)*	0.280 (0.029)*
	Grades 4+		0.358 (0.028)*	0.356 (0.028)*
Music Theory	No			
	Grades 1-3		0.031 (0.094)	0.033 (0.094)
	Grades 4+		0.482 (0.053)*	0.481 (0.053)*
Music VRQ	No			
	Yes		-0.089 (0.036)*	-0.084 (0.036)*
School type	Comprehensive			
	Selective			0.153 (0.051)*
	Secondary Modern			-0.145 (0.044)*
School mean KS2				0.383 (0.042)*
School gender	Mixed			
	Boys			0.233 (0.042)*
	Girls			0.240 (0.034)*
Random effects				
Level 1		2.651 (0.005)*	1.063 (0.002)*	1.063 (0.002)*
Level 2 - intercept		0.696 (0.018)*	0.224 (0.006)*	0.193 (0.005)*

The results of model 1 suggest that the use of a multilevel model was justified (see *random effects* section of the table). The intra-class correlation coefficient (ICC) tells us what proportion of the variation in outcomes was explained by differences between schools. This is calculated as:

$$ICC = \frac{school\ variance}{school\ variance + error\ variance} = \frac{0.696}{0.696 + 2.651} = 0.208$$

Thus, just over 20% of the variation was due to differences between schools. This is a substantial percentage and means that the use of a multilevel model was justified.

For the categorical variables, the regression coefficients in the table represent the change in the outcome variable associated with a particular category compared with the baseline category. For each of the variables indicating music participation, the baseline was students who did not take the qualification in question. Therefore, the coefficient for that variable indicates the change in KS4 APS associated with taking the qualification (holding all other variables constant) For example, in model 3 we can see that there was a significant and positive effect of taking GCSE music. The size of the effect (0.177) means that taking it was associated with an increase in average points score of approximately 1/6th of a grade (i.e. an improvement of one grade in every sixth qualification). There was also a significant and positive effect of taking a graded music exam (0.280 for grades 1-3 and 0.356 for grades 4+). For the grade music theory exam there was only evidence of a significant positive effect for those taking grades 4+. This was the largest effect (0.481) according to the model, equivalent to an increase of almost half a grade per qualification. Finally, there was a significant but very small negative effect associated with taking the VRQ (-0.084).

To put these results in context, Figure 1 presents the predicted values of the KS4 APS for students taking each of the different music qualifications. The predicted value for the students with no music qualification is given for comparison. These predictions were for students in the reference category for all of the categorical variables, and with a value of each continuous variable equal to its mean. The error bars in the figure show the 95% confidence intervals for the predictions.

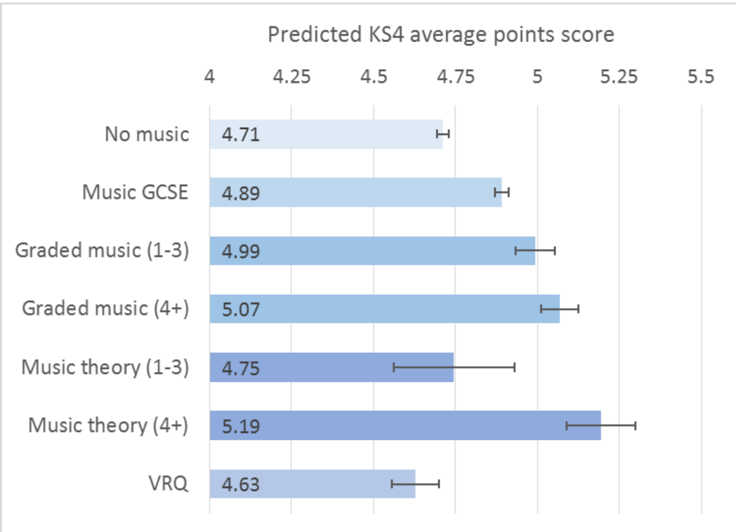


Figure 1: Predicted KS4 APS for students taking different music qualifications.

The predicted KS4 APS was 4.71 for non-music students, 4.89 for those taking music GCSE, rising to 5.19 for those taking the music theory at grades 4 and above.

The results of the models with Maths and English grade as the outcome variables are shown in Appendix A (only Model 3, including predictors both at the individual and school level). The regression coefficients for the music qualification variables for these models are presented in Table 8. These show similar results, with a slightly larger effect of taking GCSE Music on English grade (0.173) than on Maths grade (0.129) and a slightly larger effect of taking graded music exams on Maths grade (0.295 and 0.274) than on English grade (0.155 and 0.229). The effect of taking music theory at grades 4 or higher was substantially lower for English (0.224) than for Maths (0.462).

Table 8: Regression coefficients (outcome variable = subject grades, standard errors in brackets)

Variable	Maths grade	English (average) grade
GCSE Music	**0.129 (0.007)**	**0.173 (0.007)**
VRQ	**-0.111 (0.041)**	0.026 (0.041)
Graded Music, grades 1-3	**0.295 (0.034)**	**0.155 (0.033)**
Graded Music, grades 4+	**0.274 (0.032)**	**0.229 (0.032)**
Music Theory, grades 1-3	-0.047 (0.108)	0.011 (0.108)
Music Theory, grades 4+	**0.462 (0.062)**	**0.224 (0.061)**

Additional regression models were undertaken to check for any significant interaction effects between each of the music qualification variables and the background variables in the main model (with KS4 average points score as the dependent variable). The purpose of this was to investigate whether the effects of taking music qualifications, which were observed in the main model, varied amongst different groups of students. The results of these models are presented in Appendix B (for Model 3, including predictors both at the individual and school level). We now summarise the main significant interaction effects for each outcome variable in turn. Note that there were some interaction effects that were significant, but were not included in the summary below because the size of the effect was so small as to be of no practical importance.

GCSE Music

Interpreting interaction effects can be difficult, but one way to do this is by generating some predicted values (according to the regression model) of the outcome variable for different combinations of the interacting variables[8]. For example, there was a significant interaction effect between GCSE music and levels of prior attainment. The effect of this can be seen in Figure 2, which compares the predicted KS4 APS for students taking GCSE music with those not taking it, for different levels of prior attainment. This shows that the positive effect of taking music was only present for those with higher levels of prior attainment, and was largest for those with the highest prior attainment. For example, the benefit was 0.33 of a grade for those with KS2 mean fine grade of 5.5, compared with just 0.06 of a grade for a KS2 mean fine grade of 4.5.

Note that the range of values of the x-axis for this figure (and subsequent ones) was restricted to contain only values with a reasonable number of students on or around each data point.

[8] With all other variables set to the reference category (for categorical variables) or the mean value (for continuous variables)

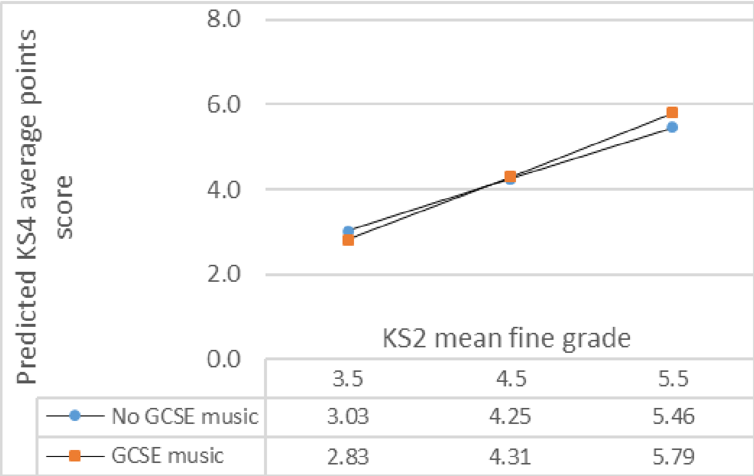


Figure 2: Predicted KS4 APS for GCSE music and non-GCSE music students by prior attainment.

There was a significant interaction effect between GCSE music and ethnicity, as shown in Figure 3. This shows that the positive effect of GCSE music was mainly present for White and Asian students only. The effect for Black students was very small and was slightly negative for Chinese students.

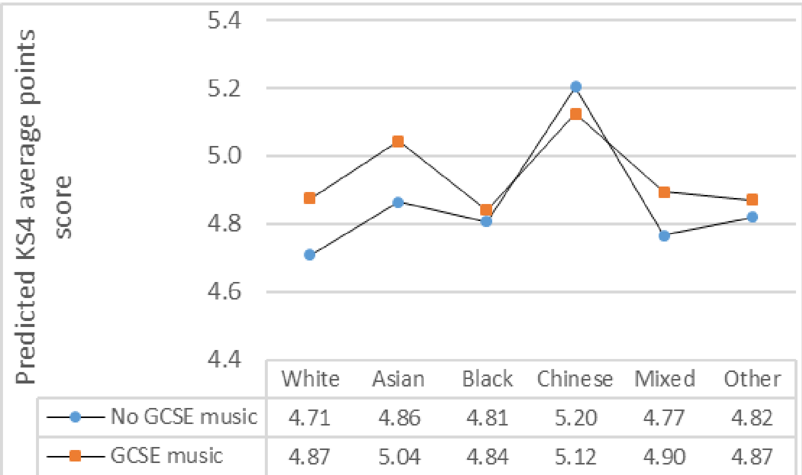


Figure 3: Predicted KS4 APS for GCSE music and non-GCSE music students by ethnicity.

There was also a significant interaction between GCSE music and SEN status. Figure 4 shows that the positive effect of taking GCSE music was larger for students without SEN than for those with any SEN. This effect was significant for those with SEN support or an EHCP, but not for those with a statement (the number of students with a statement taking music was very low). For students with an EHCP, the effect of taking music was apparently negative.

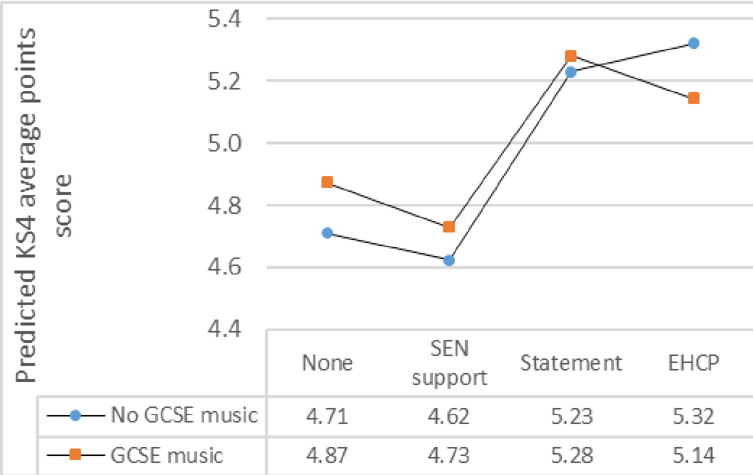


Figure 4: Predicted KS4 APS for GCSE music and non-GCSE music students by SEN status.

Finally, there was a significant interaction effect between GCSE music and school type, with the effect of GCSE music only being positive for students in comprehensive schools. This can be seen in Figure 5.

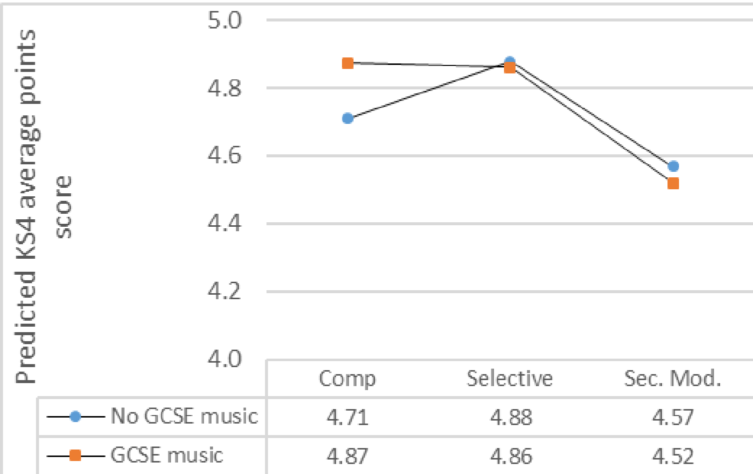
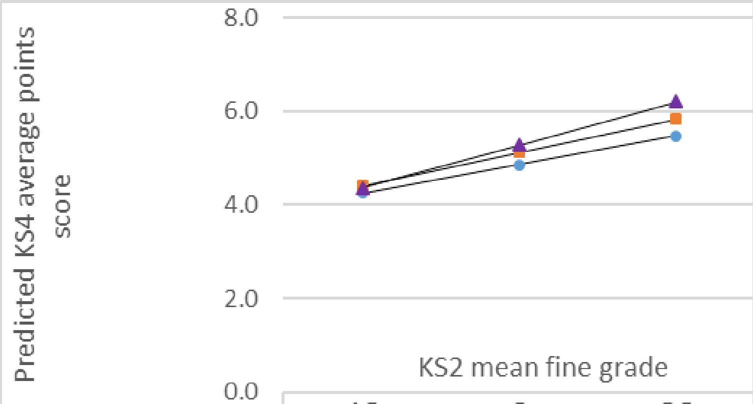


Figure 5: Predicted KS4 APS for GCSE music and non-GCSE music students by school type.

Graded Music Exams

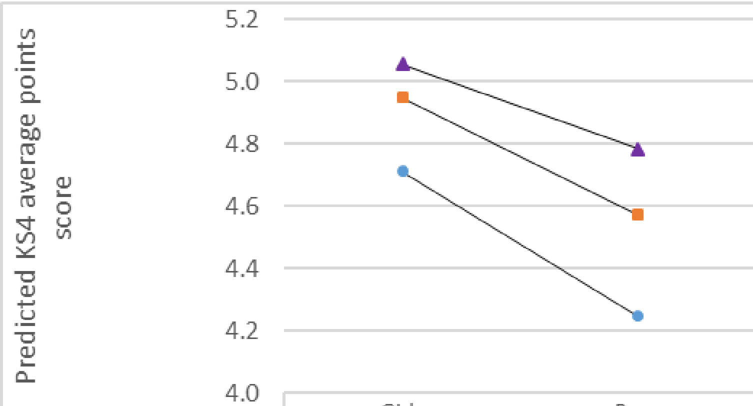
For the graded music exams, there was a significant interaction with prior attainment, as shown in Figure 6. The positive effect associated with taking graded music exams was only present for students with higher prior attainment. This was true for both grades 1-3 students and grades 4+ students, but the effect was larger for the latter.



	4.5	5	5.5
No graded music	4.24	4.86	5.47
Grades 1-3	4.40	5.12	5.83
Grades 4+	4.35	5.28	6.20

Figure 6: Predicted KS4 APS for graded music and non-graded music students by prior attainment.

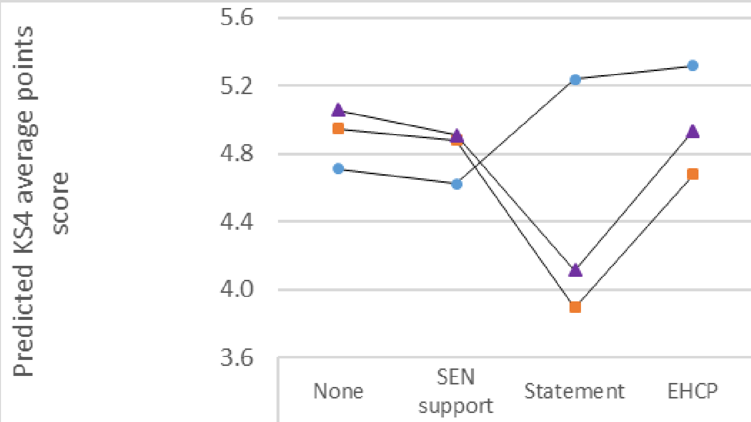
Figure 7 presents the interaction between gender and graded music exams. This was only significant for the difference between no music and taking graded music exams at grades 4+ and suggests that boys benefited to a larger degree (0.53 of a grade) than girls (0.35 of a grade).



	Girls	Boys
No graded music	4.71	4.25
Grades 1-3	4.95	4.57
Grades 4+	5.06	4.78

Figure 7: Predicted KS4 APS for graded music and non-graded music students by gender.

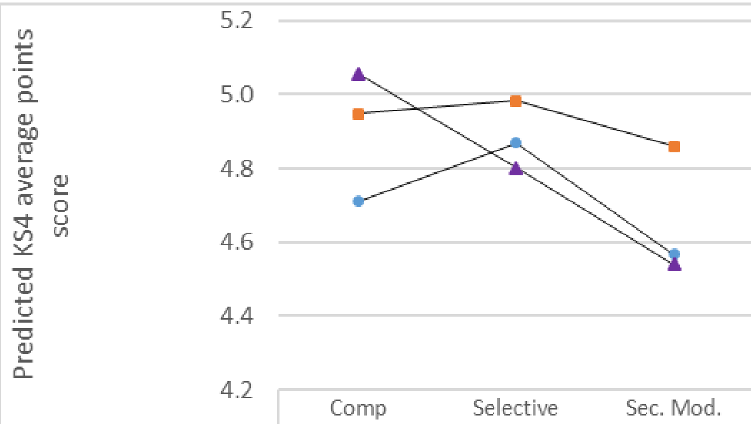
The interaction between graded music exams and SEN status is shown in Figure 8. This interaction was only significant for the difference between statement or EHCP students and those without SEN. It suggests that taking graded music exams was only beneficial for students without SEN or in the SEN support category. The effect for statement or EHCP students was negative. However, we need to be cautious about inferring anything from this pattern because of the very low numbers of students with a statement or EHCP who also took graded music exams (fewer than 10 students with a statement and fewer than 25 with an EHCP).



	None	SEN support	Statement	EHCP
No graded music	4.71	4.62	5.24	5.32
Grades 1-3	4.95	4.88	3.90	4.68
Grades 4+	5.06	4.91	4.11	4.93

Figure 8: Predicted KS4 APS for graded music and non-graded music students by SEN status.

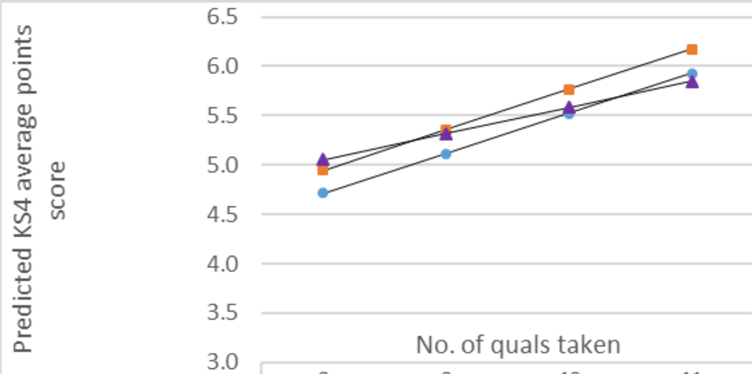
A further significant effect was present for the interaction between graded music exams and school type. Figure 9 shows that the positive effect of taking grades 4+ was only present for students in comprehensive schools.



	Comp	Selective	Sec. Mod.
No graded music	4.71	4.87	4.57
Grades 1-3	4.95	4.98	4.86
Grades 4+	5.06	4.80	4.54

Figure 9: Predicted KS4 APS for graded music and non-graded music students by school type.

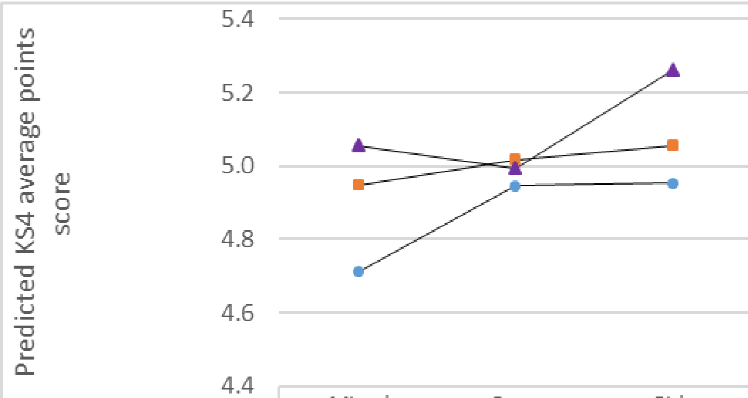
Figure 10 shows the interaction between graded music exams and the number of qualifications taken. This interaction was only significant for the comparison between no graded music students and those taking grades 4+. The impact associated with taking grades 4+ was larger for those taking fewer qualifications, with almost no difference in predicted performance for those taking 10 or 11 qualifications.



	8	9	10	11
No graded music	4.71	5.12	5.52	5.93
Grades 1-3	4.95	5.36	5.76	6.17
Grades 4+	5.06	5.32	5.58	5.85

Figure 10: Predicted KS4 APS for graded music and non-graded music students by number of qualifications taken.

Finally, there was a significant interaction with school gender, as shown in Figure 11. The effect of taking graded music exams at grade 4+ was much larger for students in mixed sex schools than for students in boys' schools. There were no significant differences between no graded music and grades 1-3.



	Mixed	Boys	Girls
No graded music	4.71	4.95	4.95
Grades 1-3	4.95	5.02	5.06
Grades 4+	5.06	4.99	5.26

Figure 11: Predicted KS4 APS for graded music and non-graded music students by school sex.

Music Theory Exams

As with other music qualifications, there was a significant interaction effect between taking music theory (at grades 4+ only) and prior attainment, with the positive association between grades 4+ and KS4 APS greater for higher achieving students. Note that the range of values for the prior attainment variable was restricted to between 5 and 5.5, due to low numbers of students who were outside of this range and took music qualifications.

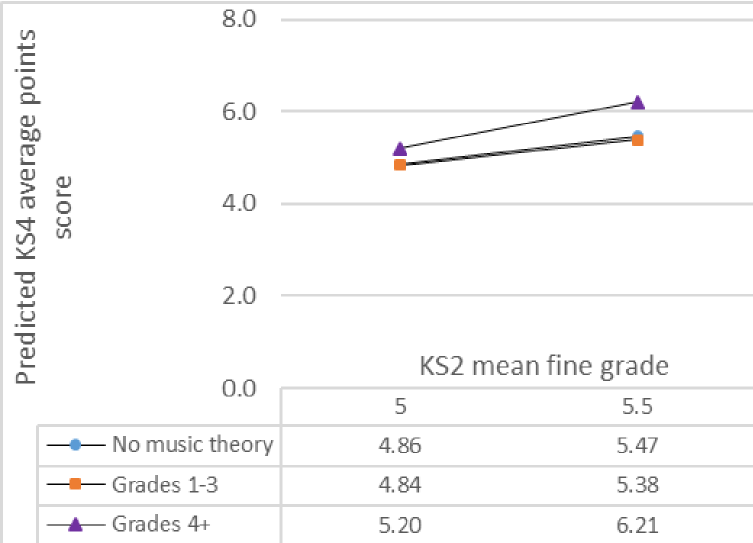


Figure 12: Predicted KS4 APS for music theory and non-music theory students by prior attainment.

The significant interaction between music theory exams and gender is shown in Figure 13. Amongst girls, there was only a significant positive effect of taking grades 4+, whereas for boys there appeared to be a positive effect of taking grades 1-3 as well. Furthermore, the positive impact of taking grades 4+ was larger for boys than for girls (although this difference was not statistically significant).

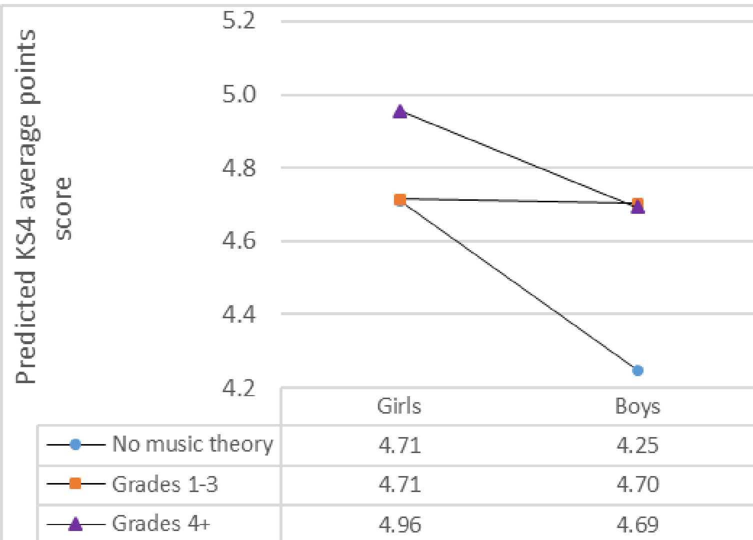


Figure 13: Predicted KS4 APS for music theory and non-music theory students by gender.

Figure 14 shows the interaction between school mean prior attainment and music theory. This shows that the positive effect of taking grades 4+ was only present for students who attended schools with lower levels of mean prior attainment.

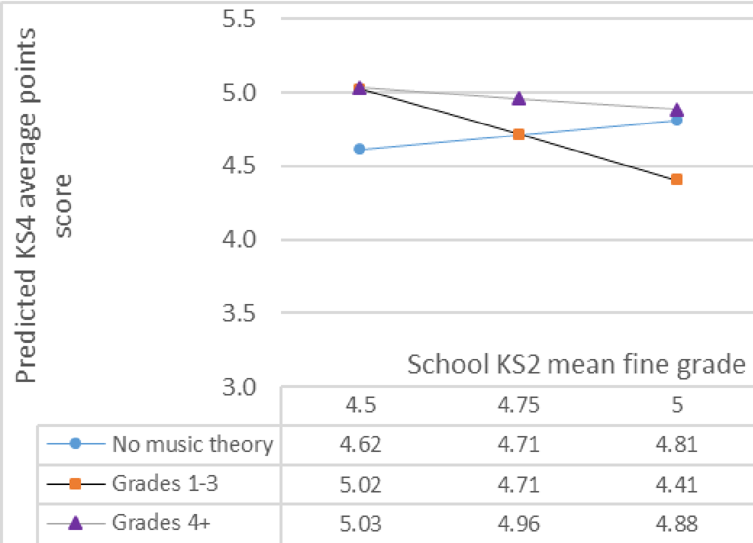


Figure 14: Predicted KS4 APS for music theory and non-music theory students by school mean KS2.

There was also a significant interaction effect between EAL status and music theory, as shown in Figure 15. This suggests that the positive impact for music theory students was only present amongst those speaking English. In fact, EAL students taking music theory exams had a much lower predicted outcome than those not taking these exams.

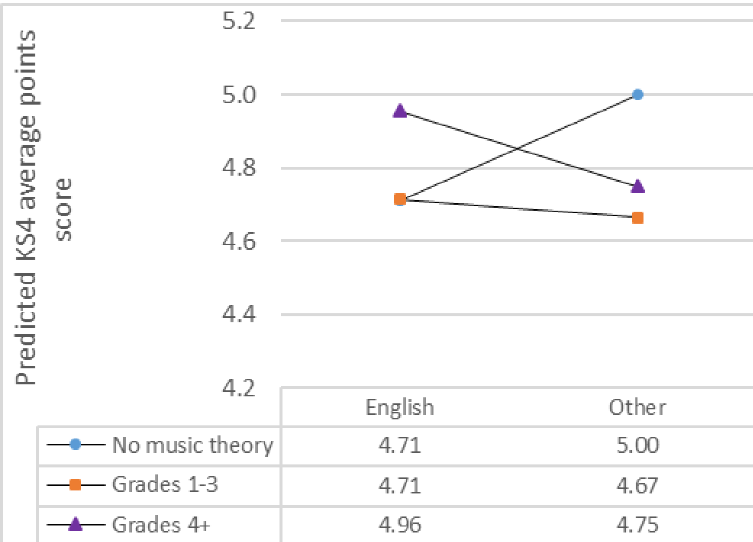


Figure 15: Predicted KS4 APS for music theory and non-music theory students by EAL status

Finally, Figure 16 shows the interaction between music theory and the number of qualifications taken. This shows that as the number of qualifications increases, the positive effect of taking music theory grades 4+ decreases.

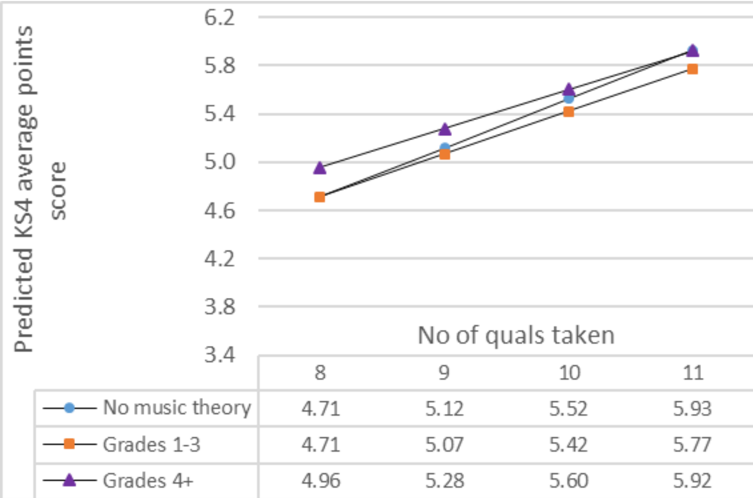


Figure 16: Predicted KS4 APS for music theory and non-music theory students by number of qualifications taken

VRQs

In Figure 17, the interaction between the VRQ and number of qualifications is shown. From this, it can be seen that the negative effect of taking a VRQ in music increased as the number of qualifications increased.

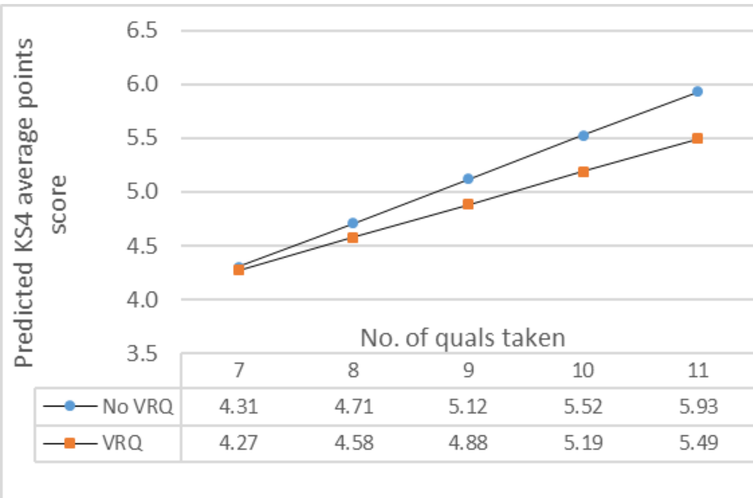


Figure 17: Predicted KS4 APS for VRQ and non-VRQ students by number of qualifications taken

There was a significant interaction with gender, as shown in Figure 18, with the negative impact of VRQ only present for girls and not for boys.

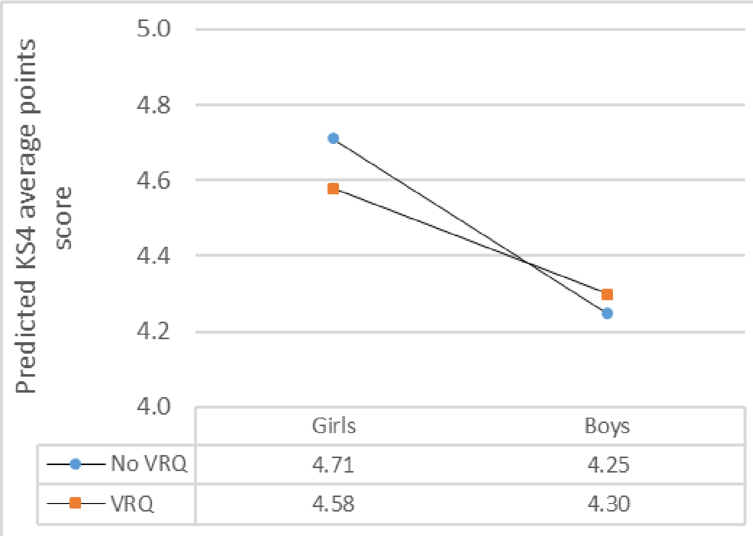


Figure 18: Predicted KS4 APS for VRQ and non-VRQ students by gender

Finally, Figure 19 presents the significant interaction between VRQ and EAL status, showing that there was a positive effect of taking the VRQ for students without English as an additional language, in contrast to the negative effect for students with English as an additional language.

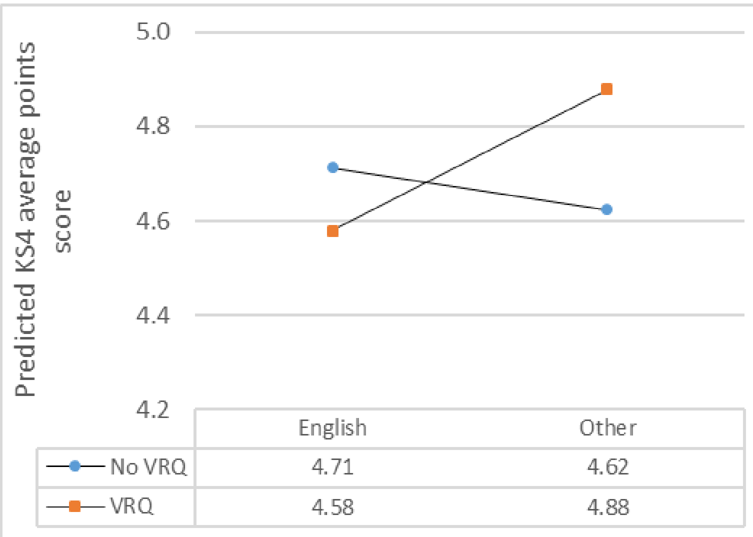


Figure 19: Predicted KS4 APS for VRQ and non-VRQ students by EAL status

Discussion

The results of this detailed analysis of national data found a positive association between taking particular music qualifications and achievement at the end of KS4. The results confirm previous findings of a positive relationship (e.g. Southgate & Rosigno, 2009; Hille & Schupp, 2014; Yang, 2015; Hallam & Rogers, 2016; Guhn *et al.*, 2020). The effects were larger for graded music or music theory qualifications at grades 4 and above than for GCSE Music. In contrast, there was a negative (but very small) association between taking a VRQ in Music and KS4 attainment.

The size of the positive effect of music qualifications was comparable with previous studies. The effect sizes were 0.10 for GCSE Music, 0.20 for graded music exams (grades 4+) and 0.27 for music theory (grades 4+). In previous research where an effect size was reported, the effects varied between 0.17 (Hille & Schupp, 2014) and 0.34 (Guhn *et al.*, 2020). The effects found in the current study were also substantive in terms of what they implied for attainment at KS4. The size of the effect for GCSE Music was equivalent to one grade in every sixth qualification, for graded music exams (grades 4+) it was one grade in every third qualification and for music theory, it was almost one grade in every second qualification.

There were some interesting differences in the size of the effect of taking music qualifications on attainment in English and Mathematics (see Table 8). In particular, the fact that the effect was larger for Mathematics than for English (for all music qualifications apart from GCSE Music). This fits in with the popular belief of a link between learning music and Mathematical attainment (Gowers, 2011). The hypothesis proposed in many studies investigating such a link is that musical tuition enhances spatial-temporal skills, which are also linked to attainment in Mathematics (Vaughn, 2000; Holmes & Hallam, 2017). However, evidence on the benefits of music on attainment in Mathematics is mixed (Vaughn, 2000; Sala & Gobet, 2017) and there appears to be no solid evidence to suggest a larger effect on Mathematics performance than on performance in other subjects.

We also found a number of significant interactions between taking a music qualification and the background variables included in the regression models. Some of these effects were consistent across most of the different music qualifications. For instance, prior attainment interacted positively with GCSE Music, Graded Music and Music Theory (grades 4+ only) qualifications, meaning that the positive effect of these qualifications was greater for students with higher levels of prior attainment. The size of the effects was substantial, particularly for graded music and music theory exams. For example, students who had a mean KS2 fine grade of 5 and took graded music exams at grades 4+ had an advantage of 0.42 of a grade per qualification over those not taking graded music exams. However, this advantage increased to over a grade per qualification for students with a mean KS2 fine grade of 6. This result contrasts with some previous research, which found that the positive impact of music was greater for students with lower prior attainment (Hille & Schupp, 2014).

There was a significant negative interaction effect between the number of qualifications taken and taking graded music (grades 4+ only), music theory or VRQ Music. In other words, for the graded music or music theory exams, the positive impact of taking the qualifications was larger for students with fewer other qualifications. For the VRQ, the negative effect of taking it was larger for those taking more other qualifications. A possible reason for this is that for students who took a large number of qualifications the additional burden of practising an instrument may have had a detrimental effect on overall attainment.

Combining these two interaction effects suggests that those most likely to benefit from taking graded music exams were those of high ability who did not take a large number of other qualifications.

There was a consistent interaction between gender and music qualifications (excluding GCSE Music), whereby boys apparently received more benefit than girls did. For the graded music and music theory exams, this meant a larger positive effect for boys; for the VRQ this meant that the negative effect was only present for girls. However, in each case the effect was not large, being less than 0.2 of a grade advantage for boys compared with girls.

Finally, one interaction effect was consistent across GCSE Music and Graded Music Exams only. This related to special needs status, with students without special needs more likely to benefit from either music qualification than those with SEN (particularly statement and EHCP students). The effect was largest for Graded Music students with a statement, but we need to be cautious about the size of the effect given the very small number of students in this group (fewer than 10 at both grades 1-3 and grades 4+). It is not clear why this effect was present, but one possibility was that learning an instrument meant that SEN students had less opportunity to undertake additional academic work, which enabled them to keep up with their peers.

A number of limitations with this study need to be mentioned. Most importantly, and as mentioned in several previous studies (Yang, 2015; Hallam & Rogers, 2016; Guhn *et al.*, 2020), we need to be cautious about concluding that learning an instrument as part of extracurricular activities (e.g. in graded music exams) *led to* better academic attainment. We cannot know for certain the direction of causation. It may be that students who were more motivated to do well academically (or who had parents who put more pressure on them to do so) were also more likely to participate in extracurricular activities such as these. We attempted to control for a motivation effect, by including a variable indicating the number of different (GCSE or equivalent) qualifications taken, since it is likely that more motivated students would take more qualifications on average. This variable had a significant and positive association with KS4 attainment. It is worth noting that when a model was run which excluded the number of qualifications variable, the size of the coefficients for the music qualifications increased (Graded Music 1-3 = 0.37, Graded Music 4+ = 0.63, Music Theory 1-3 = 0.04, Music Theory 4+ = 0.61). One possible explanation for this difference would be that the number of qualifications variable was indeed capturing a motivation effect.

In contrast to the effect of taking graded music exams, the positive effect of taking GCSE Music should not be confounded by a motivation effect. This is not an extracurricular activity and thus there was no reason to suggest that GCSE Music students were more motivated than those not taking this qualification were. Therefore, we can say with more certainty that the regression results showed some evidence that taking GCSE Music was associated with improved attainment at KS4. The size of the effect was equivalent to 1/6 of a grade which, whilst not a large effect, is not trivial.

An additional limitation of this study was the issue of the missing data on graded music exams, meaning a potentially large number of students were incorrectly categorised as not having taken a graded music exam. Given that we found a significant positive effect of taking these exams, then if we assume that the incorrectly categorised students were similar to others taking them, it may be that the true effect was larger than that estimated by the regression model.

Finally, a potential shortcoming in the data was the presence of students who regularly practised an instrument but did not take any music qualifications. An example of this would be those who were in pop or rock bands in their spare time. Again, as these students would not have been included in the groups taking a music qualification, it may be that the positive effect was larger than estimated by the regression models.

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Appendix A

Table A1: Regression coefficients (outcome variable = average English GCSE grade, standard errors in brackets)

Fixed effects		
Intercept		**4.988 (0.009)**
KS2 mean		**1.147 (0.003)**
No of quals		**0.406 (0.002)**
Gender	Female	
	Male	**-0.727 (0.004)**
Ethnicity	White	
	Asian	**0.244 (0.008)**
	Black	**0.231 (0.009)**
	Chinese	**0.196 (0.031)**
	Mixed	**0.135 (0.009)**
	Other / Unclassified	**0.123 (0.012)**
IDACI score		**-0.939 (0.017)**
FSM status	No	
	Yes	**-0.287 (0.004)**
EAL status	English	
	Other	**0.162 (0.007)**
	Unclassified	**0.127 (0.049)**
SEN status	None	
	SEN Support	**-0.231 (0.006)**
	Statement	**0.217 (0.032)**
	EHCP	**0.253 (0.015)**
GCSE Music	No	
	Yes	**0.173 (0.007)**
Graded Music	No	
	Grades 1-3	**0.155 (0.033)**
	Grades 4+	**0.229 (0.032)**
Graded Music Theory	No	
	Grades 1-3	0.011 (0.108)
	Grades 4+	**0.224 (0.061)**
Music VRQ	No	
	Yes	0.026 (0.041)
School type	Comp	
	Selective	-0.075 (0.050)
	Sec. Mod.	**-0.144 (0.043)**
School mean KS2		**0.425 (0.041)**
School gender	Mixed	
	Boys	**0.257 (0.039)**
	Girls	**0.238 (0.033)**
Random effects		
Level 1		**1.403 (0.003)**
Level 2 - intercept		**0.181 (0.005)**

Table A2: Regression coefficients (outcome variable = Maths GCSE grade, standard errors in brackets)

Fixed effects		
Intercept		**4.463 (0.010)**
KS2 mean		**1.654 (0.003)**
No of quals		**0.471 (0.002)**
Gender	Female	
	Male	**0.139 (0.004)**
Ethnicity	White	
	Asian	**0.215 (0.008)**
	Black	**0.005 (0.009)**
	Chinese	**0.748 (0.031)**
	Mixed	**-0.044 (0.009)**
	Other / Unclassified	**0.085 (0.012)**
IDACI score		**-0.783 (0.017)**
FSM status	No	
	Yes	**-0.244 (0.004)**
EAL status	English	
	Other	**0.316 (0.007)**
	Unclassified	-0.011 (0.049)
SEN status	None	
	SEN Support	**-0.013 (0.006)**
	Statement	**0.485 (0.032)**
	EHCP	**0.541 (0.016)**
GCSE Music	No	
	Yes	**0.129 (0.007)**
Graded Music	No	
	Grades 1-3	**0.295 (0.034)**
	Grades 4+	**0.274 (0.032)**
Graded Music Theory	No	
	Grades 1-3	-0.047 (0.108)
	Grades 4+	**0.462 (0.062)**
Music VRQ	No	
	Yes	**-0.111 (0.041)**
School type	Comp	
	Selective	**0.172 (0.053)**
	Sec. Mod.	**-0.100 (0.046)**
School mean KS2		**0.244 (0.044)**
School gender	Mixed	
	Boys	**0.111 (0.041)**
	Girls	**0.185 (0.036)**
Random effects		
Level 1		**1.403 (0.003)**
Level 2 - intercept		**0.181 (0.005)**

Appendix B

Table B1: Regression coefficients including interaction effects with GCSE Music (outcome variable =KS4 APS, standard errors in brackets)

Fixed effects		
Intercept		4.710 (0.009)*
KS2 mean		1.216 (0.003)*
No of quals		0.406 (0.001)*
Gender	Female	
	Male	-0.468 (0.003)*
Ethnicity	White	
	Asian	0.154 (0.007)*
	Black	0.098 (0.008)*
	Chinese	0.494 (0.029)*
	Mixed	0.057 (0.008)**
	Other / Unclassified	0.111 (0.011)*
IDACI score		-0.915 (0.015)*
FSM status	No	
	Yes	-0.295 (0.004)*
EAL status	English	
	Other	0.286 (0.006)*
	Unclassified	0.076 (0.043)
SEN status	None	
	SEN Support	-0.086 (0.005)*
	Statement	0.521 (0.027)*
	EHCP	0.611 (0.013)*
GCSE Music	No	
	Yes	0.165 (0.012)*
Graded Music	No	
	Grades 1-3	0.277 (0.029)*
	Grades 4+	0.316 (0.028)*
Graded Music Theory	No	
	Grades 1-3	0.014 (0.094)
	Grades 4+	0.425 (0.053)*
Music VRQ	No	
	Yes	-0.087 (0.036)*
School type	Comp	
	Selective	0.168 (0.051)*
	Sec. Mod.	-0.141 (0.044)*
School mean KS2		0.387 (0.042)*
School gender	Mixed	
	Boys	0.229 (0.039)*
	Girls	0.241 (0.034)*
GCSE music*KS2 mean	No	
	Yes	0.268 (0.012)*
GCSE music*No of quals	No	
	Yes	-0.012 (0.005)*
GCSE music*Gender	No – Female	
	Yes – Male	0.076 (0.013)*
GCSE music*Ethnicity	No – White	
	Yes – Asian	0.015 (0.033)
	Yes – Black	-0.131 (0.029)*
	Yes – Chinese	-0.244 (0.075)*
	Yes – Mixed	-0.036 (0.027)
	Yes – Other / Unclassified	-0.115 (0.042)*
GCSE music*FSM status	No – Not FSM	
	Yes – FSM	-0.047 (0.018)*
GCSE music*IDACI	No	
	Yes	-0.272 (0.056)*
GCSE music*EAL status	No – English	
	Yes – Other	-0.008 (0.025)
	Yes – Unclassified	-0.030 (0.198)
GCSE music*SEN status	No – None	
	Yes – SEN Support	-0.060 (0.023)*
	Yes – Statement	-0.113 (0.145)
	Yes – EHCP	-0.341 (0.063)*
GCSE music*School type	No – Comp	
	Yes – Selective	-0.181 (0.038)*
	Yes – Sec Mod	-0.049 (0.042)
GCSE music*School KS2 mean	No	
	Yes	-0.076 (0.041)
GCSE music*School gender	No – Mixed	
	Yes – Boys	0.040 (0.033)

Fixed effects		
	Yes – Girls	0.003 (0.026)
Random effects		
Level 1 Level 2 - intercept		1.061 (0.002)* 0.193 (0.005)*

Table B2: Regression coefficients including interaction effects with Graded Music (outcome variable =KS4 APS, standard errors in brackets)

Fixed effects		
Intercept		4.711 (0.009)*
KS2 mean		1.228 (0.003)*
No of quals		0.406 (0.001)*
Gender	Female	
	Male	-0.464 (0.003)*
Ethnicity	White	
	Asian	0.153 (0.007)*
	Black	0.086 (0.008)*
	Chinese	0.462 (0.027)*
	Mixed	0.054 (0.007)*
	Other / Unclassified	0.103 (0.011)*
IDACI score		-0.929 (0.015)*
Ever FSM	No	
	Yes	-0.297 (0.004)*
EAL status	English	
	Other	0.287 (0.006)*
	Unclassified	0.083 (0.042)*
SEN status	None	
	SEN Support	-0.088 (0.005)*
	Statement	0.527 (0.027)*
	EHCP	0.605 (0.013)*
Music GCSE	No	
	Yes	0.178 (0.006)*
Graded Music	No	
	Grades 1-3	0.237 (0.057)*
	Grades 4+	0.345 (0.064)*
Graded Music Theory	No	
	Grades 1-3	0.036 (0.094)
	Grades 4+	0.461 (0.053)*
Music VRQ	No	
	Yes	-0.084 (0.036)*
School type	Comp	
	Selective	0.157 (0.051)*
	Sec. Mod.	-0.145 (0.044)*
School mean KS2		0.383 (0.042)*
School gender	Mixed	
	Boys	0.234 (0.039)*
	Girls	0.241 (0.034)*
Graded Music*KS2 mean	No	
	Grades 1-3	0.201 (0.061)*
	Grades 4+	0.624 (0.075)*
Graded Music *No of quals	No	
	Grades 1-3	0.002 (0.025)
	Grades 4+	-0.143 (0.023)*
Graded Music *Gender	No – Female	
	Grades 1-3 – Male	0.087 (0.067)
	Grades 4+ – Male	0.192 (0.062)*
Graded Music *Ethnicity	No – White	
	Grades 1-3 – Asian	0.162 (0.113)
	Grades 4+ – Asian	-0.092 (0.131)
	Grades 1-3 – Black	-0.061 (0.145)
	Grades 4+ – Black	0.196 (0.198)
	Grades 1-3 – Chinese	0.175 (0.300)
	Grades 4+ – Chinese	-0.502 (0.224)*
	Grades 1-3 – Mixed	-0.067 (0.125)
	Grades 4+ – Mixed	-0.338 (0.117)*
	Grades 1-3 – Other	-0.083 (0.198)
	Grades 4+ – Other	0.063 (0.209)
Graded Music *Ever FSM	No – Not FSM	
	Grades 1-3 – FSM	0.087 (0.093)
	Grades 4+ – FSM	0.008 (0.124)
Graded Music *IDACI	No	
	Grades 1-3	-0.361 (0.279)
	Grades 4+	-0.400 (0.276)
Graded Music *Language	No – English	
	Grades 1-3 – Other	-0.062 (0.109)
	Grades 4+ – Other	-0.089 (0.116)
	Grades 1-3 – Unclassified	-2.083 (0.754)*
	Grades 4+ – Unclassified	-0.048 (1.056)
Graded Music *SEN	No – None	
	Grades 1-3 – SEN Support	0.018 (0.121)

Fixed effects		
	Grades 4+ – SEN Support Grades 1-3 – Statement Grades 4+ – Statement Grades 1-3 – EHCP Grades 4+ – EHCP	-0.059 (0.132) -1.579 (0.741)* -1.471 (0.736)* -0.877 (0.252)* -0.727 (0.520)
Graded Music *School type	No – Comp Grades 1-3 – Selective Grades 4+ – Selective Grades 1-3 – Sec Mod Grades 4+ – Sec Mod	 -0.122 (0.157) -0.412 (0.139)* 0.057 (0.246) -0.372 (0.331)
Graded Music *School KS2 mean	No Grades 1-3 Grades 4+	 -0.094 (0.191) 0.125 (0.173)
Graded Music *School gender	No – Mixed Grades 1-3 – Boys Grades 4+ – Boys Grades 1-3 – Girls Grades 4+ – Girls	 -0.166 (0.130) -0.298 (0.116)* -0.134 (0.103) -0.037 (0.104)
Random effects		
Level 1 Level 2 - intercept		1.063 (0.002)* 0.193 (0.005)*

Table B3: Regression coefficients including interaction effects with Music Theory (outcome variable =KS4 APS, standard errors in brackets)

Fixed effects		
Intercept		4.712 (0.009)*
KS2 mean		1.229 (0.003)*
No of quals		0.406 (0.001)*
Gender	Female	
	Male	-0.464 (0.003)*
Ethnicity	White	
	Asian	0.153 (0.007)*
	Black	0.086 (0.008)*
	Chinese	0.453 (0.027)*
	Mixed	0.052 (0.007)*
	Other / Unclassified	0.102 (0.011)*
IDACI score		-0.931 (0.014)*
Ever FSM	No	
	Yes	-0.297 (0.004)*
EAL status	English	
	Other	0.287 (0.006)*
	Unclassified	0.075 (0.042)
SEN status	None	
	SEN Support	-0.088 (0.005)*
	Statement	0.523 (0.026)*
	EHCP	0.603 (0.013)*
Music GCSE	No	
	Yes	0.177 (0.006)*
Graded Music	No	
	Grades 1-3	0.283 (0.029)*
	Grades 4+	0.362 (0.028)*
Graded Music Theory	No	
	Grades 1-3	0.003 (0.201)
	Grades 4+	0.245 (0.142)
Music VRQ	No	
	Yes	-0.085 (0.036)*
School type	Comp	
	Selective	0.153 (0.051)*
	Sec. Mod.	-0.145 (0.044)*
School mean KS2		0.384 (0.042)*
School gender	Mixed	
	Boys	0.234 (0.039)*
	Girls	0.240 (0.034)*
Music Theory*KS2 mean	No	
	Grades 1-3	-0.149 (0.197)
	Grades 4+	0.788 (0.174)*
Music Theory *No of quals	No	
	Grades 1-3	-0.053 (0.083)
	Grades 4+	-0.083 (0.042)*
Music Theory *Gender	No – Female	
	Grades 1-3 – Male	0.452 (0.208)*
	Grades 4+ – Male	0.200 (0.124)
Music Theory *Ethnicity	No – White	
	Grades 1-3 – Asian	0.571 (0.407)
	Grades 4+ – Asian	0.435 (0.241)
	Grades 1-3 – Black	-0.287 (0.416)
	Grades 4+ – Black	0.118 (0.477)
	Grades 4+ – Chinese	-0.186 (0.440)
	Grades 1-3 – Mixed	0.166 (0.525)
	Grades 4+ – Mixed	0.026 (0.257)
	Grades 1-3 – Other	-0.211 (1.207)
	Grades 4+ – Other	0.355 (0.334)
Music Theory *Ever FSM	No – Not FSM	
	Grades 1-3 – FSM	0.029 (0.299)
	Grades 4+ – FSM	0.137 (0.240)
Music Theory *IDACI	No	
	Grades 1-3	-2.000 (0.937)*
	Grades 4+	-0.229 (0.546)

Fixed effects		
Music Theory *Language	No – English	
	Grades 1-3 – Other	-0.336 (0.356)
	Grades 4+ – Other	-0.495 (0.211)*
Music Theory *SEN	No – None	
	Grades 1-3 – SEN Support	-0.764 (0.440)
	Grades 4+ – SEN Support	-0.025 (0.295)
	Grades 1-3 – EHCP	-1.084 (1.055)
	Grades 4+ – EHCP	0.009 (0.745)
Music Theory *School type	No – Comp	
	Grades 1-3 – Selective	0.411 (0.599)
	Grades 4+ – Selective	0.202 (0.256)
	Grades 1-3 – Sec Mod	0.110 (0.379)
	Grades 4+ – Sec Mod	-0.210 (0.528)
Music Theory *School KS2 mean	No	
	Grades 1-3	-1.617 (0.624)*
	Grades 4+	-0.678 (0.319)*
Music Theory *School gender	No – Mixed	
	Grades 1-3 – Boys	-0.658 (0.487)
	Grades 4+ – Boys	-0.141 (0.223)
	Grades 1-3 – Girls	0.705 (0.552)
	Grades 4+ – Girls	0.078 (0.225)
Random effects		
Level 1		1.063 (0.002)*
Level 2 - intercept		0.193 (0.005)*

Table B4: Regression coefficients including interaction effects with VRQ (outcome variable =KS4 APS, standard errors in brackets)

Fixed effects		
Intercept		4.712 (0.009)*
KS2 mean		1.229 (0.003)*
No of quals		0.406 (0.001)*
Gender	Female	
	Male	-0.464 (0.003)*
Ethnicity	White	
	Asian	0.154 (0.007)*
	Black	0.086 (0.008)*
	Chinese	0.452 (0.027)*
	Mixed	0.053 (0.007)*
	Other / Unclassified	0.103 (0.011)*
IDACI score		-0.931 (0.014)*
Ever FSM	No	
	Yes	-0.297 (0.004)*
EAL status	English	
	Other	0.286 (0.006)*
	Unclassified	0.075 (0.042)
SEN status	None	
	SEN Support	-0.088 (0.005)*
	Statement	0.524 (0.027)*
	EHCP	0.602 (0.013)*
Music GCSE	No	
	Yes	0.178 (0.006)*
Graded Music	No	
	Grades 1-3	0.280 (0.029)*
	Grades 4+	0.356 (0.028)*
Graded Music Theory	No	
	Grades 1-3	0.032 (0.094)
	Grades 4+	0.481 (0.053)*
Music VRQ	No	
	Yes	-0.133 (0.066)*
School type	Comp	
	Selective	0.152 (0.051)*
	Sec. Mod.	-0.144 (0.044)*
School mean KS2		0.383 (0.042)*
School gender	Mixed	
	Boys	0.233 (0.039)*
	Girls	0.240 (0.034)*
Music VRQ*KS2 mean	No	
	Yes	-0.015 (0.054)
Music VRQ*No of quals	No	
	Yes	-0.101 (0.030)*
Music VRQ*Gender	No – Female	
	Yes – Male	0.185 (0.071)*
Music VRQ*Ethnicity	No – White	
	Yes – Asian	-0.126 (0.173)
	Yes – Black	-0.222 (0.157)
	Yes – Chinese	-0.701 (1.045)
	Yes – Mixed	-0.151 (0.142)
	Yes – Other / Unclassified	-0.077 (0.247)
Music VRQ*Ever FSM	No – Not FSM	
	Yes – FSM	0.064 (0.080)
Music VRQ*IDACI	No	
	Yes	-0.120 (0.280)
Music VRQ*Language	No – English	
	Yes – Other	0.388 (0.124)*
Music VRQ*SEN	No – None	
	Yes – SEN Support	0.359 (0.269)
	Yes – Statement	-0.294 (0.523)
	Yes – EHCP	-0.012 (0.101)
Music VRQ*School type	No – Comp	
	Yes – Sec Mod	-0.237 (0.249)
Music VRQ*School KS2 mean	No	

Fixed effects		
	Yes	0.160 (0.193)
Music VRQ*School gender	No – Mixed Yes – Girls	 0.288 (0.279)
Random effects		
Level 1 Level 2 - intercept		1.061 (0.002)* 0.193 (0.005)*