science/chemi _ hich co ld infol m pac ice and policie i hin science/chemi _ ed ca ion The e eac ch and e al a ion plog amme foc ed on he follo ing a ea

- Re ealing he impac if an) of he Chemi fo All plog amme on den ' a i de belief and o he e egading science/chemi _
- Gaining ide in igh in o den 'a pila ion and plog e ion o ad science/chemi _

The e eac ch plog amme in ed den o comple e e ionnai e each ea in olde o con ide hei changing e olde ime The e ionnai e a ked he ame col e e ion each ea in olde o dilec l _ con ide change olde ime addi ional e ion e e al o in od ced in la e ea in olde o con ide mo e pecific and/ol comple e Ac o he chool ha ecei ed he Chemi _ fo All plog amme, 3 den comple ed a e ionnai e on a lea one occa ion ac o he compa i on chool, 21 1 den comple ed a e ionnai e on a lea one occa ion Some den e e al o in e e ed in olde o di c hei e pelience in mo e de ail

1.4. Research results and insights

1.4.1. Insights into students' changing attitudes and aspirations

- S den in Chemi _ fo All chool and den in compa i on chool ended o e ple imila e a Yea
- S den ' e ended o become le po i i e olde ime f om Yea o Yea 11
- An change olde ime e e all malle fo den i hin chool ha ecei ed he Chemi _ fo All plog amme
- S den in chool ha ecei ed he Chemi _ fo All plog amme con e ed mo e po i i e e han den i hin compa i on chool a Yea 11 fo hei a pila ion o ad chemi _ die and cae e, chemi _

ime, hile highligh ing bo edom, di in e , and/o pe ceiving a lack of f n a genel all mo e pe alen o e ime Addi ionall , den inclea ingl highligh ed nega ive a pec ela ed o elf confidence ch a ma e ial being con ideled o be di ic l , comple , and/o hald o nde and S den al o inclea ingl di liked e a ion , fo m lae, and mbol and ha lea ning inolved memoi a ion Man of he e alea ma in e ec and ale inheen o eaching and lea ning abo chemi l ch a he e a ion , fo m lae, and mbol ha ale ed o epe en chemical eac ion), hich highligh ome of he challenge i hin chool and fo ide plog amme and ini ia ive

Implications of aspects of teaching/learning

O hel anal i con ideled he implica ion of pecific a pec of eaching and lea ning, acco n ing fo hei chool eceiving o no eceiving he Chemi fo All plog amme and o hel fac o Simila pa e n of le l ended o be een a di e en academic ea Yea , Yea , Yea , and Yea 11)

S den ' epo of hei eache ing cience/chemi o help hem nde and he old o ide chool, and den ' epo of mo e fle en l a ending a cience/ chemi cl b, e bo h impo an po i ive pedic o of hei a pia ion o ald cience/chemi , hei in e e /enjo men in cience/chemi , hei pe ceived ili al e of cience/chemi , hei elf confidence in cience/chemi , and hei pe ceived al e of cience/ chemi o ocie S den ' epo of nde aking pac ical e pe imen and haing he chance o e plain hei idea e al o po i ive pedic o of hei in e e / enjo men in cience/chemi S den ' epo of being inolved in cla deba e o di c ion e e o hel po i ive pedic o of hei elf confidence in cience/chemi

The e alea o el po en ial a en e o help fo el den ' a i de and belief, legaldle of chool appl ing fomali ed plog amme of ac ie /e en Addi ionall , he Chemi fo All plog amme plo ded cience/chemi cl b and chance fo den o di c hei idea and e The e finding ma al o gge ho ome plog amme benefi each den

Perceptions of additional activities and events

- S den i hin chool ha eceived he Chemi fo All plog amme, compaed o den i hin o hei chool, had mo e po i ive e abo he benefi ai ing fom addi ional ac ie and e en a of Yea 11
- S den ho engaged mo e i h he Chemi fo All plog amme ho e pe ienced a lea one op ional e en o ac i) e ple ed highe pe ceived benefi
- In chool ha did no eceive he Chemi fo All plog amme, bo ended o e ple mo e po i ive e han gil abo pe ceived benefi he e gende di e ence e e minimal o no ple en fo den ho eceived he Chemi fo All plog amme

The Chemi fo All plog amme inolved a io addi ional ac ie and e en fo den ch a a el chool cl b, calee lec e , i o ind ial companie , ac i da a ni el ie , and n mo o hel ac ie) den i hin he compai on chool ma ha e al o e pe ienced a io ac ie and e en ho gh hei o n chool

S den i hin chool ha eceived he Chemi fo All plog amme, compaed o den i hin he compai on chool, had mo e po i ive e abo he

- From early secondary school, provide careers advice and information about the range of courses and qualifications available in chemistry qualifications
- Ensure girls receive a learning enhancement about
- Especially among younger students, ensure there is sufficient practical work in chemistry
- Keep memorisation to a minimum
- Only give students homework where there is a clear need to do so
- Where there are optional extension activities, such as school visits to chemistry/science clubs, ensure there are students able to access these
- Give students and their chemistry teachers the opportunity to build good, professional relationships that stretch for more than a single year
- Provide a small number of high quality practical engagements in chemistry that last longer than a single year
- Provide careers extension students where there is knowledgeable people are positive about chemistry, as these can act students in one of the subject who might otherwise not continue in

University/outreach providers

- Help give students access to high quality practical work in chemistry and to see the diversity of people who work in and in chemistry
- Work in teachers in a way that does not increase their workload
- Build partnerships in local schools in a way that does not rely on the enthusiasm of just one or two teachers in a school
- Take activities step by step in order to provide information to predominantly taken by more advantaged students, such as students in families that encourage them to attend optional extension, and students who can attend extension held out school premises.

Funders

- Ensure funding on a relatively small number of schools over a period of several years rather than many one-off large grants /La 3 1 Tf 0 0 2 no

Ne el hele , fe e econda chool den appea
o ha e e plici l a pi ed o become cien i Benne
Hoga h, 2 DeWi , A che , O bo ne, 2 1 Jenkin
Nel on, 2) The majo i of a na ionall eple en a i e

2.3. Students' aspirations and choices for science studies and careers

Rela i el fe childen in England ha e died non comp l o cience bjec a ppe econda chool and a ni e i , incl ding e peciall fe gil , fe childen fom familie i h le adan aged cic m ance , and fe childen fom ome e hnic backgo nd Elia , Jone , McWhinnie, a Homel, R del, Banne , a 14 In i e of Ph ic , a 14 Ro al Socie , a Ro al Socie of Chemi , a 1) Mo e den ha e ended o d biolog hanOchemi and mo e ha e ended o d chemi hanOph ic in ppe econda chool ome ha imila l , mo e den ha e ended o ´ d biological cience hanO ph ical cience , incl ding chemi and ph ic , a ni e i EngineeingUK, a 1 Ga b , a 1) F hel di e ience ac o field ha e al o become appaen , fo e ample he e gil ha e been le likel o d engineeing, comp e cience , ma hema ical cience , and o hel ph ical cience a ppe econda chool and a ni e i , b mo e likel o d biological cience , medicine, e elina cience, and o hel bjec ela ed o medicine Elia , Jone , McWhinnie, a EngineeingUK, a 1 Ga b , a 1 Sp inga e, Halland, Lold, Wilkin, a) Conc en l ´ ho e fom ome mino i e hnic backgo nd ha e been le likel o d ph ic and mo e likel o d engineeing, chemi , and bjec ela ed o medicine EngineeingUK, a 1 Elia , Jone , McWhinnie, a)

he majo i of den d ing chemi a ni e i
e e indeed aiming fo a ca ee ha e chemi ,
and e fe e e planning fo a ca ee ha doe no
e chemi Og nde, O e on, Thomp on, Me i ,
Boniface, 2 1) Yo ng people f om mino i e hnic
backg o nd in England ha e con e ed ha hei

3

Chemistry for All programme

4. Methods

Highlights

The Chemi fo All pogamme aimed o engage i h den fom le adan aged backgo nd, ho migh no con ide and/o con in e i h chemi

The ac i plo de of he Chemi fo All pogamme ec i ed chool i hin he Ea Midland, he No h We , and he So h Ea of England

Se en een chool eceie he Chemi fo All pogamme and i o he chool plo ded a compai on

The Chemi fo All chool and compai on chool had highe pecen age of den eligible fo fee chool meal and eligible den i h pecial ed ca ional need ppo , and lo e a ainage gade a GCSE Gene al Ce ifica e of Seconda Ed ca ion) o e ialen alifica ion, han all econda chool ac o England

S den eceie he Chemi fo All pogamme d ing Yea , Yea , Yea , and Yea 11

S den e ie ed o comple e pape o online e ionnaie each ea o con e hei de abo hei ed ca ional e pe ience, foc ing on hei de abo cience/chemi

Ac o he chool ha eceie he Chemi fo All pogamme, 3 den comple ed a e ionnaie on a lea one occa ion ac o he compai on chool, 21 1 den comple ed a e ionnaie on a lea one occa ion

Some den e al o in ed o be in e ie ed each ea, o con ide hei de abo hei ed ca ional e pe ience, foc ing on hei de abo cience/chemi , and hei e pe ience of he Chemi fo All pogamme if he e ie in chool ha eceie he pogamme

4.1. Context

In England, econda chool a a Yea age 11/12) and con in e o Yea 11 age 1 /1), and d ing cience incl ding chemi) i comp l o d ing hi ime S den can hen nde ake ppe econda ed ca ion in Yea 12 and Yea 13 age 1 /1 o 1 /1), he e den can choo e all of hei bjec GCSE o e ialen alifica ion a e all died in Yea 1 and Yea 11 i h e amina ion in Yea 11) A Le el o e ialen ppe econda alifica ion a e all died in Yea 12 and Yea 13 i h e amina ion in Yea 13)

A pec of he ed ca ion em in England can change o e ime School pe fo mance in England in 1 4/ 1 a con ide ed ho gh he pe cen age of den achie ing o mo e GCSE o e ialen) alifica ion a gade A* o C, incl ding in Engli h and in ma hema ic A ne econda chool acco n abili em a hen in od ced in 1 Depa men fo Ed ca ion, c) School pe fo mance in England in 1 / 1 and on ad ha been con ide ed ho gh he a e age A ainmen ' co e fo GCSE o e ialen) alifica ion pe den , hich ef lec pe fo mance ac o alifica ion incl ding ma hema ic and Engli h hich ece e ice he eigh ing of o he alifica ion) Q alifica ion efo m, hich occ ed fom 1 in age fo di e en bjec , al o en ailed ha GCSE e amina ion gade a e no n me ical fom 1 o) a he han alphabe ical, he e n me ical and alphabe ical gade a e no e ac l e ialen Depa men fo Ed ca ion, c Of al, 1) S den a e al o e ied o nde ake a minim n nbe of pac ical ac i ie in cience a GCSE and a A Le el, and den a e a e ed on hei kno ledge, kill, and nde anding of pac ical o k in cience a GCSE and a A Le el Of al, 1) A Le el d ing i no linea , i h e amina ion a he end of he co e, a he han mod la , i h e amina ion pe mod le

Similar results were also observed when comparing the sample schools against all other secondary schools in England, which included slightly different average scores for the different approaches. Given the relatively small number of sample schools, however, statistical tests

Perceptions of teachers

Di elence in den ' e ionnaile epon e acio ime, and di elence in epon e acio den ele e ploed hio gh epea ed mea e mi ed m l i le el) modelling Snijde Bo ke, 2 12) Repea ed mea e modelling con ide e pon e fom all ailable den and doe no e ile all den o ha e e ponded on e el occa ion Ho , Moelbeek, an de Schoo , 2 1) Acio bo h coho , 4 den comple ed a e ionnaile on a lea one occa ion 3 den fom chool ha eceie ed he Chemi fo All plogamme and 21 1 den fom compai on chool) The epea ed mea e modelling acco n ed fo he ame den being e ed on m l iple occa ion he e den ' epon e e likel o be ome ha imila in ead of being independen , acio ime) and al o acco n ed fo den being cl e ed i hin chool he e den ' epon e e likel o be ome ha imila i hin chool, in ead of being independen d e o he haed eaching/leaning con e and ide en onmen) The modelling a nde aken i h ime con ideed a a fac o, hich facili a ed con idea ion of di elence acio an and all pa ic la pai of ime poin

The modelling foc ed on con ideing he he pa e n of di elence acio ime ied acio den ho did and did no eceie he Chemi fo All plogamme hich o ld be e ealed hio gh a a i icall ignifican in eac ion of ime plogamme' i hin he modelling and ill a ed b he den ' ae age epon e pe ea) If den had imila ini ial e o e en if hei e ini iall di ed), an impac of he Chemi fo All plogamme o ld be ho n hio gh he e den hang di en pa e n of change in hei b e en e hen compaed o he compai on den

Engagement with the Chemistry for All programme

The Chemi fo All plogamme deli ed ac i ie and e en o all den fom Yea o Yea 11, ch a alk and pe en he e a on i B e)1 a 11,) TJETEMC /Span <</Lang en GB)/gja indepen3 d o All plog

5

Students' changing views over time

5. Students' changing views over time

Highlights and key findings

S den in chool ha did and did no eceiXe he Chemi fo All p log amme ended o e p e imila Xe a Yea

S den 'Xe ended o become le po i iXe oXe ime f om Yea o Yea 11

5.1.1. Chemistry for All and comparison students

A Yea Table 5-1), con ideing bo h coho combined, he den i hin chool ha eceiXed he Chemi fo All pogamme and he den i hin compai on chool ended o e pe imila Xe The onl di ence e ha den in chool ha eceiXed he Chemi fo All pogamme e pe ed lo e Xe han ho e in compai on chool fo in e /enjo men in cience/chemi and eaching/leaning e pe ience ela ed o pac ical/ e pe imen al o k

Engagement with the Chemistry for All programme

S den ho o ld b e en l ha Xe gea e engagemen i h he Chemi fo All pogamme ho e ho e ecoded a a ending a lea one, and/ o ho e ho e ecoded a a ending mo e han one, op ional ac i /eXen ac o Yea , Yea , Yea , and Yea 11) ended o e pe mo e po i i Xe ini ial Xe a Yea han he compai on den Table 5-2)

5.1.2. Students with di erent characteristics and circumstances

Gender

A Yea Table 5-3), con ideing bo h coho combined, i hin chool ha eceiXed he Chemi fo All pogamme and al o i hin compai on chool gi l and bo ended o e pe imila a pia ion o ad cience/ chemi enco agemen o d cience/chemi and home ppo fo cience/chemi achieXemen

Con ideing bo h coho combined, i hin chool ha eceiXed he Chemi fo All pogamme a Yea , bo ended o e pe mo e po i i Xe han gi l egading pe ceiXed ili of cience/chemi in e e in cience/

Indicator (1–4 scales, unless otherwise shown)			Chemistry for All students				Chemistry for All students			
	M	SD	M	SD	D	Sig. (p)	M	SD	D	Sig. (p)
A pi a ion o ad cience/chemi all)	2		2		.146	.007	2	3	.180	.004
A pi a ion o ad cience/chemi A Le el d ing	2 1	1	2 3		.140	.010	2		.158	.013
A pi a ion o ad cience/chemi ni i d ing	2		2	1	.126	.020	2 1	3	.157	.014
A pi a ion o ad cience/chemi caee	2		2	3	.130	.016	2 2		.172	.007
A pi a ion o ad cience caee	2		2	3	.130	.016	2 2		.172	.007
Pe ceie ed ili of cience/chemi	2		3		.166	.002	3 13		.225	<.001
In e e in cience/chemi	2 1		2			23 1	3		.189	.003
Self confidence in cience/chemi	2 2		2	3		1	2	2	.124	.049
Val e of cience/chemi o ocie	2	1	3 11	1	.185	.001	3 1		.248	<.001
Teaching/lea ning e pe ience in e ac ion/deba e/di c ion	2		2		1	1	2		.128	.042
Teaching/lea ning e pe ience p ac ical/e pe imen al	2		2	3	23	3	2		2	1
Teaching/lea ning e pe ience e ele ance/applica ion	2		2		1	3	2			1 1
Teaching and lea ning e pe ience all)	2 3		2		3 2	1	2	2		12
Pe cep ion of eache	3		3				3 13			

No e Re l fom bo h coho combined The able ho he mean M' he a e age) and anda d de a ion SD' he e en of di pe ion a o nd he mean), oge he i h he magni de D' Cohen' D) and ignificance Sig p)' p al e) of he diffe ence ac o g o p

5.2. Changes in students' views across time

Change in den ' e acio ime and an di eren pa ern of change acio di eren den ere con idered hi gh epea ed mea e modelling Table 5-5) Thi acco n ed fo he ame den being e ed on m l iple occa ion here den ' e pon e ere likel o be ome ha imila in ead of being independen acio ime) and al o acco n ed fo den being cl ered i hin chool here den ' e pon e ere likel o be ome ha imila i hin chool in ead of being independen d e o he haled eaching/lea ning con e and ide en onmen) Comp ehen ive de ail of den ' changing e pe ea and pe coho ae a ailable a S pplemen al Ma e ial

The modelling e ealed change occ ing o e ime fo e el o come Table 5-5) A an o e e , gene ali ing acio bo h coho and acio chool ha ecei ed and did no ecei e he Chemi fo All p og amme, a Yea 11, den ended o con e Table 5-6)

- Po i ive e egading he al e of chemi o ocie and pe cep ion of hei eache
- Ne al e egading ili al e of chemi in ele /enjo men in chemi , and e pe ience of eaching/lea ning
- Nega ive e egading hei elf confidence in chemi , enco agemen o con in e i h cience/chemi , home ppo fo chemi achie emen , and a pi a ion o ad chemi d ing and ca ee

E en ja all den ' e ended o become le po i ive o e ime fom Yea Table 5-1) o Yea 11 Table 5-6) The clea e e cep ion ere ha he den ill ended o epo ha he Some ime ' engaged in e a c ic la engagemen i h cience/chemi hich co ld occ i hin and o ide of chool) and ha he ill Some ime ' had famil enco agemen / haed e a c ic la engagemen Fo he e o a ea , a io change occ ed fom ea o ea b i h no clea pa e n) compa i on den ho ed no di ence hen compa ing hei Yea and Yea 11 e e a addi ional e nde aken a pa of he epea ed mea e modelling), hile he Chemi fo All den epo ed igh l highe a Yea 11 han Yea

5.2.1. Chemistry for All and comparison students

Con ideing bo h coho combined Table 5-5), he epea ed mea e modelling e ealed di eren pa e n of change o e ime fo he den ho ecei ed he Chemi fo All p og amme compa ed o he compa i on den fo

- A pi a ion o ad cience/chemi o e all and fo pecific a pi a ion o ad A Le el d ing, ni e i d ing, and ca ee hen con idered epa a el)
- Pe cei ed ili of cience/chemi
- In ele /enjo men in cience/chemi
- Self confidence in cience/chemi

Teaching and lea ning e pe ience , o e all and fo he pecific indica o of ha ng oppo ni ie o e plain idea and opinion , e pe iencing and engaging in a ange of p ac ical ac i ie , and ha eache e cience o help nde and he o ld o ide chool, hen con ide ed epa a el)

Pe cep ion of eache

E a c ic la engagemen i h cience/chemi

The e di e ence e e cha ac e i ed b change o e ime being malle fo den i hin chool ha ece ed he Chemi fo All p og amme S den ended o e p e imila e a Yea **Table 5-1**) b e en l den in chool ha ece ed he Chemi fo All p og amme ended o con e ligh l highe e a Yea 11 han den i hin compa i on chool ho did no ece e he p og amme **Table 5-6**)

Specificall , a Yea 11 ic la engagemen i h

11 den ended o conXe po i iXe Xe egading hei geneal achieXemen mo iXa ion aiming fo op glade and he be oppo ni ie), ligh l nega iXe Xe fo hei pe onal Xal e of chemi chemi being a Xal ed and inhen a pec of hei iden i), and ligh l nega iXe Xe fo hei famil cience capi al/ connec ion hei pecep ion of hei famil membe haXng cience ela ed alifica ion job and/o in e e in alking abo cience) Addi ionall again a Yea 11, den ended o conXe c len cience glade and e pec ed GCSE chemi / cience glade be een 4 and on he n mec glade cale, i h eflec ing he highe glade and eflec ing glade U) den ended o e pec ha he o ld achieXe a o nd glade C if he e e o ake A LeXel chemi on a cale i h A* eflec ing he highe glade and U eflec ing he lo e)

A Yea 11, den i hin chool ha eceiXed he Chemi fo All p og amme e pe 1 flece po i iXe XTJETEMC /Span <</Lang en GB)/MCID 4 11 XBDC BT 1 4T 2 1

Books at home

There are no differences in patterns of changing between 2006 and 2009 across countries in the number of books at home and those with more books at home across countries receiving or not receiving the Chemistry for All programme. Even if all, it is possible to infer that the Chemistry for All programme had a similar influence on students with fewer books at home and students with more books at home. Nevertheless, socio economic circumstances are complex, and considering the number of books at home in this analysis only reflects one particular and simplified perspective.

At Year 11 (Table 5-9), considering both cohorts combined, within schools that received the Chemistry for All programme, students reported more books at home ended up in higher grades than students

No e Re l f om bo h coho combined The able ho he mean M' he a e age) and anda d de a ion SD' he e en of di pe ion a o nd he mean), oge he i h he magni de D' Cohen' D) and ignificance Sig p)' p al e) of he diffe ence ac o g o p C en and GCSE g ade a e ho n on a cale U, 1 1, 2 2,3 3 , 4 4, , , ,) e pec ed A Le el g ade a e ho n on a 1 cale 1 U, 2 E,3 D, 4 C, B, A, A*) Indica o 1 4 cale nle o he i e

6

Students' likes and dislikes about science/chemistry

6. Students' likes and dislikes about science/chemistry

Highlights and key findings

Man den liked e pe imen al/p ac ical o k in cience/chemi , al ho gh highligh ing hi became le pe alen a den gle olde

Some den appecia ed hei eache , and highligh ing hi became mo e pe alen a den gle olde

S den al o liked lea ning ne hing lea ning man hing and/o a a ie of hing and lea ning abo ele an hing incl ding lea ning abo he o ld and/o ho hing o k)

S den di liked ha ng o i e e en i el incl ding ha e o i e abo e pe imen al/ p ac ical o k), al ho gh highligh ing hi a le pe alen a den gle olde

den e plici l men ioned chemi opic 1 in ance acio Yea , Yea , Yea i , and Yea 11 2 of all e pon e), biolog opic in ance 4), and ph ic opic 33 in ance 2) The p éalence of he e di en bjec canno be compaed, ho e ed, gi en ha he e ion a e plici l o ien a ed o ad chemi fom Yea i on ad

The p ealence of ome ca egoie ied acio ime Table 6-1 and Table 6-2) epea ed mea e modelling a ed o conc eń l con ide change acio ime and den ho eceie ed and did no eceie he Chemi fo All p ogamme Ne ed hele , he malle n mbe of e pon e fo ome ca egoie ma ha e limi ed he po en ial of an anal i o defini iel con ide di ence Fo bo h coho con ideed oge he a Yea , Yea , Yea i , and Yea 11, epea ed mea e modelling e ealed he follo ing he e pa en acio ime e imila acio den ho did and did no eceie he Chemi fo All p ogamme, nle o he i e men ioned)

> E pe imen al and/o p ac ical o k change occ ed o e ime i h a le e e of change fo ho e ho eceie ed he Chemi fo

I lo e doing he p ac ice and he opic in he econd pape of chemi I lo e a king abo abio ic and bio ic f el and fac o ha a ec he global empe a e, he a mo phe e along ide i h a king abo he me al and he f el ha o nd he o ld'

Mentioning particular science topics:

I like o lea n abo ho a om and all kind of bonding o k'

Ion bond pe iodic able'

A om'

Elec o l i'

A he momen , I like lea ning abo e o ice and he a mo phe e'

Global a ming, po l ion, c de oil'

I like lea ning abo o ganic chemi '

Lea ning abo he a mo phe e'

Lea ning abo he h man bod '

Lea ning abo he elemen '

P o on elec on and ne on'

Fun, enjoyment, and/or interest:

Tha i in e e ing'

I f n'

The le on a e e ci ing and f n o lea n'

I enjo he e pe imen and I find i e in e e ing'

In e e ing opic'

I like ha i keep me in e e ed in cience'

The in e e ing na e of he bjec e do'

I j like chemi '

I hink chemi i f n e peciall hen e do p ac ical'

I f n doing e pe imen '

Teachers being good, beneficial, and/or positively perceived:

The eache i nice'

I like m eache'

We do lo of p ac ical and eache make i ea '

M eache i good a eaching i '

I like ha opic a e a gh ell and e a e f e en l e ed'

I e emel in e e ing m eache help me lo '

E pe imen and he a I am being a gh '

G ided h o gh he bjec

Good eache , good e ipmen '

I i ama ing beca e o eache eache i e ell'

Teache i in e ac i e and helpf l'

Teache kno e e hing abo he bjec '

I i good and he eache a e pa ionate abo hei job'

I i good a he eache help hen o don' nde and a opic'

The g idance and ppo p o ded'

The eache gi e o confidence o ill achie e ell in o GCSE' and he con en i in e e ing'

The eache make e nde and a ce ain opic befo e mo ng on We lea n a a ie of hing'

Teache make bjec enjo able'

The eache a e e f n and make le on in e e ing'

I find i he ea ie o of all he cience I like m eache hich make i mo e enjo able'

Learning new things:

P ac ical and lea ning ne hing'

Lea ning ne hing'

Lea ning hing I didn' kno , p ac ical'

The n al hing ha ake place in e pe imen and lea ning abo ne and in e e ing hing'

We' e al a lea ning ne hing'

Learning many things and/or a variety of things:

I enjo he ide ange of bjec e d a a pa of chemi '

I like lea ning abo he di e en opic and ho he in e ine'

I enjo he ide ange of bjec e d a a pa of chemi '

I like lea ning abo di e en hing'

The di e i in opic'

Learning about relevant things:

Kno mo e abo he o ld'

Lea ning abo ho he ma e ial in he o ld o k'

Lea ning abo o bod '

Lea ning ho he o ld o k Theo o k'

Lea ning ho hing o k'

The bjec can be engaging and help in nde anding i a ion ac o he o ld'

In e e ing and help nde and he a hing o k'

I like ho i link o e e da life I like lea ning ne hing'

I co e a ide ange of bjec i gi e a be e nde anding of he o ld'

We ge o do in e e ing p ac ical hich help in da o da life and help o e pand o kno ledge'

The p ac ical and being a gh ho i i ele an o e e da life'

Utility of science/chemistry and any wider benefits from learning/careers:

We learn something new every day and I

6.2. What things do you not like about science/chemistry at your school?

Similar findings were revealed across the two school years when considered separately and when combined. Considering both school years of students combined across Years 10, Year 11, Year 12, and Year 13, encompassing students within schools having received the Chemistry for All programme and students within other schools, the most prevalent themes for What things do you not like about science/chemistry at your school' were the following

Writing within teaching/learning (13 instances across Years 10, Year 11, Year 12, and Year 13 123% of all responses). This included writing about practical/experimental work and writing in general

Self-confidence related aspects across/all aspects (11 3 instances 12.4%). This category encompassed students mainly conveying having science/chemistry as hard, difficult, complex, confusing, and/or hard to understand and

Boredom, not enjoyment, and/or disinterest (11 instances 9.6%)

Either finding and/or memorising [illegible]) TJETEMC /Span <</Lang (en-GB)/MCID 3 4 2 4 2a
generally perceived negative relationship of the detail being provided (12 instances 10.4%)
This category encompassing

hich co ld be cha ac e i ed a le fe en
men ioning o e ime

Doing p ac ical o k no clea change e
e ealed o e ime

Te book change occ ed o e ime i h a
le e e en of change fo ho e ho eceive ed
he Chemi fo All p og amme), hich co ld
be cha ac e i ed a le fe en men ioning
o e ime

Memo i a ion/ emembe ing change occ ed
o e ime, hich co ld be cha ac e i ed a
mo e fe en men ioning o e ime

6.2.1. Examples of responses

Writing within teaching/learning:

The i en o k'

When e ha e o i e a lo '

Load of i ing'

Lo of i ing and e plana ion '

Long i ing a k '

The le on i ing o load '

The i ing can ge bo ing'

Self-confidence related aspects:

Di ic l '

I ' e dETEMC /Span << n GnfEFE BDC)TjEMC ETEMC /Span <</L 1) 1 k/GS1 g 1 1 Tm

Textbooks within teaching/learning:

Ha e o do a lo of e book ok'

Cop ing o of e book s'

Wo king f om book s/doing e s s'

Wo king f om e book s'

Book ok in he en e ha e j s ead o he e book and i e i do n'

Learning having to involve memorisation/remembering:

Lea ning he pe iodic able b hea '

Memo i ing pe iodic able'

Ha ng o emembe fo m la s'

I 's a lo o emembe mole s'

Remembe ing e e hing'

Too man e a ion s ha a e oo m ch fo me o emembe '

E a ion s, emembe ing all of he hing s I need o in o de o do ell'

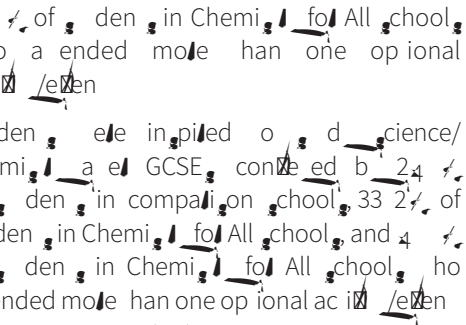
Te s s a e on memo ecall no appl ing he chemi s '

6.3. Summary

The finding a im ha man den like e pe imen al/ p ac ical o k in cience/chemi , b come den di like ha ng o i e e en i el incl ding ha ng o i e abo e pe imen al/p ac ical o k), al ho gh highligh ing he e like and di like became le p e alen a den g e olde Some den appecia ed hei eache , and highligh ing hi became mo e p e alen a den g e olde Highligh ing ha cience/chemi a f n, enjo able, and/o in e e ing a gene all le

7

Students' perceptions of activities and events



The la ge di e ence in olved pe cep ion ha e a ac i ie /e en inc ea ed he den ' kno ledge

1 of he pon e from den i hin chool ha eceiXed he Chemi l fo All p ogamme and 1 of he pon e from den i hin compa i on chool) Fo he olde coho of den alone, mo e den con Xe ed nega iXe Xe i hin chool ha eceiXed he Chemi l fo All p ogamme 1) compa ed o den in compa i on chool) V , p)

A ide fom gene all nega iXe Xe ch a bad'), ac iX ie and eXen e mo fe en l con ide ed o be nega iXe h o gh being bo ing o nin e e ing Nega iXe Yea 11 e ample a e a follo

Bad'

No good'

The 'e no in e e ing'

Bo ing '

I don' like cience, o I hink he eem bo ing'

Ieleban '

Pe onall I don' hink he 'e ef l'

The don' help'

The a e no Xe infoma iXe'

The can be Xe epe i iXe'

Poin le nle he a e e ion e ion'

I hink ha a lo of he eXen a e n b people ho don' make i f n So hen i 'no f n I don' haXe an in e e ini '

8.2. Summary

S den ' epo of hei eache ing cience/ chemi o help hem nde and he o ld o ide chool po i ixel p edic ed hei a pi a ion o ad cience/chemi al o hei in e e /enjo men in cience/ chemi , hei pe ceixed ili al e of cience/ chemi , hei elf confidence in cience/chemi , and hei pe ceixed al e of cience/chemi o ocie S den epo of mo e fe en l a ending a cience/chemi cl b a al o an impo an po i ixe p edic o of hei ixe Doing p ac ical e pe imen and ha ing he chance o e plain idea e al o impo an po i ixe p edic op a e al o

9

Factors associated with aspirations: the impact of social inequalities, perceived utility of chemistry (extrinsic motivation), and personal value of chemistry

9. Factors associated with aspirations: the impact of social inequalities, perceived utility of chemistry (extrinsic motivation), and personal value of chemistry

Highlights and key findings

Thi ec ion a i h an i a ix anal i and ea e in finding fom ali a ix ca e die

Pedic ix modelling con ideed fo o come, a e pe ed b den d ing Yea 11 o all a pia ion o ad chemi acio A Le el d ing, ni el i d ing, and caee) pecific a pia ion o ad d ing chemi a A Le el pecific a pia ion o ad d ing chemi a ni el i and pecific a pia ion o ad chemi ´ caee

Boadl imila finding e e ealed hen con ideing den ' o all a pia ion o ad chemi acio A Le el d ing, ni el i d ing, and caee) and hen con ideing den ' pecific a pia ion o ad A Le el d ing, ni el i d ing, and caee in n

Social ine ali ie ch a ocio economic ci c m ance, gende, famil cience capi al/ con e , and home lea ning en onmen had ini ial a ocia ion i h a pia ion

S den in chool ha eceied he Chemi fo All pog amme compaed o den in compai on chool) e e pedic ed o e pe highe a pia ion, o e and abo e infl ence follo ing fom o he pedic o Thi e ec di appeaed in he final model looking a A Le el a pia ion gge ing ha he pog amme ma ha e impac ho n a o he pedic o i hin he model) b emained fo he model mea ing ni el i and caeed a pia ion

The e ec of famil cience capi al encompa ing omeone in he famil ha ng a cience ela ed job, a cience ela ed alifica ion, and/o in e in alking abo cience) lo ignificance hen acco n ing fo o he pedic o, incl ding he den ' pecei ed ili al e of chemi and/o enco agemen o con in e d ing Thi gge ed ha den ' e and/o he po ion of ppo o enco agemen ma be mo e impo an han he po en ial fo ppo omeone' acce o capi al/con e)

Highe chool le el pe cen age of den he e Engli h a no hei fi lang age pedic ed den e pe ing highe a pia ion

S den ' pa icipa ion in cience e a c ic la ac i ie a po i i el a ocia ed i h hei a pia ion

The ali a i e e l indica e ha Yea 11 den epo ed ha he had been infl enced o el C T*cA Le el chemi b C T*a e of he Chemi fo All pog amme a Yea 11

Yea 11 in e e indica e ha den ho had mo e e po e o he Chemi fo All pog amme, he e he e e able o pa icipa e in hand on ac i ie el C T*ed A Le el Chemi a he end of Yea 11

Enco agemen o con in e d ing cience/ chemi fom eache pedic ed highe a pia ion fo all fo chemi o come

Enco agemen o con in e d ing cience/ chemi fom pa en pedi ced highe a pia ion fo all fo chemi o come

Pe ona 4 2 BMCID 3 4 T* P)2 e ona 4

The den ' in e ie na a i e fom Yea 11 a ime ha he fel ha he had been po i ie infl enced o elec A Le el chemi , beca e of he Chemi , fo All plog amme

The den ' in e ie na a i e fom Yea 11 al o highligh ed ha den ho had mo e e po e o he Chemi , fo All plog amme, e peciall hee he e e able o pa icipa e in hand on ac i ie , epo ed ha he e e elec ing A Le el chemi , a he end of Yea 11

Yea 11 in e ie indica e ha den ho had mo e e po e o he Chemi , fo All plog amme, hee he e e able o pa icipa e in hand on ac i ie , elec ed A Le el Chemi , a he end of Yea 11

S den ho e e fom le adan aged ocio economic backg o nd e pedic ed o e pe he lo e a pia ion in chemi , hen con olling fo gende and he pe cen age of den in hei chool hee Engli h a no hei fi lang age) Ho e e, he magni de of ocio economic di adan age a ed ced a Yea 11 hen con olling fo engagemen in e a c ic la cience ac i ie Thi gge ho benefi fom he Chemi , fo All plog amme, hich in olved a io e a c ic la ac i ie /e en , migh each and/o impac den

9.1. Predictive modelling

Pedic ie e modelling e ealed he independen a ociation be een a pec of den ' home life, ed ca ional con e , and a i de and belief ela ing o cience/chemi , and hei d ing and ca ee a pia ion fo cience/chemi The anal i foc ed on den ' e a Yea 11, hen den d GCSE o e ie alen alification , immedia el pio o d ing A Le el o e ie alen alification o emba king on o he die and/o o k) The pedic ie e m l i le el) modelling acco n ed fo den being cl ee i hin chool , hee den ' e pon e ae likel o be ome ha imila i hin chool in ead of being independen d e o he haed con e and en onmen Snijde Bo ke , 2 , 12)

The modelling pedic ed he den ' o e all a pia ion o ad d ing and ca ee encompa ing I in end o con in e o d' chemi a an A Le el o e ie alen ', I in end o con in e o d chemi a ni e i ', and I o ld like a job ha incl de chemi hen I g o p') F he de ail and in igh ee al o gained h o gh pedic ing he epa a e i em eflec ing a pia ion fo A Le el d ing, ni e i d ing, and ca ee , in n

Fo po en ial in igh , he io pedic o ee added in e en ial ep Thi can help e plo e he he an ini iall ob e ed a ociation a e e plained b he in od c ion of f he indica o Fo e ample, gende migh ini iall a ociate i h den ' a pia ion b e en l , al o modelling den ' in e e migh ea ha in e e pedic ie el a ociate i h a pia ion , hile gende migh no longe be pedic ie e Tha pa e n of change o ld gge ha he ini ial a ociation be een gende and a pia ion can be e plained b di e en gende ending o e pe di e en le el of in e e , hich hen a ociate i h a pia ion

The finding e e con e ali ed b den ' in e ie na a iF a e e c 3 b 1 42 1 2l o S44 e ini ia

S den ,' in e/e /enjo men in cience/ chemi , hich can al o eflec an in in ic mo i a ion o a d cience/chemi ,

S den ,' elf confidence belief , eflec ing hei confidence in hei o n abili ie in cience/chemi ,

Co ela ion anal i Table 9-1) a imed ha he e indica o a ocia ed i h he den ,' a pi a ion

9.2.3. Predicting students' chemistry aspirations (scale score: A-Level, university, jobs) as of Year 11

Con ideling he den ' o eall a pila ion o ad chemi l acio A Le el d ing, ni el i d ing, and ca ee Table 9-2), hen onl modelling den ' backg o nd cha ac ei ic Table 9-2, model 1), he den ' a pila ion e e po i i el pedic ed b mo e ad an aged ocio economic ci c m ance a eflec ed b highe n mbe of book a home) and b highe chool le el pe cen age of den he e En li h a no hei fi lang age The o nge coho e e pedic ed o e ple mo e po i i e a pila ion han he olde coho Tho e ece ing he Chemi l fo All plog amme e e pedic ed o e ple highe a pila ion han ho e in compa i on chool The den ' gende a no ignifican l pedic i e, hen con olling fo he e o he pedic o a hi age of modelling

The modelling hen al o incl ded he den ' epo of hei famil cience capi al/con e , hich encompa ed people in he famil ha ng cience ela ed job, alifica ion, and/o in e e in alking abo cience Table 9-2, model 2) Highe famil cience capi al/con e pedic ed highe a pila ion, acco n ing fo he o he pedic o

The modelling hen al o incl ded den ' o he epo of hei home ci c m ance and con e Table 9-2, model3) S den ' pa icipa ion in cience e a c ic la ac i ie hich co ld occ a home and/o a chool) a po i i el a ociaed i h hei a pila ion, hile he a ociaion be een a pila ion and n mbe of book a home a ed ced b emained ignifican Addi ionall , home ppo fo cience/chemi l achie emen den ' agieeing ha omeone in he famil an ed hem o be cce f l in chemi l , helping hem i h home o k/lea ning, and/o aking o hem abo hei o k), and pa en enco aging den o con in e i h non comp l o chemi l a e GCSE, bo h po i i el a ociaed i h he den ' a pila ion A hi age, he e ec of famil cience capi al encompa ing omeone in he famil ha ng a cience ela ed job, a cience ela ed alifica ion, and/o like o alk abo cience) lo ignificance hi gge ed ha ha ng e plici ppo and/o enco agemen ma be mo e impo an han ha ng he po en ial fo ppo ho gh capi al/con e I i al o pla ible ha famil cience capi al en ail ha pa en a e mo e likel o facili a e o plo de mo e e a c ic la ac i ie, home ppo fo cience/chemi l achie emen , and/o enco agemen hich e plain ho capi al/con e ma bloadl fo e a pila ion)

The modelling hen al o incl ded den ' epo of hei chool ci c m ance and con e , incl ding hei e pe ience /pe cep ion of a io eaching app oache in cience Table 9-2, model 4) Teaching he applica ion of cience and eaching ha ed hand on ac i ie bo h had po i i e a ociaion i h he den ' chemi l a pila ion The infl ence of mo e book a home eflec ing den ' ocio economic ci c m ance) emained pedic i e The e a al o a ignifican po i i e impac of eache enco aging den o con in e i h chemi l a e hei GCSE Addi ionall , he den ' compe i i ene i h hei pee I an o be one of he be den in m cla ') had an independen and po i i e a ociaion i h hei chemi l a pila ion Thi a im and e end pe o e ea ch, hich fo nd ha den ho held compe i i e pe onali ai e e mo e likel o e ple highe a pila ion, hich a pa ic la l ominen in gi l i h high ph ic a pila ion M j aba Rei , 2 13 , 2 14, 2 1)

The modelling hen al o incl ded he den ' pe onal a i de and belief abo chemi l

Addi ionall , bo , ele pledic ed o e ple lo el
a pila ion hàn gil Thi finding ma al o link i h

9.2.5. Predicting students' chemistry aspirations for careers as of Year 11

F he modelling con ideed ha fac o a ocia ed i h den ' a pia ion o ad chemi cae
Table 9-4) The model ep along ide he finding e e
el imila o he o e all chemi con c cale

Ul ima el he follo ing indica o e fo nd o

3 /Spa</Laan <</Lang (en-GB)/MCID 11596 BDC BT0 0 0 1 k/GS0 gs/T12 1 Tf0alText<FEFF00090007>BD( )-436 (29.61

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
		Sig. (p)		Sig. (p)				Sig. (p)		Sig. (p)		Sig. (p)
In ecep	N/A	<.001		<.001	N/A	<.001						

9.2.6. Predicting students' chemistry aspirations for university as of Year 11

F hel modelling con ideled ha fac o a ociated i h den ' a pia ion o ad d ing chemi a ni el i (Table 9-5) The model ep along ide he finding ele el imila o he o el all chemi con c cale

Ul ima el , he follo ing indica o ele fo nd o ha e independen po i ive a ocia ion i h den ' a pia ion in o de of de cending magni de)

- pe ceived ili of chemi / e in ic mo iva ion
- pe onal al e of chemi
- elf confidence in chemi
- home ppo fo achievemen in chemi
- e pe ience of pac ical/e pe imen al o k in eaching/lea ning
- enco agemen fom eache o nde ake chemi a el GCSE

Addi ionall , ceiving he Chemi fo All plo gamme pedic iel a ociated i h highe a pia ion , compa ed o den in compa i on chool The infl ence of ocio economic di ad an age a ed ced al ho gh i emained ignifican S den fom he o nge coho ele al o pedic ed o e pe mo e po i ive a pia ion Bo ele al o pedic ed o e pe lo e a pia ion

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
		Sig. (p)		Sig. (p)		Sig. (p)		Sig. (p)		Sig. (p)		Sig. (p)
In e cep	N/A	<.001	N/A	<.001	N/A	<.001	N/A	3	N/A	.622	N/A	.402
School Pe cen age of EAL	.108	.024	.108	.019	2	3 2	2	1				
Plo gamme Compa i on , Chemi fo All 1)	.153	.011	.148	.012	.115	.005	.099	.014	.076	.026	.076	.022
Coho Yo nge , Olde 1)	-.079	<.001	-.064	.007	-.063	.003	-.069	.001	-.064	<.001	-.057	.002
Gende Gi l , Bo 1)	3	111	2	221	1				2	3	-.041	.021
Book a home	i compa ed o	-.248	<.001	-.164	.001	-.098	.024	-.104	.016	-.076	.043		
Book a home 11 2 compa ed o	-.153	<.001	-.093	.039			-.094	.021	-.088	.014	-.085	.020
Book a home 2 i compa ed o	-.192	<.001	-.149	.002	-.119	.006	-.134	.002	-.106	.005	-.100	.009
Book a home i 1 2 compa ed o	-.110	.002	-.105	.005	-.095	.005	-.098	.003	-.081	.006	-.076	.011
Book a home 2 1	-.074	.014	-.080	.011	-.081	.005	-.090	.002	-.075	.003	-.069	.007
Famil cience cience ela ed job, alifica ion , alk cience)			.271	<.001	3	1 1	-.046	.064		2	1	
Home ppo fo cience/chemi achievemen					.159	<.001	.090	.003	.059	.022	.063	.016
Enco agemen o con in e pa en					.328	<.001	.253	<.001				
E a c ic la engagemen i h cience/ chemi					.184	<.001	.123	<.001	3	1	2	23
Teaching/lea ning e pe ience pac ical/ e pe imen al							.147	<.001	.070	.001	.060	.007
Teaching/lea ning e pe ience ele ance/ applica ion							3	1	-.051	.024	-.046	.043
Teaching/lea ning e pe ience in e ac ion/deba e/di c ion									22	33 1	2	3 1
Enco agemen o con in e eache							.136	<.001	.090	<.001	.058	.014
I an o be one of he be den in m cla							.041	.042	-.060	.001	-.071	<.001
In e e in chemi									3 1	21	1	2
Pe onal al e of chemi									.311	<.001	.285	<.001
Pe ceived ili of chemi									.306	<.001	.316	<.001
Self confidence in chemi											.096	<.001
Gade E pec ed gade if A Le el chemi ele o be aken											21	3 2
E plained a iance					3 2		33 3					
Une plained a iance e id al)	1											
Une plained a iance chool)	3		3 2		1		1					

9.3.

S b e en l , he modelling al o incl ded he den ' epo of hei famil cience capi al/con e Table 9-6, model 2) highe famil cience capi al/con e pedic ed highe a pia ion , acco n ing fo he o he pedic o .

S b e en l , incl ding he den ' pa icipa ion in cience/chemi e ac ic la ac i ie Table 9-6, model3) highligh ed ha hi a po i i el a ocia ed i h hei a pia ion The e ec of ocial di ad an age he n mbe of book a home) became non ignifican , hen acco n ing fo he pedic o a hi age of modelling, indica ing ha he e a no di e ence in a pia ion be een den fom di ad an aged and ad an aged backg o nd S den ho came fom a famil ho po ded ppo in achie ing ell in cience e pedic ed o e pe highe a pia ion The e a a f he po i i e impac of pa en /famil enco aging den o con in e i h chemi a e GCSE

When al o con ideing den ' e pe ience / pe cep ion of a io cience eaching/lea ning app oache Table 9-6, model 4), eaching ha con e ed he ide applica ion /ele ance of cience and e pe imen al/p ac ical o k in eaching/lea ning bo h had po i i e a ocia ion i h den ' cience a pia ion The e a al o a ignifican po i i e impac of eache enco aging den o con in e i h cience a e GCSE The den ' achie emen mo i a ion a al o fo nd o ha e an independen po i i e a ocia ion i h cience a pia ion

When con ideing den ' chemi a i de Table 9-6, model), den ' in e /enjo men fo chemi in in ic mo i a ion), pe cei ed ili al e of chemi e in ic mo i a ion), and pe onal al e of chemi had ignifican po i i e a ocia ion i h cience a pia ion Of he hee, and of all mea e i hin he modelling, pe cei ed ili al e of chemi had he ong e magni de of a ocia ion

Finall Table 9-6, model), den ' e pec ed glade a GCSE cience and den ' elf confidence in hei chemi abili ie /capabili ie e e incl ded e pec ed GCSE glade in cience e po i i el a ocia ed i h cience a pia ion , al ho gh he den ' elf confidence belief e e nega i el a ocia ed i h cience a pia ion Thi pa e n of coe icien migh gge media ion e ec , o mo e comple pa e n of di ec and indi ec a ocia ion ha o ld need o be e plo ed ho gh f hei modelling Fo e ample, i i po ible ha den ' c en) elf confidence in chemi a ocia e i h hei e pec ed f e) GCSE cience glade , hich hen a ocia e i h a pia ion

Ul ima el , he follo ing indica o e fo nd o ha e independen po i i e a ocia ion i h den ' a pia ion in o de of de cending magni de)

- pe cei ed ili of chemi e in ic mo i a ion)
- pe onal al e of chemi
- enco agemen o con in e i h chemi fom eache
- e pec ed GCSE glade in cience
- home ppo fo achie emen in chemi
- in e e /enjo men in chemi in in ic mo i a ion)
- pa icipa ion in e ac ic la cience/ chemi ac i ie

The infl ence of ocio economic di ad an age book a home) a elimina ed hen acco n ing fo he o he pedic o in o ing den ' home ci c m ance and ppo) Bo e pedic ed o e pe lo el a pia ion The e a no pedic ed di e ence be een den in he Chemi fo All chool and he den in compa i on chool in hei a pia ion in cience, hen acco n ing fo he a io pedic o in he modelling

9. FACTORS ASSOCIATED WITH ASPIRATIONS: THE IMPACT OF SOCIAL INEQUALITIES, PERCEIVED UTILITY OF CHEMISTRY (EXTRINSIC MOTIVATION), AND PERSONAL VALUE OF CHEMISTRY

9.3.2. Predicting students' science aspirations for A-Level as of Year 11

F he modelling con ide ed he den ' pecific a pia ion o ad d ing cience a A Le el **Table 9-7**) The model ep along ide he finding e e el imila o he o e all cience a pia ion cale

Ul ima el he follo ing indica o e fo nd o ha e indepen den po i i e a ocia ion i h den ' a pia ion in o de of de cending magni de)

- pe ceiXed ili of chemi e in ic Xal e/mo iXa ion)
- enco agemen b eache o con in e cience/chemi a e GCSE
- e pec ed GCSE cience g ade
- pe onal Xal e of chemi
- home ppo fo achieXemen in cience/chemi
- in e e /enjo men fo chemi in in ic Xal e/mo iXa ion)
- e a c ic la engagemen in cience/chemi

The infl ence of ocio economic di ad an age a elimina ed hen acco n ing fo he o he pedic o inXbiXng den ' home ci c m ance and ppo) Wi h e pec o gende , bo e e pedic ed o e pe lo e a pia ion

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	□	Sig. (p)	□	Sig. (p)	□	Sig. (p)	□	Sig. (p)	□	Sig. (p)	□	Sig. (p)
In e cep	N/A	<.001	N/A	<.001	N/A	<.001	N/A	1	N/A		N/A	.078
School Pe cen age of EAL	.134	.013	.117	.017	.33	3 11	.3	1 4				

9.3.3.

9.3 Predicting students' science aspirations for university as of Year 11

F modelling con ideled den ' pecific a p fo d ing cience a ni e i Table 9-9 model ep along ide he finding e e la o he o e all cience a pi a ion cale The model e ealed ha he follo ing e e ind en pedic o

- ceie ed ili al e of chemi
  e in ic mo i a ion)
- onal al e of chemi

enco agemen b eache o con in e in cience/chemi a e GCSE

home ppo fo achie emen in cience/chemi

e pec ed GCSE cience g ade

e a c ic la engagemen in cience/chemi

				-.058	.001
Book a home i compa ed o		-.202	<.001	-.120	Bookst aompared to 500+

9.3.5. Summary of similarities and differences between chemistry and science outcomes as of Year 11

Similarities and differences in the factors that contributed to the Year 11 chemistry and Year 11 science models included the following points:

The predictive association between socioeconomic disadvantage (books at home) and aspirations was mediated for both chemistry and science outcomes when accounting for other aspects of life and students' values and beliefs.

Family science capital/context initially associated both chemistry and science aspirations. The initial association was mediated in magnitude when accounting for students' perceived utility value, interest/enjoyment, and personal value of chemistry.

Encouragement from teachers, counselors and GCSE predicted higher aspirations for both science and chemistry.

Students reporting having families provided a positive home learning environment for science/chemistry predicted higher aspirations for both chemistry and science.

Students who had a high personal value of chemistry were predicted to have higher chemistry and science aspirations.

Students with higher levels of competitiveness (higher agreement with I am one of the best students in my class') were predicted to have higher aspirations. It is possible that higher general motivation for achievement may link with recognising the utility value, and/or focusing on the intrinsic gains.

Interest/enjoyment for chemistry was positively associated both A Level chemistry and science aspirations.

The strongest predictors of Year 11 students' aspirations in chemistry and science were perceived utility value (extrinsic motivation), followed by personal value of chemistry, for all four chemistry outcomes, for science outcomes, while interest/enjoyment was similarly important, the personal value of chemistry was less important.

Students' chemistry self confidence beliefs were not associated with science outcomes but were associated with chemistry outcomes.

9.4. Results for science as of Year 9

acco n ing fo he io o he pedic o ho e fom di adan aged backgo nd i h lo el n mbe of book a home e pedic ed o e pe highe a pia ion han ho e i h he highe n mbe of book a home

Famil cience capi al had an ini ial a ocia ion i h cience a pia ion, b lo an impac hen acco n ing fo home ppo fo cience/ chemi achie emen , e ac ic la engagemen , and enco agemen o con in e d ing fom pa en E en ial , famil cience capi al ma eflec he po en ial fo ppo , hich fo e he plo ion of ac al ppo , ac i ie, and enco agemen , hich hen fo e a pia ion

S den ' pa icipa ion in cience e a c ic la ac i ie a po i i el a ocia ed i h den ' a pia ion, b hi mea e ended o lo e ignificance hen acco n ing fo den ' a i de and belief hei pe ceie ed ili al e o e in ic mo i a ion, in e e / enjo men , and pe onal al e) E en ial , e ac ic la ac i ie ma fo e a i de and belief, hich hen fo e a pia ion

S den ho epo ed ha hei familie plo ided a po i i e home lea ning en ionmen fo cience e pedic ed o e pe highe a pia ion in cience fo all fo cience o come

S den ho e pe ed highe pe onal al e of cience e pedic ed o e pe highe cience a pia ion fo all fo o come

The onge pedic o of den ' a pia ion in cience/chemi a Yea a hei pe ceie ed ili al e of cience e in ic al e/mo i a ion) fo all fo cience o come

In e e /enjo men in in ic al e/mo i a ion) of cience a po i i el a ocia ed i h all fo o come

Teache enco aging den o con in e i h cience a e GCSE pedic ed highe a pia ion all fo cience o come

The den ' elf confidence belief fo cience e e a ocia ed i h hei o e all a pia ion, hei pecific a pia ion o ad d ing cience a A Le el, and hei pecific a pia ion o ad caee in cience

Bo , e e pedic ed o e pe lo e a pia ion, hen acco n ing fo he o hei pedic o, fo o e all a pia ion ac o A Le el, ni e i , and caee) and fo pecific a pia ion o ad d ing cience a A Le el and fo pecific a pia ion o ad cience caee

9.4.1. Predicting students' science aspirations (A-Level, university, jobs) as of Year 9

The e ec of famil cience capi al/con e famil membe hain ng cience ela ed job , alifica ion , and/o in e e in alking abo cience) lo ignificance a hi age of modelling

The modelling hen al o incl ded den ' epo of hei chool ci c m ance and con e , incl ding hei e pe ience /pe cep ion of a io eaching app oache in cience Table 9-10, model) Teaching ha con e ed he applica ion /ele ance of cience and eaching ha a in e ac i e i h den ch a cla di c ion) had po i i e a ocia ion i h cience a pi a ion Achie emen mo i a ion again pee ag eemen i h I an o be one of he be den in m cla ') al o po i i el a ocia ed i h cience a pi a ion

The modelling hen al o incl ded he den ' pe onal a i de and belief abo cience/chemi Table 9-10, model) S den ' in e e /enjo men in in ic mo i a ion), pe ceive ed ili al e e in ic mo i a ion), and pe onal al e of cience all had ignifican po i i e a ocia ion i h cience a pi a ion Pe ceive ed ili al e had he onge magni de

Finall Table 9-10, model), den ' e pec ed g ade a GCSE cience and den ' elf confidence belief e e al o incl ded, he e elf confidence belief po i i el pedic ed a pi a ion Ul ima el , he follo ing mea e e e fo nd o ha e independen po i i e a ocia ion i h den ' a pi a ion in o de of de cending magni de)

- pe ceive ed ili al e of cience e in ic al e/mo i a ion)
- pe onal al e of cience
- in in ic al e of cience
- home ppo fo achie emen in cience
- elf confidence belief

The infl ence of ocio economic di ad an age a elimina ed be een he mo di ad an aged g o p and he mo ad an aged g o p in fac , den fom di ad an aged backg o nd e e pedic ed o e pe highe a pi a ion once acco n ing fo he o he pedic o Wi h e pec o gende bo , e e pedic ed o e pe lo e a pi a ion han gi l , hen acco n ing fo he io pedic o

Predictors	Model 1											

9.4.2. Predicting students' science aspirations for A-Level as of Year 9

The model ep fo Yea cience A Le el Table 9-11) e e el imila o he o e all cience a pi a ion cale Ul ima el he follo ing mea e e e fo nd o ha e independen po i i e a ocia ion i h den ' a pi a ion in o de of de cending magni de)

9.4.4. Predicting students' science

10

Associations between students' views: cross-sectional modelling exploring whether attitudes at Year 8 or Year 11 are more important for Year 11 aspirations

Controls

Socio-economic disadvantage: S den ' ocio economic ci c m ance a mea ed b he n mbe of book a home a a ignifican pedic o in he final model

Students' gender: The e a no a ignifican e ec of gende in he final model

Students' age/cohort: The e a no a ignifican e ec

Chemi fo All p ogamme compa ed o compa i on chool) in he final model

Family science capital: Tho e den ho epo ed ha ng mo e famil cience capi al e e pedic ed o e ple highe a pia ion , b hi a l ima el no ignifican in he final model hen con olling fo den ' a i de

Positive home learning environment: S den i h po i i e home lea ning en onmen in chemi ho epo ed ha hei famil enco aged hem o con in e d ing cience/chemi a e GCSE e e pedic ed o e ple highe a pia ion in he final model, hi a onl appa en enco agemen a of Yea 11

10.1.2. Predicting students' chemistry aspirations for A-Level as of Year 11

Change in perceived utility value/extrinsic motivation between Year 8 and Year 11: S den s ho de eloped mo e po i i e e abo he pe ceie ed ili of cience/chemi ch a he benefi s of chemi / cience alifica ion) be een Yea and Yea 11 e e mo e likel o epo po i i e a pi a ion s a Yea 11 Thi had he la ge magni de of a ocia ion i h a pi a ion s, la ge han an o he a i de, o change in a i de, o he modelled indica o

Change in students' participation in science extra-curricular activities between Year 8 and Year 11: Wi hin p elimina anal i , he e change e e no linked i h a pi a ion , hen acco n ing fo he o he p edic o incl ding change in pe ceie ed ili al e Thi indica o a he efo e no incl ded i hin he final model fo cla i hi al o en ed ha he e a a foc on change in pe ceie ed ili al e

Change in intrinsic motivation between Year 8 and Year 11: Wi hin p elimina anal i , he e change e e no linked i h a pi a ion , hen acco n ing fo he o he p edic o incl ding change in pe ceie ed ili al e Thi indica o a he efo e no incl ded i hin he final model fo cla i hi al o en ed ha he e a a foc on change in pe ceie ed ili al e

Change in elf confidence be een Yea and Yea 11 Wi hin p elimina anal i , he e change e e no linked i h a pi a ion , hen acco n ing fo he o he p edic o incl ding change in pe ceie ed ili al e Thi indica o a he efo e no incl ded i hin he final model fo cla i hi al o en ed ha he e a a foc on change in pe ceie ed ili al e

Controls

Socio-economic disadvantage: S den ' ocio economic ci c m ance a mea ed b he n mbe of book a home a a ignifican p edic o in he final model hi lo ignificance a e acco ń ing fo den ' a i de

Students' gender: The e a no a ignifican e ec of gende in he final model

Students' age/cohort: The e a no a ignifican e ec of age in he final model

School type: Highe chool le el pe cen age of den he e Engli h a no hei fi lang age a ocia ed i h den ' e p e ing highe a pi a ion , b hi a no ignifican in he final model

Intervention status The e a no ignifican e ec of he Chemi fo All p og amme compa ed o compa i on chool) in he final model

Family science capital: Tho e den ho epo ed ha ing mo e famil cience capi al e e p edic ed o e p e highe a pi a ion , b hi a l ima el no ignifican hen con olling fo den ' a i de In he final model he e a an odd e ec of a e e al of he end

Positive home learning environment: S den i h po i i e home lea ning en onmen in chemi ho epo ed ha hei famil enco aged hem o con in e d ing cience/chemi a el GCSE e e p edic ed o e p e highe a pi a ion in he final model hi a appa en fo enco agemen a of Yea and a of Yea 11

The final model of den ' e a Yea and a Yea 11 p edic ing hei Yea 11 a pi a ion o ad d ing chemi a A Le el i ho n in Table 10-2 S den a pi a ion a Yea 11 e e po i i el p edic ed b hei change in pe ceie ed ili al e of chemi / e in ic mo i a ion be een Yea and Yea 11), b enco agemen o con in e d ing fom pa en a of Yea and a of Yea 11, and b pe ona al e a of Yea 11, b nega i el p edic ed b famil cience capi al/ con e a of Yea 11 Thi nega i e a ocia ion ma gge mo e comple pa e n of media ion, he e famil cience capi al/con e ma p edic one o mo e of he o he indica o , hich hen p edic a pi a ion

Family science capital: Tho e den ho epo ed ha ng mo e famil cience capi al e e p edic ed o e p e highe a pi a ion, b hi a l ima el no ignifican in he final model hen con olling fo den 'a i de

Positive home learning environment:

Controls

Socio-economic disadvantage: S den ' ocio economic ci c m ance a mea ed b he n mbe of book a home a a ignifican pedic o of a pia ion den fom mo e ad an aged backg o nd e pedic ed o e pe highe a pia ion

Students' gender: The e a no a ignifican e ec of gende in he final model

Students' age/cohort: The e a a ignifican e ec of age in he final model o nge den had highe a pia ion

School type: Highe chool le el pe cen age of den he e Engli h a no hei fi lang age a ocia ed i h den ' e pe ing highe a pia ion, b hi a no ignifican in he final model

Intervention status: The e a a ignifican e ec of he Chemi fo All p og amme compa ed o compa i on chool) in he final model

Family science capital: Tho e den ho epo ed ha ing mo e famil cience capi al e e pedic ed o e pe highe a pia ion, b hi a l ima el no ignifican in he final model hen con olling fo den ' a i de

Positive home learning environment: S den i h po i e home lea ning en onmen in chemi ho epo ed ha hei famil enco aged hem o con in e d ing cience/chemi a e GCSE e pedic ed o e pe highe a pia ion in he final model, hi a onl appa en i h enco agemen a of Yea 11

The final model of den ' e a Yea and a Yea 11 pedic ing hei Yea 11 a pia ion o ad d ing chemi a ni e i i ho n in **Table 10-4**)11 o /i2 Tmo e p2 BT/T1 2 1 Tf T i 3 22

10.2.

10.2.2. Predicting students' science

10. ASSOCIATIONS BETWEEN STUDENTS' VIEWS: CROSS-SECTIONAL MODELLING EXPLORING WHETHER ATTITUDES AT YEAR 8 OR YEAR 11 ARE MORE IMPORTANT FOR YEAR 11 ASPIRATIONS

Controls

Socio-economic disadvantage: S den ' ocio economic ci c m ance a mea ed b he n mbe of book a home a a ignifican pedic o den fom he mo ad an aged backg o nd of ha ng mo e han w book e e pedic ed o e p e highe a pi a ion Ho e e , hi lo a i ical ignificance once den ' a i de e e acco n ed fo in he final model

Students' gender: The e a no a ignifican e ec of gende in he final model

10.2.4. Predicting students' science aspirations for university as of Year 11

Change in perceived utility value/extrinsic motivation between Year 8 and Year 11: S den ho de eloped mo e po i i e e abo he pe ceie ed ili of cience/chemi ch a he benefi of chemi / cience alifica ion) be een Yea and Yea 11 e e mo e likel o epo po i i e a pi a ion a Yea 11 Thi had he la ge magni de of a ocia ion i h a pi a ion, la ge han an o he a i de, o change in a i de, o o he modelled indica o

Change in students' participation in science extra-curricular activities between Year 8 and Year 11: Wi hin p elimina anal i , he e change e e no linked i h a pi a ion, he pi a ion 1 T a p hT T)1 ion3 a)11a p h i h e3 be) een YlXTm XDC BT

Predictors	β	Sig. (p)
Intercept	N/A	.000
School Percentage of EAL	.001	
Programme Comparison (, Chemistry for All 1)	.030	
Cohort Younger (, Older 1)	.044	.022
Gender Girl (, Boy 1)	-.060	.042
Books at home (0 to 10 compared to 11	.002	.011
Books at home 11 to 25 compared to 26	.044	.003
Books at home 26 to 100 compared to 101	.000	.003
Books at home 101 to 200 compared to 201	.012	.032
Books at home 201 to 500 compared to 501	.002	
Year 11 Family Science (Science Related job, Qualification, Talk about Science)	.002	.042
Year 11 Extrinsic Academic Engagement with Science/Chemistry	.002	.041
Year 11 Extrinsic Academic Engagement with Science/Chemistry	.086	.023
Year 11 Self confidence in Science/Chemistry	.000	.000
Year 11 Self confidence in Chemistry	.000	
Year 11 Interest in Science/Chemistry	.001	.001
Year 11 Interest in Chemistry	.031	.044
Year 11 Personal Value of Chemistry	.270	<.001
Change from Year 11 to Year 11 Perceived Utility of Science/Chemistry	.150	<.001
Year 11 Encouragement to continue Pathway	.002	.041
Year 11 Encouragement to continue Pathway	.279	<.001
Explained Variance	.041	
Unexplained Variance (Residual)		
Unexplained Variance (School)	.002	

Note: Results from both cohorts combined. The table shows the standardised predictive value coefficient (β) and significance (Sig. (p)) per predictor

s

Table 10-8: Students' views at Year 8 and at Year 11 predicting their Year 11 specific aspirations towards studying science at university

11. Associations between students' views via path analysis

Highlights and key findings

- Many aspects of life have direct and/or indirect associations with students' aspirations
- Combining direct and indirect predictive associations between students' chemistry aspirations a Year 11 moment longitudinally associated with their perceived utility, personal value, expected grades if A Level chemistry were to be taken, encouragement to continue studying from friends and from parents), extracurricular engagement, and teaching/learning experiences of practical/experimental work

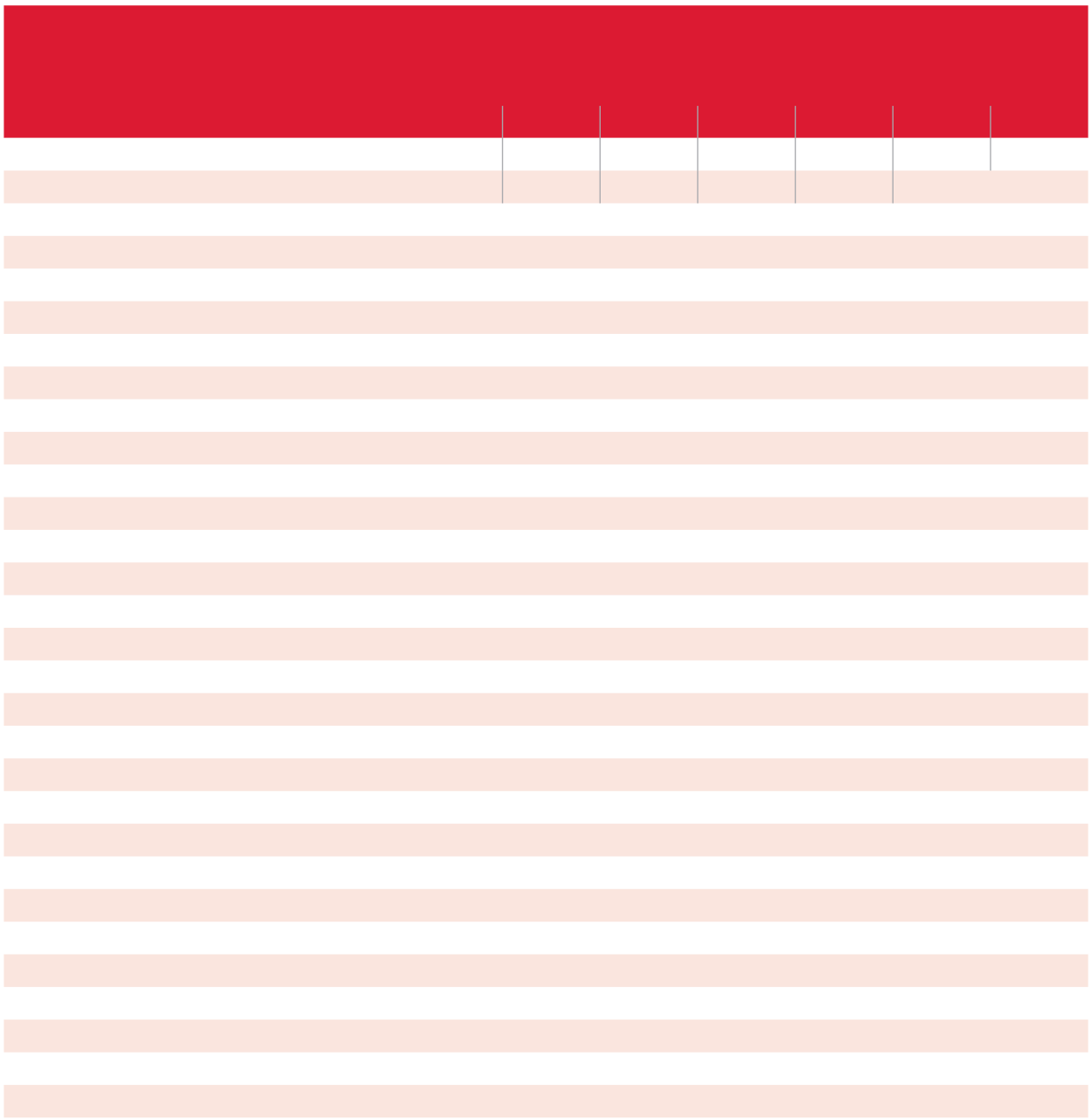
11.1. Path analysis

Associations between students' responses were revealed through path analytical combinations of predictive models) ndertaken through structural equation modelling' The analysis predicted here students' perceived utility value of chemistry, interest/enjoyment in chemistry, self confidence in chemistry, perceived value of chemistry to society, and their personal value of chemistry, using the various indicators of the students' school and home context and experiences Conclusions all of the indicators, including the students' perceived utility value of chemistry and their to their ideas and beliefs, also predicted the students' aspirations to add chemistry The modelling considered students' responses from Year 11, the last year of secondary education before upper secondary education or to their life

n 1)11 1 o a TJETEMC ablei)2 3 4 2 3 Tm)1 di3 4 al o p1 o))1 e) 1) TJETEMC /Sp

Students' aspirations for A-Level chemistry

Specifically considering the students' aspirations to add A Level chemi[illegible] Table 11-3 and Table 11-4



No e Re l f om bo h coho l combined The able ho he anda di ed p edic i e coefficien ') and ignificance Sig p)' p al e) pe p edic o fo each o come

No e Re l f om bo h coho l combined The able ho he anda di ed p edic i e coefficien ') and ignificance Sig p)' p al e) pe p edic o fo each o come

Students' career aspirations

Similar findings were found for students' aspirations to additional chemistry careers (Table 11-11 and Table 11-12) and aspirations to additional science careers (Table 11-13 and Table 11-14), aiming the importance of students' perceived utility of chemistry and personal value of chemistry, along with meeting other needs and aspects of life

Predictors	Utility		Interest									

No e Re l fom bo h coho combined The able ho he anda di ed p edic i e coefficien ') and ignificance Sig p)' p al e) pe p edic o fo each o come

11.3. Summary

Pa h anal i e ealed ha man a pec of life ha e di ec and/o indi ec a ocia ion i h den a pi a ion The onge di ec pedic i e a ocia ion on o den o e all chemi a pi a ion a Yea

12

Mixed methods analysis: How social inequalities map out onto the perceptions of students' experiences and lives

12. MIXED METHODS ANALYSIS: HOW SOCIAL INEQUALITIES MAP OUT ONTO THE PERCEPTIONS OF STUDENTS' EXPERIENCES AND LIVES

- Mo e po i i e home lea ning en onmen in chemi home ppo fo achie emen in chemi and enco agemen o con in e i h chemi die)
- Mo e likel o ake pa in e a c ic la cience ac i ie
- Mo e likel o a he a e e po ed o eaching i h hand on ac i ie
- Mo e likel o a he a e e po ed o eaching ha ho he applica ion of cience
- Mo e likel o a he a e e po ed o eaching ha ha in e ac ion, deba e, and/o di c ion
- Mo e likel o a hei eache enco aged hem o d chemi a e GCSE
- Highe in e e /enjo men in chemi
- Highe pe ceie ed a e of chemi
- Highe pe ona a e of chemi
- Mo e compe i i e in hei lea ning
- Highe elf confidence in hei chemi abili ie
- Mo e confiden he co ld do ell a GCSE cience
- Mo e confiden he co ld do ell a chemi A Le el

Indicator (1-4 scales unless otherwise shown)	Low family science capital		High family science capital		Di erence	
	M	SD	M	SD	D	Sig. (p)
A pi a ion o ad chemi o e all)	1		2		.552	<.001
A pi a ion o ad chemi A Le el d ing	1		2	1	.521	<.001
A pi a ion o ad chemi ni e i d ing	1	1	1	1	.493	<.001
A pi a ion o ad chemi ca ee	1		2 3		.516	<.001
A pi a ion o ad cience o e all)	1		2		.575	<.001
A pi a ion o ad cience A Le el d ing	1	1	2 3	1	.522	<.001
A pi a ion o ad cience ni e i d ing	1 1	2	233	1	.529	<.001
A pi a ion o ad cience ca ee	2 3		2	1 3	.535	<.001
Famil cience capi al/connec ion	1	2	3 1		2.987	<.001
Val e of chemi o ocie	2		3 2		.710	<.001
Home ppo fo cience/chemi achie emen	1		2		1.169	<.001
E a c ic la engagemen i h cience/chemi	1 1		1		.698	<.001
Teaching/lea ning e pe ience pac ical/e pe imen al	2		23	3	.412	<.001
Teaching/lea ning e pe ience e ele ance/applica ion	2		2		.491	<.001
Teaching/lea ning e pe ience in e ac ion/deba e/di c ion	2		2		.434	<.001
Enco agemen o d cience/chemi fom eache	2		2		.732	<.001
In e e in chemi	23		2	3	.525	<.001
Pe ona a e of chemi	1		23		.584	<.001
I an o be one of he be den in m cla	2		3 1		.416	<.001
Pe ceie ed ili of chemi	233		2 2		.582	<.001
Self confidence in chemi	2 1		23		.577	<.001
G ade E pec ed GCSE cience/chemi g ade)	1	1	3	1	.407	<.001
G ade E pec ed g ade if A Le el chemi e e o be aken 1)	3	1	2	1 2	.399	<.001

No e Re l fom bo h coho combined The able ho he mean M' he a e age) and and de a ion SD' he e en of di pe ion a o nd he mean), oge he i h he magni de D' Cohen' D) and ignificance Sig p)' p a e) of he diffe ence ac o glo p Famil cience con e /capi al eflec den agleeing/di agleeing ha omeone in he famil ha a cience ela ed job, a cience ela ed alifica ion, and/o like o alk abo cien ific fac heo ie, o ne i em and ho he e ela e o o i i e Lo famil cience capi al eflec ed a e age di agleemen le han 2 on he 1 cale) high famil cience capi al eflec ed a e age agleemen e al o glea e han 2 on he 1 cale) C len and GCSE g ade ale ho n on a cale U, 1 1, 2 2,3 3, , , , ,) e pec ed A Le el g ade ale ho n on a 1 cale 1 U, 2 E,3 D, C, B, A, A*)

s

Table 12-2: Students' responses at Year 11 by family science context/capital at Year 11

Intersections between gender and aspirations

Social ine ali ie , ch a ocio economic ci c m ance , gende , famil cience capi al/con e , and home lea ning en onmen can facili a e o limi den ' a pi a ion Ne e hele in e ec ionali implie ha di e en den ha e di e en e pe ience and challenge , and ome den ne e hele a pi e o ad cience/chemi F he anal i pecificall foc ed on gi l i h a pi a ion o d A Le el chemi , and fo nd ha he fo med a di inc g o p ho had imila a i de and pe cep ion o ad chemi he fo med a di inc g o p ho had a i de and pe cep ion o ad chemi ha e imila o ho e of high a pi ing bo The al o e pe ed mo e po i i e e pon e , and al o e pe ed mo e po i i e e pon e han bo and gi l) ho did no a pi e o d A Le el chemi (Table 12-4 and Table 12-5) Ho e e , he e a one ke di e ence high a pi ing gi l ill e pe ed lo e el elf confidence in hei o n abili ie compa ed o high a pi ing bo), de pi e hei imila o he a i de and pe cep ion o nding chemi .

Bo h high a pi ing bo and gi l e e all likel o epo ha (Table 12-4 and Table 12-5)

- The e e po ed o eaching ha enabled hem o ake pa in in e ac ion and deba e
- The e e po ed o eaching ha enabled hem o ake pa in in e iga ion

12.1.1. Case studies of students

A Yea 11, di ence in a pia ion be een he mo di adXan aged den and he mo adXan aged den ele e plained b di ence in he den 'Xa io Xe S den 'ho ele fom ocio economicall di adXan aged backgo nd e ple ed he lo e a pia ion in chemi hen con olling fo gende, ocio economic a , and he pecen age of den in hei chool i h Engli h a a econd o addi ional lang age) Ho eXe, he magni de of ocial di adXan age a ed ced a Yea 11 hen e con olled fo engagemen in e a c ic la cience ac iX ie We fo nd imila pe of e ec fo cience o come The mo in ele ing poin i ha he infl ence of ocio economic di adXan age a elimina ed be een he mo di adXan aged go p and he mo adXan aged go p fo all fo chemi o come al ho gh hee ele ill ome di ence be een ome of he o hei ca egoie of di adXan age) The ali a iXe anal i f hei e ploe h and/o ho den 'Xe link i h hei a pia ion, and e peciall con ide ho he Chemi fo All pogamme ma haXe ppo ed den and hei a pia ion and a i de

The ali a iXe finding indica e ha al ho gh ome den fom le adXan aged ocio economic backgo nd ele no e abo con in ing i h cience o chemi a he a of he d , b Yea 11 ome den had deXeloped onge chemi and cience) iden i ie, hee he impac of he Chemi fo All pogamme pla ed a age pa , and ome had indeed cho en o ake chemi A LeXel Fo ca e die of den ho epe en nde epe en ed go p in chemi female, e hnic mino i , lo ocio economic a), help o e ploe and ill a e he e aea The e ca e al o help ill a e ho fac o highligh ed h o gh he an i a iXe anal i , ch a e a c ic la engagemen , peceiXed ili 'e in ic mo iXa ion, in ele /enjo men , and elf confidence) ela e o den ' a pia ion

Four case study students who are from each of the three under-represented groups: disadvantaged socio-economic circumstances, female, and ethnic minority

De pi e he challenge a o nd ocial ine ali ie ome gil fom le adXan aged ocio economic and/o e hnic mino i backgo nd decided on emaining in chemi a e hei GCSE, and a pec of ppo co ld be a ib able o he Chemi fo All pogamme Hee e di c fo ca e d den fom Xa io nde epe en ed go p le adXan aged ocio economic cic m ance, female, and fom e hnic mino i backgo nd) and al o highligh ca e die of hei pee ho ae fom adXan aged ocio economic backgo nd The e gil ho ed high mo iXa ion o ad achieXemen in gene al and/o compe i iXene), conXe ed high gene al a pia ion, and, in pa ic la, enjo ed chemi The Chemi fo All pogamme helped hem align he idea of hei f e elXe i h chemi , pa ic la hen he benefi of non comp l o cience/chemi alifica ion ele conXe ed b he pogamme Belo ae bief pen po ai of he e gil ho e di c i hin o na a iXe o b an ia e ke poin abo ha i i ha help keep den i hin he chemi ajec o

Tara, British female (mixed-race Black Caribbean and White heritage), strong chemistry identity, average socio-economic circumstances, but high science capital

Ta a ha a Xe ong chemi iden i She epo ha he ha ha al abili in hé bjec hei pecep ion of hei na al abili ae ha diXe hei o con in e i h non comp l o chemi die She ha a high pe onal Xal e and peceiXed ili Xal e of chemi She i a high abili den fom a mi ed ace backgo nd and hei paen ae emi killed pofe ional She i fom a lo cience capi al backgo nd al ho gh ha an olde ibling ho ha become a n e and a fa hei ho enco age hei o con in e i h chemi She an a caee ei hei in

Pi a i fom a middle cla famil he paen ae pofe ional , and picall , fo den of Indian hei age, hee i an empha i fom he famil on en ering he medical pofe ion She doe no hae a high pe onal al e of chemi al ho gh doe hae a high e in ic/ ili al e of chemi She i of ae age abili , plan o con in e i h chemi beca e he mo he ha old he o do medicine

She like pac ical ok b i moe in ee ed in biolog and doe no ee he elf a being a chemi Nee hele , he a he Chemi fo All pogamme einfoced he idea ha he ho ld con in e i h chemi Unlike o he den , he doe no feel ha he Chemi fo All pogamme helped he gain moe kno ledge abo he caee and co e ha ae ailable i h a po 1 chemi alifica ion, b he did a ha chemi i no m ch moe enjo able'

Adam, migrant male (now naturalised British of Muslim heritage), weak chemistry identity, high socio-economic circumstances, high family science capital

De pi e being a high abili den , Adam ha a eak chemi iden i , epo finding i di ic l and complica ed, and doe no like chemi Nee hele , he find ma hema ic ea , de pi e he o bjec being ome ha in e linked He alk abo e iing a ma hema ic alifica ion o be an achi ec , b a ha he ha no need fo chemi De pi e haing high famil cience capi al, he i nee hele le connec ed i h chemi Hi iden i appea o be ongl foc ed o ad ma hema ic, a bjec he enjo He ecogni ed po i ie poin abo he Chemi fo All pogamme, b he aid ha he e ee no eno gh o in him a a fom hi cho en caee

Mark, British White male, strong chemistry identity, advantaged socio-economic circumstances, and high science capital

Mak i fom a moe ocio economicall adan aged famil and ha high abili in chemi He ha a ppo ie ne ok ao nd him, hee he di c e hi choice i h hi famil and eache He a pie o con in e i h chemi beca e he enjo i , high n ien GB, hig 21 a 4 2 3 1

e ionnaire e pon e ealed ha perceived ili al e a he ingle mo impo an predic o of den ' o erall a pira ion o ad chemi ac o A Le el and ni e i d ing, and o ad caree) and fo he p i of an one of he e pecific pa h a The pa h anal i f he highligh ed ha den ho ecei ed he Chemi fo All prog amme e predic ed o e pe highe perceived ili al e of chemi han compari on den hen acco n ing fo hei pe onal chala ac eri ic, cir m ance, and o he e The in e ie allo ed a mo e open ended e plora ion of den ' e abo chemi , and ill a e and clari f he impo ance of den hating a a ene abo caree and co e a ailable i h a po 1 alifica ion, ho hi a a ene e in ic mo i a ion) fi in i h o he impo an chemi a i de and ocial di ad an age, and ha ole he Chemi fo All prog amme pla ed in de eloping den ' chemi a pira ion The anal i of he in e ie na ra i e fo nd ha , b he end of he Chemi fo All prog amme, he e a a film and clea link be een choo ing A Le el chemi and ecogni ing ha chemi alifica ion can pro ide oppo ni ie la e in life

Chemi a a doo opene ' nde pin con c ion of chemi alifica ion a ha ing di inc and clea a ailable oppo ni ie, hich a e ni e o chemi and/o he cience in gene al Ma am had indica ed ha he cho e o con in e i h chemi beca e

"It's really relevant to what I want to do at university. You need those subjects to get into the course I want to do, and I just find them really interesting, as well."

Almo all in e ie ee e a a e ha nde aking a po 1 chemi alifica ion o ld be of benefi Tho e ho had a ended Chemi fo All e en ha pecificall pro ided info ma ion abo caree e able o become mo e en h ed abo chemi and make mo e info med deci ion

"It [the Chemistry for All programme] introduced many apprenticeship options, all of the di erent university courses, so it did really open that up … with the programme we were taught about apprenticeships, and I hadn't really considered that before but it, obviously, made me realise that it is a good option." Ma am)

"Well, I understood there's a lot more you can do with science than just medicine, like there's way more fields that it applies to. Like forensics … it made me interested in a lot of fields, like the way they applied chemistry, a lot of things. I suppose it did make me in a sense want to take it in university at the time."

Arooj chemistry student, British Muslim female of Sri Lankan heritage, disadvantaged socio-economic circumstances, low family science capital

Recogni ing he link be een enhanced f e oppo ni ie and chemi alifica ion emerged a den plogre ed hro gh econda chool

"There are a couple of times when I changed my mind in career decisions halfway through Year 12. Because, in the beginning, I was wanting to do medicine and then I think I changed to wildlife conservation. Even with those sorts of backgrounds, I think chemistry is still something I will use. Because I have to know about content to be able to translate for people in areas of the medical field and stu ."

Aliyah, chemistry student, ethnic minority female, average socio-economic circumstances, low family science capital

D ing GCSE die Yea 1 and Yea 11), den e die di ec l a ked he he he had been an impac of he Chemi fo All prog amme on hei kno ledge abo caree and co e ha migh be facili a ed b a po 1 chemi alifica ion I became appa en ha he prog amme indeed pla ed a ke ole in helping o clea e he e connec ion The e ample he e of chemi a a doo opene ', fom a ange of den fom di ad an aged backg o nd , help demon a e he e icac of he Chemi fo All prog amme in enabling a hal ed nde anding abo he benefi of a po 1 chemi alifica ion Po i i el eaching and ppo ing le ad an aged den appea ed o help den o align hei f e el e i h chemi , hich migh no ha e been o he i e po ible S den e al o a ked if he Chemi fo All prog amme had an impac on ho he a hem el e in he f e and he he hi in ol ed chemi

"I would love to do some sort of research job, hopefully making a new medicine, or a doctor, and have a research project as well … Just learning where you go to from school and what you can achieve has really pushed me to take chemistry in particular because it's just something that's so broad. I keep saying it because it's going to anything that you want to really with chemistry. That is something I have been looking into as well." Ta a)

Man den e able o appleci a he al e of ha ing a po 1 chemi alifica ion The Chemi fo All prog amme appea ed o be e ec i e in ppo ing hi b pro iding a ge ed alk and a emblie on he di e en o e den co ld ake o p e a po 1 alifica ion and hich alifica ion co ld lead o di e en pe of caree

"It [the Chemistry for All programme] showed me that there is a much wider range beyond the 16 level and that university can be very exciting indeed." Ma k)

Addi ionall , ip o o ide olgani a ion, chemi a el chool cl b, and demon a ion and e peri men pro ided a pa of he Chemi fo All prog amme helped o clea e connec ion be een den ' iden i ie and chemi Fo e ample, he Chemi fo

12. MIXED METHODS ANALYSIS: HOW SOCIAL INEQUALITIES MAP OUT ONTO THE PERCEPTIONS OF STUDENTS' EXPERIENCES AND LIVES

in e nali e he p oblem, he a ha ng he p oblem, he concl ded, a he and he lack of na al abili o nde and he o k i ho had o k On he o he hand, he bo i h ajec o ie o a d chemi o en aligned hem el e i h he no ion ha chemi i ha d fo e el one b i h pe i en had o k he o ld be able o do ell in i bo did no appea o in e nali e i e a o nd di ic l o o en, o he elf iden ified i h he no ion of ha ng a na al ap i de

"I think, in general, it's not easy, but fairly straightforward. There are some concepts that are hard to grasp, but it's not extremely hard to the point where it's stressing me out and I don't know what to do about it. It's one of those subjects where I take my time doing. I think I can definitely reach my target grade, but if I work even harder, I can get better than that. This year I have been working consistently around B grades and A grades. Next year I could definitely do that well if I – maybe even better … if I continue doing chemistry over the next year and a half and I manage to do well in it, I think I should take a career in it." A chemi den , B i i h M lim male of Paki ani he i age)

P student. British Muslim male c

a subject very interesting. They're some of my favourite subjects, which is why I decided to keep them on A-Level … Yes. I enjoy learning about the content side of it, and then realizing that at practicals. And also, just generally, I think it's really interesting to be able to have an understanding of the physical phenomena around you and seeing how those ideas can be used in industry, I think is something that is really interesting to me … the science as a whole is kind of I want to go into and I'm kind of quite involved with – chemistry is one of the subjects in sciences I'm most interested in." John)

"I love science as a whole because you find out lots of new things and you can just learn about everything that you could. And chemistry, I really greatly enjoy because you can have rules for certain things and it can apply to so much that you can have a set of rules and just apply it to a lot of things, and I really like that." Tala)

S den ho had he abili o con in e i h chemi b ho did no enjo i o lacked an pe onal al e of chemi e le likel o con in e i h i once i a no longe comp l o Fo Adam, hi a he ca e even ho gh he aid po i i e hing abo he benefi of a po 1 alifica ion ha he lea n abo fom he Chemi fo All plogamme

"Yeah. You can get, like, you have more job opportunities."

He a ill i e clea ha chemi a no fo him

"I just find it kind of boring."

Wha a appa en fom he ein e e i ha den ho appeaed o enjo chemi , had a pe onal al e of chemi , and op ed o d i f he al o came fom backgo nd i h po i i e home lea ning en onmen and/o famil cience capi al

"Yes, my dad, he wants it [the student to study chemistry]. If he could do his time over again, he would try so much harder in chemistry and physics because he like those two subjects in particular. So, yeah, he encourages me along to try my best." Tala)

Ano he den , Li a, had an olde i e ho a al o ppo ed and enco aged b hei fa he o con in e i h chemi and he cience 'Li a' olde i e had con in ed in he cience and, in n, ppo ed he Acce o ok e pe ience plo ded b he i e had enabled Li a o pic e he elf a a chemi , enhance he pe onal al e of chemi , and helped o align a po i i e iden i i h chemi

"Hopefully – I would love to do some sort of research job, hopefully making a new medicine, or a doctor, and have a research project as well. That is something I have been looking into as well … [these ideas came about because] my sister actually brought me to the hospital. I got to hang around with her for a few days, but it was really interesting. And she's doing a research project currently because she does love science and she didn't want to give it up. So, I think, the hospital have funded a research project for the senior doctors and she's part of the team have that. I have got to come in and have a look and be around that for a few days … I could [be a chemist], I do love chemistry and yes, I could [be a chemist]."

The Chemi fo All plogamme pla ed a c cial pa in b ilding on he in e e of den 'Al ho gh Li a had ppo fom he famil in being made a a e abo he ca ee a ailable i h a po 1 alifica ion, and a gene al in e e in chemi , he Chemi fo All plogamme helped o ppo hi deci ion f he

"This programme just really helped me to build on the interest [in chemistry] and then learn and then hopefully learn more … when we did the programme, it went along with these that we were learning about in school, and because of that, we had a basic understanding already, and then it just built on that and obviously it was really interesting … Meeting the students (involved in the Chemistry for All activity provisions) and knowing what courses they have been doing has really widened the amount of courses I thought there was."

Fo o he den enco agemen fom eache al o helped o boo hei engagemen i h chemi ,

"Well, I had a very good teacher … and she was very enthusiastic and also the lessons were always quite exciting, practical sometimes, sometimes theory, and it was just generally very engaging." Mak)

Fa imah' a pia ion o do iple cience and o con in e i h he ph ical cience a A Le el app F)11 k o boo hee d he

I i i e clea f om Fa imah ha de pi e being f om a ingle pa en famil and being of e hnic mino i a he ha high a pi a ion hich appea o be linked o he copio amo n of ppo he i ge ing f om he mo he , he eache and he Chemi fo All ac i ie Being a pa of he Chemi fo All ac i ie ha helped i h de eloping a chemi iden i , and con in ing i h chemi ha na all become he e pec ed pa h fo he , bo h f om he o n e pec a ion of he elf and f om ho e a o nd he

"It [the Chemistry for All programme] made me more interested, like I enjoyed doing the experiment, the more practical side of chemistry."

Man bigh gi l in e nali ed i e a o nd feeling ha he e e no good eno gh o con in e i h chemi o ha he fel ha he e e p e en l nable o do ell in chemi beca e of hei o n pe ceie ed lack

Factors associated with students' self-confidence

outside what the standard like specification was for our grades and that helped in the exams because it was a slightly more novel context."

For Mark, the Chemistry for All programme also had a positive impact on his personal value of chemistry.

"It's [the Chemistry for All programme] shown me that it can be much more exciting than the textbooks make out, yes."

The Chemistry for All programme also had a positive impact on helping Mark realise the options available to him in a post 16 chemistry qualification

"I would say it has, yes, there's a variety of jobs that I'm aware of now which I wasn't before in the programme and I may well pursue those in the future, yes … Well, definitely helped with my GCSE grades because it was, it had a deeper understanding of the sciences and so then I got good grades so I was wanting to progress towards the scientific areas so it made a difference in that respect, yes."

While these positive associations between the Chemistry for All programme and students' perceptions and identification with chemistry could lead to a choice to continue with chemistry, positive experiences did not necessarily entail positive chemistry aspirations for all students. For example, Pria had a less positive chemistry identity, despite coming from a family in advantaged socio economic circumstances. Her family background did not, however, include having high science capital

12.6. Chemistry for All shows the relevance of chemistry to everyday life through teaching about the wider applications of science and the impact on students' value of science to society

One important aspect that the Chemistry for All programme was able to do was to show students how well as to have practical experimen

12. MIXED METHODS ANALYSIS: HOW SOCIAL INEQUALITIES MAP OUT ONTO THE PERCEPTIONS OF STUDENTS' EXPERIENCES AND LIVES

Year 11 multi-variate analysis: Value of science to society

Wi h he e ela ion hip o lined i hin he ali a i e

13. Discussion

S den i hin chool ha eceiXed he Chemi

e a ion , fo m lae, and mbol and ha eaching/ lea ning in olved memo i a ion/ emembe ing

The e finding help a im and e end p io le ea ch, hich ha imila highligh ed ha den ha e o en app ecia ed e pe imen al/p ac ical o k Haml n, e al , , Haml n, Ma he , Shanahan, 1 Na ional Fo nda ion fo Ed ca ional Re ea ch, 11) Fo e ample, p io le ea ch ha highligh ed ha econda chool den and hei eache) gge ed ha ,

Man a pec of life, ch a e ac ic la engagemen , a ocia e i h den ' pe onal a i de and belief ela ed o cience/chemi , hich hen a ocia e i h hei a pica ion Beca e of he po en ial fo indi ec a ocia ion, man a pec of life ma be mo e impo an han he migh ini iall appea The e finding al o gge ho ome Chemi ' fo All plogamme benefi migh each den Vario e ac ic la ac i ie, e pe ience of eaching/lea ning, and o he a pec of life a ocia e i h den ' a i de and belief, hich a ocia e i h hei d ing and ca ee a pica ion Plogamme ac i ie/e en ma be e pe ienced po i i el and/o fo e den ' pe ceie ed ili of chemi h o gh g ea e a a ene of he benefi of cience/chemi d ing and ca ee, hich ma hen a ocia e i h d ing and ca ee a pica ion

The den ' pe ceie ed ili al e of chemi and pe onal al e of chemi e impo an independen pedic o of den ' a pica ion fo d ing and ca ee in cience/chemi Pe ceie ed ili al e con ide cience/chemi being al ed a inhe en l ppo ing pa ic la ca ee ch a ag eeing ha Making an e o in cience/chemi i o h i beca e i ill help me in he o k ha I an o do la e on' and/o I hink cience/chemi ill help me in he job I an o do in he f e') Pe ceie ed ili al e of cience and al o in e e in cience/chemi ha e o en a ocia ed i h den ' a pica ion o ad cience ela ed d ing and ca ee Ba e Hen ik en, 1 M j aba Rei , 1 4 Regan DeWi , 1 Sheld ake, 1) S den ha e o en ecogni ed ha chemi can be nece a o helpf l fo f he ca ee, e peciall in medicine, hea h, and pha mac Sp inga e, Ha land, Lo d, Wilkin,) Pe onal al e con ide cience a a al ed and inhe en a pec of omeone' iden i ch a ag eeing ha Science/ chemi i impo an o me pe onall ' and/o Thinking cien ificall i an impo an pa of ho I am') Pe onal al e i an impo an a pec of mo i a ional heo ie Eccle ,), and ha been fo nd o po i i el a ocia e i h den ' a pica ion o ad cience ela ed die and ca ee Sheld ake, 1)

Predictive modelling

F he c o ec ional anal i be een Yea and Yea 11 e ealed n me o in igh

- C o ec ional anal i indica ed ha den i h inc ea ing pe ceie ed ili al e of cience/chemi incl ding inc ea ingl

chemi , d ing and ca ee . Thi di pa i a en mo e pominen ac o , den i h di e en le el of ocio economic ci c m ance and famil cience capi al

- Social ine ali ie linked i h di e ence in a pi a ion, a ell a di e ence in pe ceived e pe ience of chemi / cience ed ca ion Some den ma be mo e pepa ed and ppo ed o appleci a e and lea n abo cience i hin chool, gi en home lea ning en onmen ha ma bloadl ppo and/ o enco age lea ning fo cience/chemi
- S den fom famil backg o nd i h highe cience capi al e pe ed highe cience/ chemi a pi a ion, pe ceived ili of cience/chemi , elf confidence belief, and o he a i de , a ell a mo e po i i e pe cep ion of cience eaching, and e e mo e likel o engage in e a c ic la ac ie
- S den fom famil backg o nd i h mo e ad an aged ocio economic ci c m ance e pe ed highe cience/chemi a pi a ion, pe ceived ili of cience/ chemi , elf confidence belief, in e e / enjo men , and o he cience a i de , a ell a mo e po i i e pe cep ion of cience eaching, and e e mo e likel o engage in e a c ic la cience ac ie

Chemistry as a 'door-opener' discourse

One heme ha a e alen fom he den in e e na a ie a ecogni ion of he e and ili of chemi alifica ion a facili a ing ca ee , job , and f e oppo ni ie in gene al), e en ial i h chemi alifica ion being a po en ial doo opene '

- S den fom nde epe en ed go p , ch a gi l , ho e fom e hnic mino i backg o nd , and/o ho e i h le ad an aged ocio economic ci c m ance) ho had a ended Chemi fo All e en pecificall co e ing he opic of ca ee , e able o become mo e en h ed abo non comp l o chemi co e and make mo e info med deci ion abo con in ing i h chemi
- The Chemi fo All plog amme helped den , e peciall ho e fom nde epe en ed go p , o become a a e of and nde and he connec ion be een non comp l o chemi alifica ion and he ca ee and co e ha b e en l become a ailable
- The Chemi fo All plog amme a able o ppo gi l , ho e fom e hnic mino i backg o nd , and/o ho e i h le ad an aged ocio economic ci c m ance o align hei f e el e i h chemi
- The an i a ie e l e ealed ha pe ceived ili al e cience/chemi being ef l and al ed fo facili a ing ca ee , job , and f e oppo ni ie in gene al) follo ed b pe onal al e of chemi chemi being a al ed and inhe en a pec of iden i e he onge pedic o of den ' a pi a ion The ali a ie e l indica ed ha he o mea e co ld in e ec , and i h implica ion o den ' ide ajec o ie Specificall , if den co ld no ea il con ide chemi o be an inhe en a pec of hei iden i , b ecogni ed he ili of chemi , he co ld con ide chemi A Le el a an a en e o ad o he pofe ion ch a medicine a he han chemi Holding a pe onal al e of chemi ma be e peciall impo an o con in e i hin chemi

Natural ability and non-compulsory choices

Ano he pe alen heme fom he den ' in e e na a ie in olved na al alen and/o cle e ne ' onl den ho e pe ceived o be na all good a chemi i h li le e o e pe ceived o be he one ho co ld legi ima el emain i hin chemi The e belief co ld help o einfo ce ome den ' deci ion o emain in non comp l o chemi ed ca ion, e peciall ho e fom familie i h ppo i e home lea ning en onmen fo cience, i h highe le el of famil cience capi al, and/o mo e ad an aged ocio economic ci c m ance Ho e e, he pe cep ion and di co e a o nd na al abili ' co ld di co age ome o he den fom chemi

- The e a a gende pecific con c ion among o ng omen he e chemi a a ociated i h he iling hald o k and/o e iling na al abili , hich co ld lead o ome o ng omen deciding no o d non comp l o chemi E en ial , a aining a po i i e chemi iden i co ld be di ic l fo o ng omen if he con in ed o compa e hem el e i h he no ion of being cce f l in chemi a meaning being na all cle e '
- Some o ng omen in e nali ed p oblem i h hei chemi lea ning, linking incea ing di ic l ie and lo e confidence i h feeling ha chemi e ied na al abili Some o ng men e e nali ed an p oblem he e incea ing di ic l ie did no nece ail eflec an hing abo hem el e and/o h o gh iden if ing i h he no ion ha he held a na al ap i de) and ha ma e co ld ill be achie able i h pe i ence, hich co ld help p o ec hei chemi iden i ie
- Some o ng omen fom o he nde epe en ed backg o nd) e e able o align hei f e el e i h chemi , beca e of he Chemi fo All plog amme Valio in pi a ional and enjo able e pe ience e e ci ed, oge he i h hei incea ing

in e e , and/o po i i e e den a e al o no a fa l if he do no choo e cience/chemi d ing o ca ee a en e The nde l ing i e ma in ol e p o ding and main aining ppo o ha cience/chemi d ing and ca ee can be con i en l con ide ed o be fea ible and achie able, hile emo ing an a oidable ba ie o ha f ee and info med choice can be made F om a ide pe pec i e, m ch a en ion ha foc ed on inc ea ing he n mbe of den d ing cience ela ed bjec o ha he co ld hen follo cience ela ed ca ee Ro al Socie of Chemi , 2 14 Ro al Socie , 2 14) Conc en l , he field of ed ca ion and cience co ld al o change

We ecommend ha pecific o gani a ion help o inc ea e chemi pa icipa ion in a n mbe of a

Government, awarding bodies, professional organisations,

14

References

14. References

Abraham, I., Reis, M. (2012). Practical Work I.

Ba e, M , Hen ik en, E K , L on , T , Schleine , C 2 11) Pa ici pa ion in cience and echnolog o ng people' achie emen ela ed choice in la e mode n ocie ie *Studies in Science Education, 47* 1),3 2 doi 3 2 2 11 4 21

Bong, M , Skaal k, E 2 3) Academic Self Concep and Self E icac Ho Di e en A e The Reall *Educational Psychology Review, 15(*1), 1 doi 23 /A 2 3 2 3 2 3 2

Bonne e, R , Clo le , K , Sch nn, C 2 1) Falling in lo e and a ing in lo e i h cience ongoing infoma cience e pe ience ppo fa cina ion fo all child en *International Journal of Science Education, 41* 12), 1 2 1 3 doi 3 2 1 1 23 3 1

Bi i h Academ 2 1) *Count us in: Quantitative skills for a new generation* London Bi i h Academ

Bloman, K , Pa chmann, I 2 14) S den ' applica ion of chemical concep hen olving chemi l plblem in di e en con e *Chemistry Education Research and Practice, 15* 4), 1 2 doi 3 /C4RP 1J

Bloman, K , Ekbo g, M , Johnel , D 2 11) Chemi l in cli i Pe pec i e on eaching and lea ning chemi l in S edi h ppe econda chool *Nordic Studies in Science Education,* 7 1), 3

B chol, C B , Be ege , S , Fle i, A K , Kapple , C 2 14) Majo ing in STEM Wha Acco n fo Women Ca ee Deci ion Making A Mi ed Me hod S d *The Journal of Educational Research, 107*3), 1 1 doi 2 2 1 2 13

Calab e e Ba on, A , Kang, H , Tan, E , O'Neill, T , Ba i a G e a, J , Blecklin, C 2 13) C a ing a F e in Science T acing Middle School Gi l ' Iden i Wo k O e Time and Space *American Educational Research Journal, 50* 1),3 doi 3 2 2 3 1212 1 42

Ca lone, H , John on, A) Unde anding he Science E pe ience of S cce f l Women of Colo Science Iden i a an Anal ic Len *Journal of Research in Science Teaching, 44*), 11 121 doi 2/ ea 23

Ca ell, S , Cha l on, A , Clemence, M , Pe igle , N , Pope, S , Q igle , A , Silman, T 2 14) *Public Attitudes to Science 2014* Lo </Lang en GB)/MCID 2 /EDC BT Science 2 14 TL T TJETEM A/EDC BT CID 3 1 , M , P

Eccle, J, Wigfield, A, Ha old, R, Bl menfeld, P 1 3) Age and Gende Di e ence in Childen' Self and Ta k Pecep ion d ing Elemen a School *Child Development*, *64*3), 3 4 doi 1111/j 14 241 3 h 2 4

Elia P, Jone P, McWhinnie, S) *Representation of Ethnic Groups in Chemistry and Physics* London The Ro al Socie of Chemi and he In i e of Ph ic

EngineeingUK 1) *Engineering UK 2018: The state of engineering* London EngineeingUK

Ed an, S, Jim ne Alei andle, M P Ed)) *Argumentation in Science Education: Perspectives from Classroom-Based Research* Dodech /London Spinge doi 1 / 1 2 2

Fedick, J, Eccle, J 2) Childen' compe ence and al e belief fom childhood h o gh adole cence G o h ajec olie in o male e ped domain *Developmental Psychology*, *38* 4), 1 33 doi 1 3 12 1 4 3 4 1

Fedick, J, Bl menfeld, P, Pali, A 4) School Engagemen Po en ial of he Concep , S a e of he Edence *Review of Educational Research*, *74* 1), 1 doi 1 3 1 2 3 4 4 1

F ak, E M, Seidel, T, I el on, H, Bigg, D 12) E pelimen al and Q a i E pelimen al S die of In i Ba ed Science Teaching A Me a Anal i *Review of Educational Research*, *82*3), 3 32 doi 1 3 1 2 3 4 4 3 12 4 2

Ga b 1) *Key Indicators in STEM Education* London The Ga b Chai i able Fo nda ion

Ga b Chai i able Fo nda ion 1) *Good Practical Science* London Ga b Chai i able Fo nda ion

Godec, S, King, H, Aichel, L 1) *The Science Capital Teaching Approach: engaging students with science, promoting social justice* London Unie i College London

Haml n, B, Han on, T, Malam, S, Man, C, Smi h, K, William, L) *Young people's views on science education: Science Education Tracker 2019: Wave 2* London Wellcome T

Haml n, R, Ma he , P, Shanahan, M 1) *Young people's views on science education: Science Education Tracker Research Report February 2017* London Wellcome T

Halackie ic , J, Ro ek, C, H lleman, C, H de, J 12) Helping Paen o Mo i a e Adole cen in Ma hema ic and Science An E pelimen al Te of a U ili Val e In e en ion *Psychological Science*, *23*), doi 11 11 3 3

Hod on, D 1 3) Re hinking Old Wa To ad A Mo e Ci i ical App oach To Pac ical Wo k In School Science *Studies in Science Education*, *22* 1), 1 2 doi 1 3 2 3 22

Og nde, J , OŽe on, T , Thomp on, C , Me i , R , Boniface, S 2 1) Be ond gad a ion mo iŽa ion and ca ee a pi a ion of nde gad a e chemi , den *Chemistry Education Research and Practice, 18*( ), 4 4 1 doi 3 /c p 24 j

Oli Že , M , Wood McConne , A , Mao , D , McConne , A 2 1) Female enio econda ph ic den engagemen in cience a ali a iŽe d of con c iŽe infl ence *International Journal of STEM Education, 4* 4), 1 1 doi 11 / 4 1

Po Žn, P , Ha ni, A 2 14) Anal i of he Decline in In e e To a d School Science and Technolog fom G ade Th o gh 11 *Journal of Science Education and Technology, 23*), 4 2 doi / 14 12

Rahman, M T , Le i , S 2 1) EŽal a ing he eŽidence ba e fo eŽidence ba ed in c ional p ac ice in chemi h o gh me a anal i *Journal of Research in Science Teaching*, 1 2 doi 2/ ea 21

Regan, E , Child , P 23) An inŽe iga ion of Ii h den ' a i de o chemi he p omo ion of chemi in chool p ojec *Chemistry Education Research and Practice, 4* 1), 4 3 doi 3 / B2RP 3 J

Regan, E , DeWi , J 2 1) A i de , In e e and Fac o Infl encing STEM En olmen Beha Žo An OŽe Že of Rele Žan Li e a e In E K Hen ik en, J Dillon, J R de Ed), *Understanding Student Participation and Choice in Science and Technology Education* Do dech Sp inge doi / 3 4

Sp inga e, I , Ha land, J , Lo d, P , Wilkin, A ( ) *Why choose physics and chemistry? The influences on physics and chemistry subject choices of BME students.* London The In i e of Ph ic and he Ro al Socie of Chemi *C2RP20045G*

S a , S , Macleod, S (1) *Evaluation of STEMNET's operations and impacts 2011-2015: Summary report* Slo gh Na ional Fo nda ion fo Ed ca ional Re ea ch

Tan, E , Calab e Ba on, A , Kang, H , O'Neill, T (13) De iding a ca ee in STEM ela ed field Ho middle chool gi l a ic la e and nego ia e iden i ie in p ac ice in cience *Journal of Research in Science Teaching, 50* ( ), 11 3 11 doi / 2/ ea 2113

TNS BMRB (1) *Public attitudes to chemistry: research report* London Ro al Socie of Chemi

T ipne , J , Ne man, M , Bangpan, M , Ni a, C , MacKin o h, M , Sinclai , J ( ) *Factors Influencing Young People (Aged 14-19) in Education about STEM Subject Choices: A systematic review of the UK literature* London Wellcome T

T ne , S , Ie on, G ( ) Fi een p pil ' po i i e app oach o p ima chool cience hen doe i decline *Educational Studies, 36(*2), 11 1 1 doi (3 3 1 2

Upad a a, K , Salmela A o, K (13) De elopmen of School Engagemen in A ocia ion Wi h Academic S cce and Well Being in Va ing Social Con e A Re e of Empi ical Re ea ch *European Psychologist, 18* 2), 13 1 doi 2 / 1 / a 1 3

Vaino, K , Holb ook, J , Rannikm e, M (12) S im la ing den ' in in ic mo i a ion fo lea ning chemi h o gh he e of con e ba ed lea ning mod le *Chemistry Education Research and Practice, 13*), 1 1 doi 3 /C2RP 1 G

an den H k, A , Meeli en, M , an Langen, A (1) In e en ion in ed ca ion o p e en STEM pipeline leakage *International J2LB*