Impact & Engagement Summary

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April 2018 – v6

Since its inception in April 2013 (initially as the Rutherford Schools Physics Project) Isaac Physics has continued to monitor the usability of its programmes and evaluate its impact and effectiveness. This report summarises the quantitative and qualitative outcomes we have measured as a result of our own data collection as well as collaboration with other data sets such as the Department for Education examination tables and UCAS university application data.

The report is structured to address the following key performance indicators:

1. Attainment Raising
2. University Entrance and Ambition
3. Teacher Engagement
4. Student Engagement
5. Widening Participation: Priority and Opportunity Areas.

Headline Results

1. Attainment Outcomes

a. Schools that actively engage with Isaac Physics can raise **40% of their cohort's** A level grades from **C** to **B**.

b. The larger the fraction of students that engage with Isaac Physics in a school, the greater the effect on the cohort's exam results.

c. Our cost-price question books, to support teachers in attainment raising, have attracted ~ **13.4 million question attempts** (out of a total of 16.6 million to date) from **71,229 distinct users**.

2. University Entrance Ambition & Success

a. Compared with cohort matched non-users, Isaac Physics users are:

i. **very significantly more likely to apply** to high tariff universities.

ii. **very significantly more likely to receive an offer** from a high tariff university.

iii. **very significantly more likely to achieve and accept their place at a high tariff university**.

b. A higher proportion of Isaac Physics users, taking both physics and maths at A level, meet or exceed their predicted grades compared with the whole cohort taking those subjects.

c. The average grade point difference between predicted and achieved grades is positively correlated with Isaac activity for both male and female students. The average grade point difference (between predicted and achieved) for **male students** applying to Russell Group universities with Physics and Maths A-level is **-1.36.** For an **Isaac male super-user** applying to the Russell Group with maths and physics the average point difference is **-1.19** (negative numbers indicate that students achieved grades are less than their predited grades).

d. The percentage of Isaac women who apply to study physics at University is greater (for all categories of usage) than the female cohort average. This is also true for male students but the difference is smaller.

Headline impact:

Teacher comment from 2017 survey:

- "First and foremost, this has given me a chance to upskill and therefore it has a direct impact on my teaching practice.
- It provides me a different perspective to teach and my students have benefited because they have been able to expand/deepen the understanding as they are exposed to different sets of problems.
- My students have been able to identify their own misconceptions and as they solve and consider problems from the book, they are able to correct these as they progress with their studies.
- I have seen a significant change in that they approach their tasks more carefully, have developed the most essential skill of drawing diagrams, simplify problems, make connections across cross-curricular topics and mathematics more easily.
- They are able to plan their work and self-assess their work - which means that they are able to better manage their workload and time.
- Class-room discussions now are more focussed on Physics and problem-solving. Increased competitiveness and the joy of working out correct solutions drive them to do more."

Female teacher from an academically non-selective state school with a degree in chemistry, teaching physics to A-level, chemistry to GCSE.

Headline Results Continued

e. The EXACT individual level data supports headline 2c above and shows that a greater proportion of Isaac users are accepted to courses at Oxbridge and Russell Group universities compared with the cohort average.

3. Teacher Engagement

a. In 1 month in 2017, we reached **41%** (**982**) of teachers teaching A level physics.

b. In December 2017, teachers answered approximately 3000 questions in one week.

c. Isaac Physics CPD events for teachers are key in retaining them for longer on the platform.

d. In the last week of February 2018: 478 teachers were active on Isaac, 181 of them were answering questions.

e. The number of homeworks set and tracked per week peaked at ~1500 in the middle of September 2017 – **equivalent to 3,000 hours of saved marking time per week** (10 mins per homework per student for an average class of 12)**.**

f. Teachers self report an average **reduction in workload** of **2 hours per week** through using Isaac. This independent measure also indicates that about **3000 teacher hours were saved per week** at the September peak.

4. Student Engagement

a. Between August 2017 and January 2018 we had approximately 25% of the current A level cohort actively engaged (answering questions) on Isaac.

b. Development of print resources has been instrumental in encouraging student engagement, with surges in activity with the start of each academic year.

c. On average 15.3% of the students who register on the mentor scheme attempt more than 60% of the work (more than 30 weeks of regular homework in addition to anything they are set at school).

d. 295 students from non-traditional HE backgrounds, from 111 different schools across England, attended an attainment raising, residential bootcamp in Cambridge in early January 2018. These students have now been offered follow-up support in the form of online tutorials to continue to revise their exam material.

5. Widening Participation: Priority Areas

a. 9 Ogden-Isaac Widening Participation Fellows are located around England to provide regular intense interactions with schools and students in priority areas.

b. Our study of Isaac online use by geographical location has revealed that both teachers and students are using the platform across all of England. We also see regions where students work without encouragement from their teacher.

Headline impact:

Student data and comments from 2017 survey:

Respondent demographics:

- **37%** Female, **60%** Male, **3%** other or prefer not to say.
- 5% Y10, 3% Y11, **68% Y12**, **21% Y13**, 3% Other
- **17%** independent schools, **79%** state schools, **4%** other.

Quantitative responses:

- **74%** of students agreed or strongly agreed that Isaac Physics helped them to improve their physics grade.
- **82%** of students agreed or strongly agreed that IP helped them to progress to more difficult questions on their own.
- **72%** of students agreed or strongly agreed that IP has encouraged them to answer questions not set by their teachers.
- **75%** of students said that IP has helped them become more confident in physics.

Comments:

- "Made Physics more challenging by applying a wide of context into the questions, thus making it more enjoyable."
- "When I started in November 2016, I was doing level 1/3 questions, sometimes even struggling with these. Now I am frequently tackling level 4-6 questions, often on topics that I have self-taught through the Isaac platform. That alone is a testament to how much progress I have made thanks to this site."

HEADLINES

Attainment Outcomes

1. Schools that actively engage with Isaac Physics, can raise **40% of their cohort's** A level grades from **C** to **B**.

2. The greater fraction of students that engage with in a school the greater the effect on the cohorts exam results.

Evidence

The postitive difference in A level improvement between Isaac and non-Isaac schools is only seen for physics from 2013 to 2016. There is no such difference for biology and no such difference for physics between 2013 and 14 before Isaac Physics existed. Furthermore, any fluctuations that are observed are random effects as shown by their P-values.

1. Attainment Raising

Can active use of Isaac Physics improve exam results? Yes

The Department of Education provides A level examination results tables each year for individual schools by subject and by grade. Using this data we were able to investigate our impact on A level attainment by calculating A level scores in physics and biology for each school in 2013 and 2014 (before Isaac Physics was available) and also for 2016.

To quantify any impact we may have, we grouped schools either as active Isaac schools, semi-active Isaac schools or inactive Isaac schools. We then calculated the average improvement in physics and biology scores for the active and inactive groups between 2014 and 2013, and 2016 and 2013. Our hypothesis was that the biology scores should not be influenced at all by whether a school was an active Isaac Physics school or not, and therefore would act as a control measure for our results.

The level of activity of each school was determined by two measures

1. immersion, $IM = \#\ users\ on\ IP / \#\ students\ taking\ A\ level\ Physics\ in\ 2016$
2. performance,
   $PE = \#\ correct\ question\ attempts\ /\ \#\ students\ taking\ A\ level\ Physics\ in\ 2016$

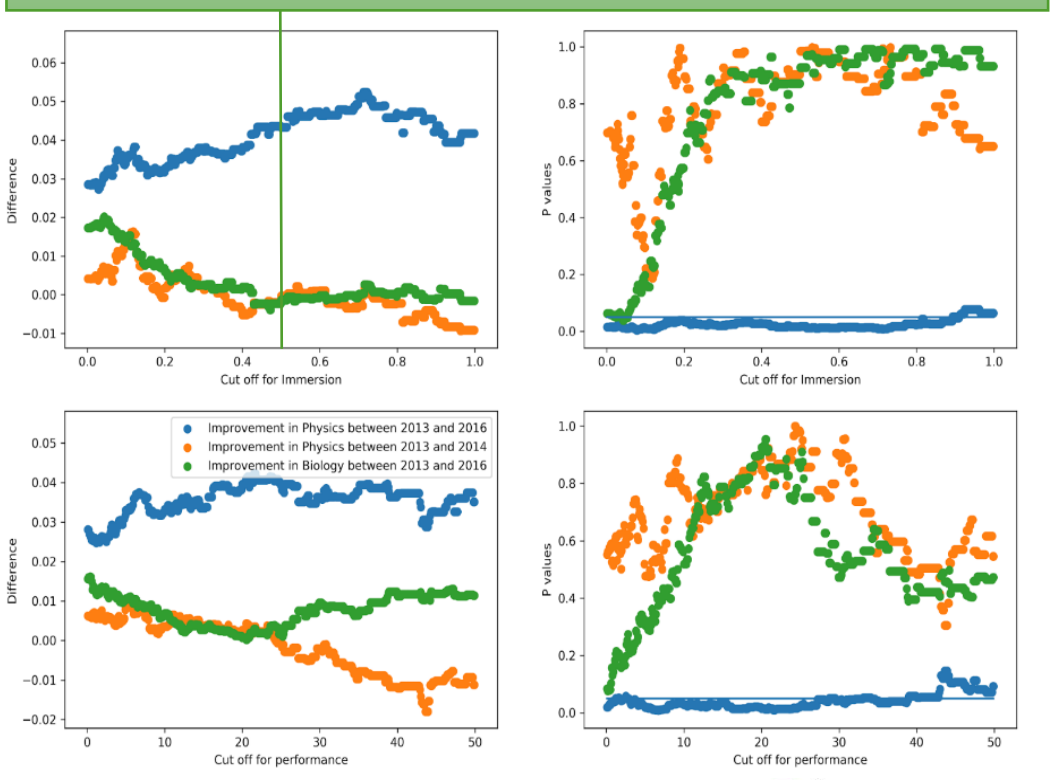
The quantitative measure of Isaac impact was defined as the difference between the average improvement of the IP active schools – the average improvement of the inactive schools.

$$Difference = < improvement >_{active} - < improvement >_{inactive}$$

P-values between 0.01 and 0.05 imply strong evidence.

The cut-off value for immersion and performance were gradually increased to incrementally raise the bar of what it means to be "active". For example, an immersion cut-off of 0.5 defined active schools as those where 50% of their A level physics students had actively answered Isaac questions.

For **schools that have at least 50%** of their physics cohort using Isaac Physics, this difference of 0.043 is equivalent to **40%** of them **improving** their grade **from a C to a B**



HEADLINES

Attainment Outcomes

3. All Isaac active schools, independent of their free school meal percentage, experience an improvement in A-level score in 2016 compared with previous years

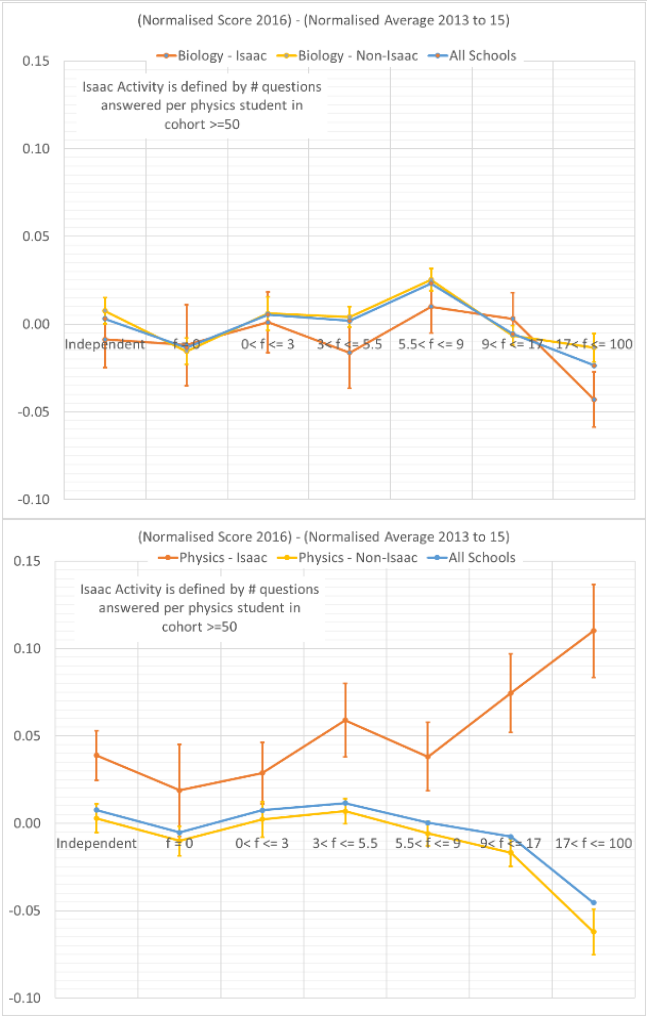
4. School with higher percentages (> 9%) of free school meals experience an even larger improvement in A level score with Isaac activity than their counterparts.

Evidence

To counter any wider school effects that may be taking place (changes in management structure, change in head of science…) we compared biology outcomes for the same groups of schools as for physics. Biology showed no statistically significant change for any schools in marked contrast to physics.

Using the same metric of a computed school A level score we investigated the whether Isaac Physics affected results for all schools or whether it was particularly effective for particular demographics. Using the DfE results tables were were able to group schools by free school meal percentage and then by Isaac activity (active and non-active).

% Free School Meals (f)	Physics		Biology	
	Isaac Schools	Non-Isaac Schools	Isaac Schools	Non-Isaac Schools
Independent	62	211	70	265
f = 0	25	345	28	474
0< f <= 3	27	113	27	115
3< f <= 5.5	22	181	25	197
5.5< f <= 9	34	175	36	224
9< f <= 17	28	198	34	291
17< f <= 100	10	68	23	149



In the graphs above we have binned schools according to their reported percentage of FSM (or independent school) and whether they are Isaac active or not. For each bin, we calculated the average difference in A level score in 2016 compared with their average score for 2013 to 2015. The error bars show one standard deviation of error in each of the averages.

Biology shows little change between 2016 and earlier years for all FSM bins and there is no statistically significant difference between Isaac and non-Isaac schools. For physics however, the picture is very different. All Isaac schools experience a significant improvement (the mean for all schools shown in blue) with a greater improvement for schools with a high percentage of free school meals.

HEADLINES

Book production numbers

1. Since their launch we have distributed more than **100,000** mastery books:

   Pre-University Physics: **57,000**

   Pre-University Physical Chemistry: **22,500**

   GCSE Physics: **26,500**

Take up and use:

2. **User numbers** (to 30th April 2018)**:**

   Pre-uni physics: **47,959**

   GCSE physics: **22,332**

   Physical Chemistry: **5,832**

3. **Book question attempts** (to 30th April 2018): **13,395,518** **80.6%** of all Isaac question attempts up to this date. These attempts are distributed as follows:

   Pre-uni physics **9,630,658**

   GCSE physics **3,046,597**

   Physical Chemistry **718,263**

1.1 Attainment Raising Support: Mastery Resources

Isaac Physics' aim has always been to improve students' facility to solve problems with the aim of developing the confidence and experience to approach problems that are written in a university style. Students must however be fluent in both conceptual and mathematical techniques in order to develop the necessary confidence and fluency.

We have produced three mastery books (https://isaacbooks.org), that are coupled to our online platform, to enable students and teachers to have access to large numbers of problems to practice physics and maths concepts. The attainment raising results that we describe in section 1 we believe are, in no small part, a result of the large scale use of these books.

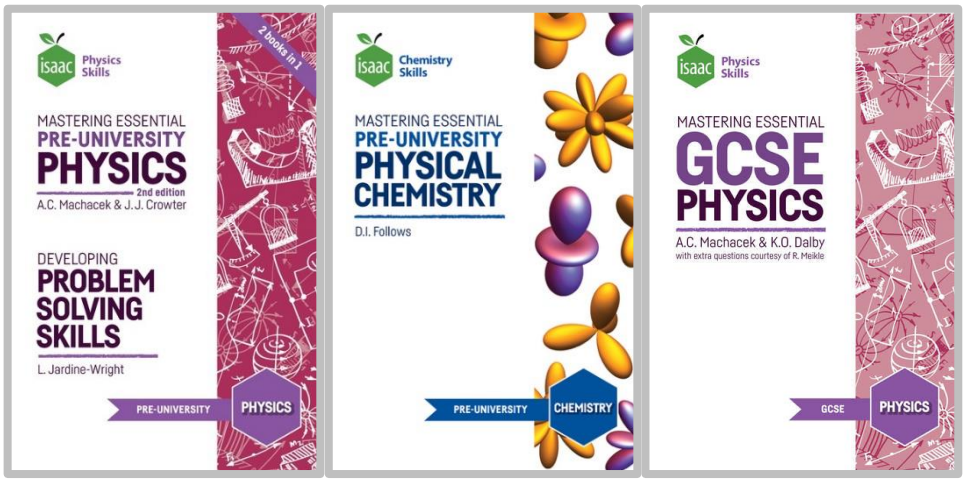
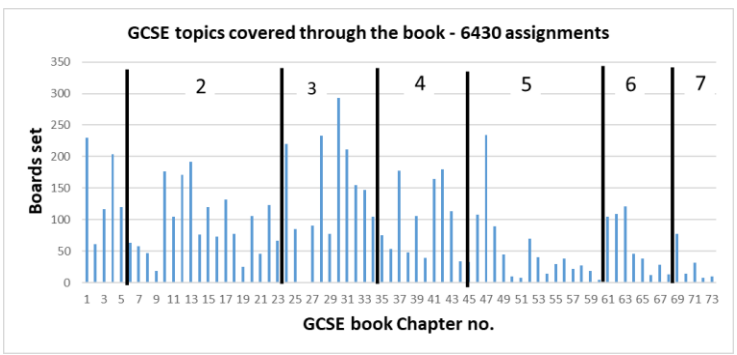


Figure 1: Three "Mastery" books in order of publication. The first was launched in September 2015 and the third, GCSE book, in Sept 2017. A fourth question book, Pre-university Maths for Scientists, is in preparation (thumbnail below). https://isaacbooks.org

Title	Quantity distributed	GCSE Book Impact	Value
Pre-University Physics	57,000	**Teachers assigning GCSE book work**	568
Pre-University Physical Chemistry	22,500	**Number of assignments (boards) set**	6430, equivalent to 180,000 student homeworks
GCSE Physics	26,500	**Average number of assignments per teacher**	11.3

The launch of the GCSE book in September 2017 presented a definitive and recent timeline for us to investigate the impact on teachers and students. The right-most columns in the table above show the current usage statistics for the GCSE resource. The histogram below shows that the all of the content is proving relevant and useful, with all chapters being used. Further analysis of Isaac usage is given in section 4, including the distribution of student age groups and their usage of Isaac.



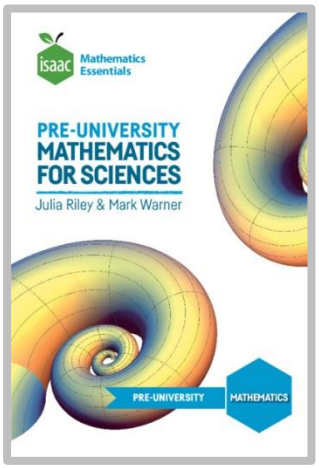


Figure 2: Coming soon.

HEADLINES

University Entrance Outcomes

1. Students who use Isaac are very significantly more likely to apply to high tariff universities compared with students of similar demographic controls.
2. Greater activity on Isaac results in an increased likelihood of receiving an offer from a high tariff univesity.
3. Active users of Isaac are more likely to achieve and accept a place at a high tariff university .
4. Across all IP activity IP users are more successful in taking up courses at high tariff universities than a non-IP users.

Evidence

UCAS STROBE service, compared IP user cohorts with 500 non-IP cohorts (matched in demographic, GCSE grades, gender, etc) . This matching gives a robust baseline against which we can measure any effect or impact of Isaac Physics, and its statistical significance.

2. University Entrance Ambition & Success

Do more Isaac Physics users aspire to apply to top universities? **Yes, IP users are "very significantly" more likely to apply to high tariff universities*.**

Does greater activity on Isaac Physics increase likelihood of an offer from a top university? **Yes, IP users are "significantly / very significantly" more likely to receive an offer from a high tariff university.**

Do more Isaac Physics users achieve and accept places at top universities? **Yes, IP users are "significantly / very significantly" more likely to achieve and accept their place at a high tariff university.**

The UK universities applications service (UCAS), through their service STROBE, have provided us with application statistics with cohort-mapped demographic controls to investigate whether Isaac Physics students are more likely to apply to top universities. Cohorts are matched on a score that represents the combination of:

age, ethnicity, gender, socio-demographics of the home address, proportion of their school being eligible for free school meals, achievement at GCSE level or equivalent.

We provided UCAS with three sets of user data, split by levels of activity on Isaac – low-active, active, super-active – as determined by the number of questions that they attempted between their AS year finishing (previous July) and their A2 exams (June).

- **super-users (3,098)** have attempted at least 200 questions in the year before their A2 exams.
- **active users (4,098)** have made between 50 and 200 question attempts in the year before their A2 exams.
- **low-active users (4,229)** have attempted fewer than 50 questions in the year before their A2 exams.

	Low-Active			Active			Super-Active		
High Tariff Unis	Apply %	Offer %	Accept %	Apply %	Offer %	Accept %	Apply %	Offer %	Accept %
IP cohort	55	92	58	55	94	63	54	95	65
STROBE matched cohort	42	92	58	43	91	58	46	91	58
Significance level	v. sig. high	none	none	v. sig. high	sig. high	v. sig. high	v. sig. high	v. sig. high	v. sig. high

It is important to note that acceptance means that students have achieved their offer grades and have accepted their place.

How might we interpret these results?

Applications: Why does the difference between IP cohorts and the matched cohorts decrease with activity? If we look at the baseline measure for each activity group it increases from 42% to 46%. This means that, for example, the cohort matched to our super-active users have higher aspirations in applying to high tariff universities than the cohort matched to our IP low-active group. We see that, broadly, across all activities, ~55% of the IP cohort apply to high tariff universities.

Offers: The percentage of those receiving an offer, having applied to a high tariff university, increases with Isaac engagement by 0% for the low-active group (92% receive an offer whether Isaac users or not) to 4% (very high significance) for the super-active group (91% to 95%).

(See next page for the list of high tariff universities)*

38 HIGH TARIFF UNIVERSITIES

"The University of":

Aberdeen, Bath, Birmingham, Bristol, Cambridge, Dundee, Edinburgh, Exeter, Glasgow, Leeds, Liverpool, Manchester, Nottingham, London Institute in Paris, Sheffield, Southampton, St Andrews, Strathclyde, Sussex, Warwick, York.

Brighton and Sussex Medical School,
Cardiff University,
Courtauld Institute of Art (University of London)
Durham University,
The Glasgow School of Art,
Heriot-Watt University, Edinburgh,
Hull York Medical School,
Imperial College London,
King's College London (University of London),
Lancaster University,
London School of Economics and Political Science (University of London),
Newcastle University,
Oxford University,
Royal Veterinary College (University of London),
SOAS University of London,
St George's, University of London,
UCL (University College London)

Acceptances: The percentage of those achieving and accepting an offer at a high tariff university increases with Isaac activity, from 0% for low-active users (58% whether Isaac users or not) to 7% for super-active users (58% to 65%).

Across all levels of activity, the increased application rate combined with equal or greater offer and acceptance rate means that more Isaac Physics users are successful in taking up courses at high tariff universities than a non-Isaac user that is the similar in every other respect.

Does Isaac Physics usage mean that students taking maths and physics are more likely to meet or exceed their predicted grade? Yes.

The UCAS EXACT service have calculated the difference in achieved and predicted grade point for all individuals applying to STEM courses at university and for each of our three Isaac "active" groups.

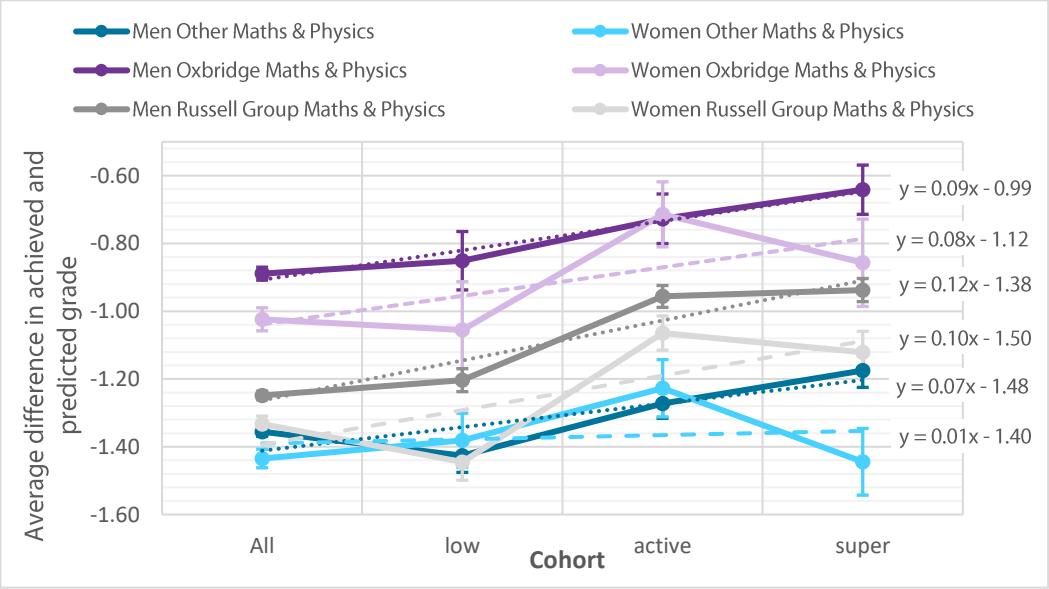
Zero change means that students achieve their predicted grades, a change of +1 is equivalent to a student achieving AAA compared with a prediction of AAB or BBB compared with a prediction of BBC.

As described in the previous section, Isaac activity has been classified in the period between the time at which students would take AS or mock exams, on which teachers typically base predictions, and A2 results.

The distribution of students achieving a given change in prediction and achieved grade has also been disaggregated by

- entry year
- whether a student has taken maths and/or physics at A level,
- gender,
- the university course applied to, and
- which group of universities they have applied to (Oxbridge, Russell Group, Other).

The graphs below show the mean change in grade for male and female students entering university in 2017, that had studied both maths and physics at A-level as a function of activity on Isaac for each of the different university types they applied to.



The positive gradient of all of the trendlines (dots and dashes) shows that increased activity on Isaac reduces the underperformance of students (relative to teachers' predictions). We see that the positive gradient is similar for men and women for each university type except "other". We can also see from this data that students applying to Oxbridge are on average closer to meeting their predictions than for Russell Group or Other university types (a negative difference means that the achieved score was less than the predicted score).

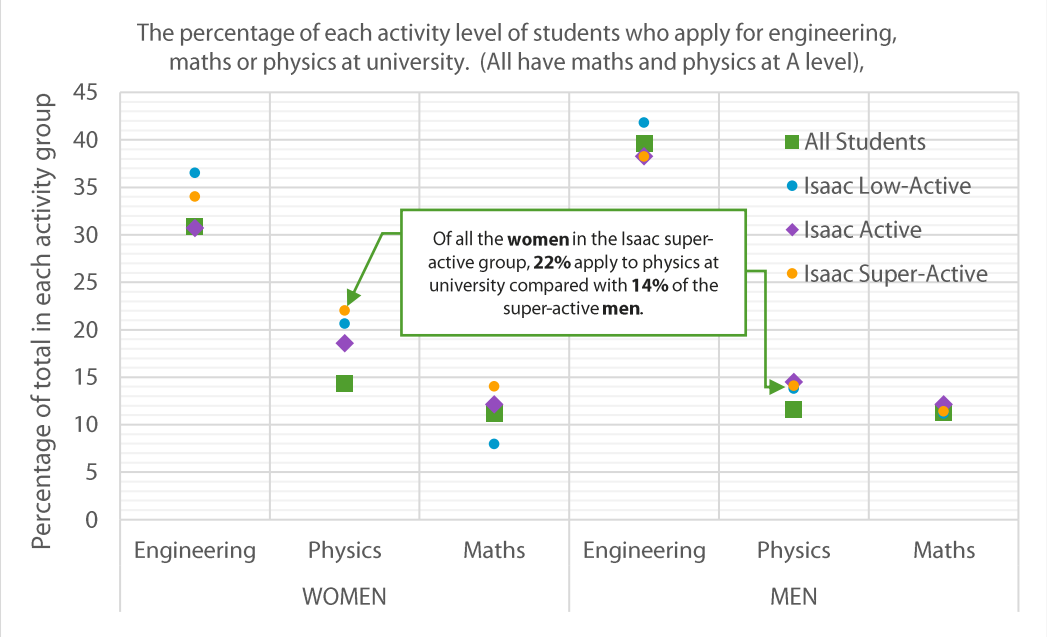
Headlines

Achievement:

1. Both male and female students who are more active on Isaac on average achieve grades closer to those that were predicted for them.

2. The correlation between amount of Isaac activity and achievement of predicted grades is strongest for students applying to Oxbridge and Russell Group universities, thus Isaac usage improves their chances of a place at a top university.

One must consider the question as to whether teachers of students using Isaac are better predictors of grades and therefore this correlation is due to teachers' ability to predict rather than the fact that using Isaac improves students' ability to achieve their grades. It is unlikely however that we would see such a strong correlation with usage if the result was purely down to the ability of the teacher to predict. It is interesting however that there is more fluctuation in the point change for women than for men.



Of the men and women that use Isaac Physics, what fraction go on to apply to study engineering, physics or maths at university? How does this vary with Isaac engagement?

We calculated the percentage of male and female students in each activity group, who have taken both maths and physics at A level, that choose to take engineering, physics and mathematics at University in 2017. The data in the plot above shows that for both women and men the percentage of students choosing to take physics at university is higher in all three cohorts (low-, active and super-active) than for students as a whole. For example, of the 500 super-active women who take both physics and maths at A level , 110 of them chose to go on to Physics at university compared with 1865 out of a total of 12990 for the whole maths and physics female cohort, an increase of 50%. This data cannot prove causation but it does show that women using Isaac are more likely to apply for physics than men and that both male and female Isaac users exceed the average application numbers, proportionally.

Gender	University Type	% All applicants accepted	% Isaac Users (all) accepted
Women applying for physics	Oxbridge	7.7	10.0
	Russell Group	47.9	51.3
	Other	27.6	20.8
Men applying for physics	Oxbridge	14.3	17.4
	Russell Group	47.9	48.9
	Other	32.9	25.0

When we look at the acceptance data from UCAS for male and female students applying for physics at University we see that a greater proportion of Isaac users (combining all three categories of low-, active and super-active for statistical significance) are accepted to physics courses at Oxbridge and Russell Group Universities.

HEADLINES

Teacher Engagement Outcomes

1. In 2017, in 1 month, we reached **41%** (**982**) of teachers teaching A level physics.
2. In December 2017, teachers answered approximately 3000 questions in one week.
3. Isaac Physics CPD events for teacher are key in retaining them for longer on the platform.

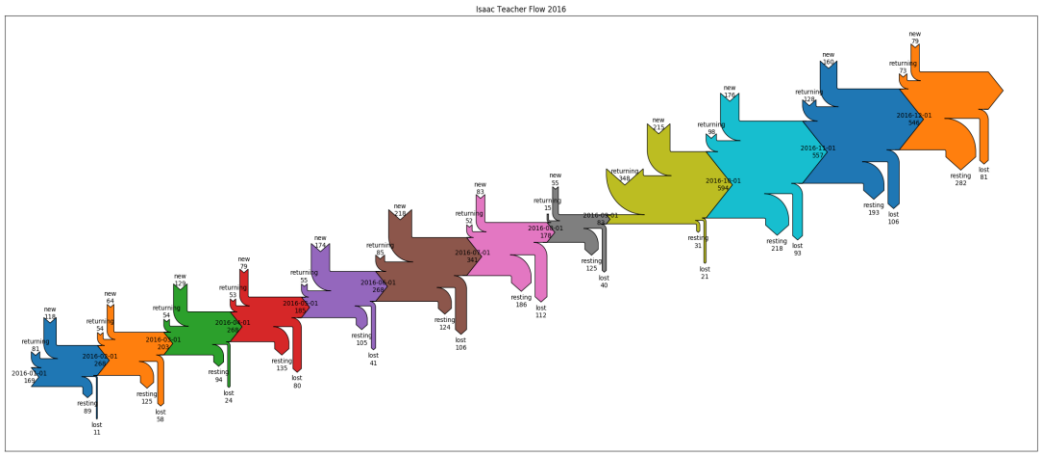
Evidence

In 2016 there were **2418 schools** who entered students for A level physics and in October 2017 we had **982 active teachers** on Isaac.

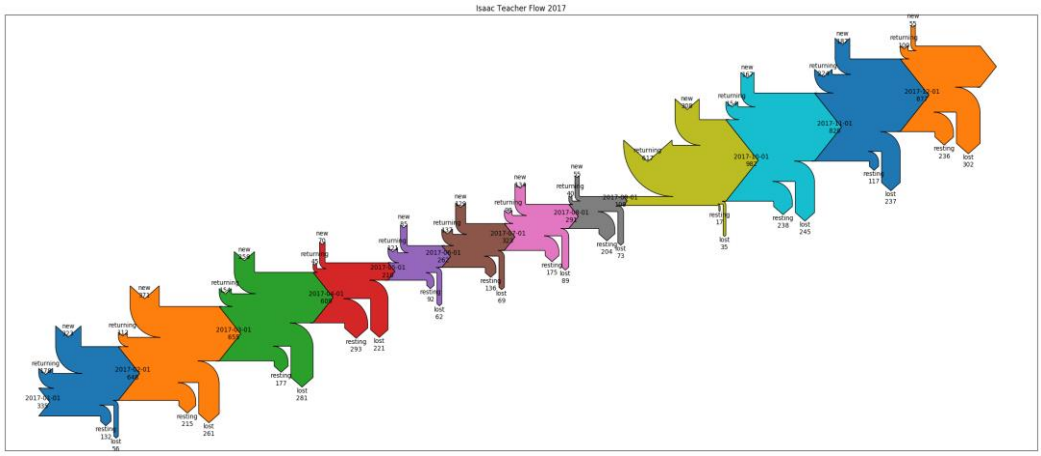
We continually monitor site usage recording question attempts, hints viewed and setting and viewing of homeworks.

3. Teacher Engagement

At the end of March 2018 we have 5221 registered teachers but we have investigated this number further to understand what fraction of these teachers are using Isaac actively.



The figure above shows the "churn" each month in teachers. Each coloured block represents a month in 2016 (January to December) and the size of the block represents the number of teachers that are active that month. The down arrows from the top of the diagram indicate influx (returning or new teachers), the down arrows on the bottom of the diagram indicate teachers who are lost or who rest to return in a subsequent month.



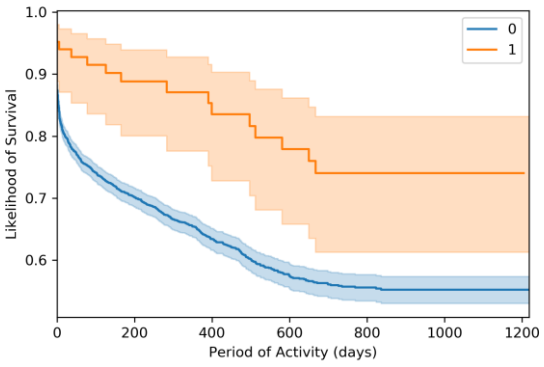
Here we see the same diagram for 2017, now however we should take care with the "lost" arrows as we progress to the right as the uncertainty as to whether teachers are lost or resting increases (they may yet return).

What is clear from these diagrams however is that we are losing more teachers than we wish to and want to understand why.

Further investigation shows that initial drop-off is large, but as teachers spend more time on the platform, they are more likely to remain. Our investigation also indicates that teachers are more likely to remain on the site for longer if they have attended one of our CPD (continuing professional development) events.

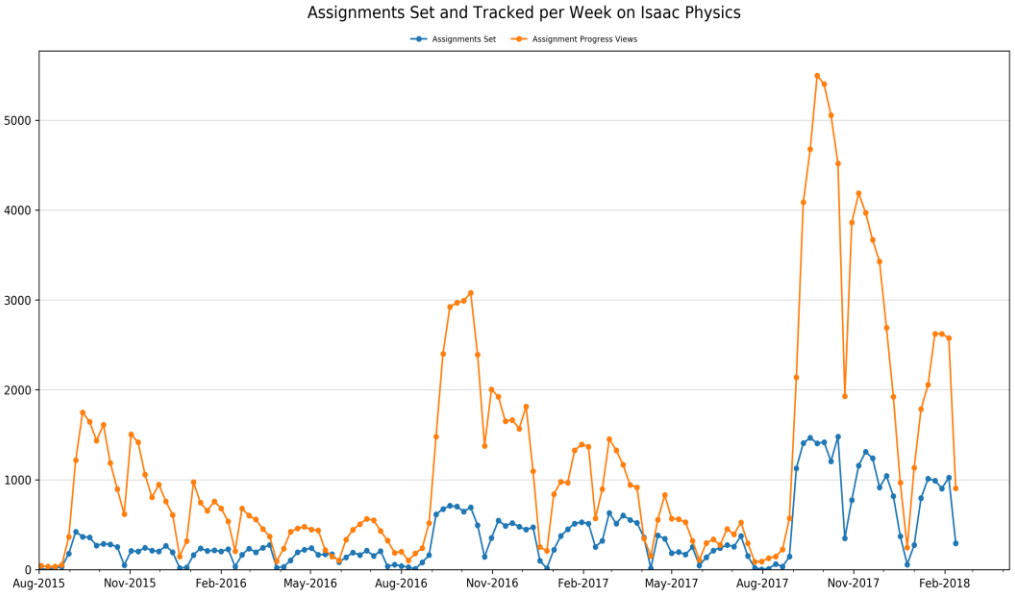
These results give clear messages for our strategy to maintain and improve teacher engagement in the future.

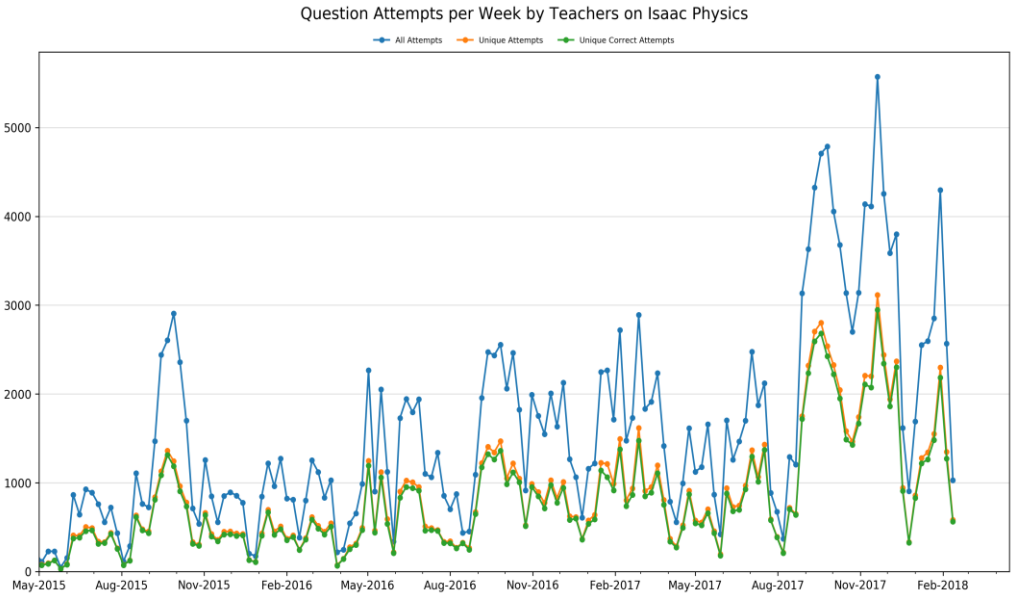
Figure 2: This graph compares the "survival" rate for teachers who have NOT attended an Isaac CPD event (blue) with those who have (orange).



3.1 Teacher Activity & Subject Knowledge Enhancement

Teachers who setting and tracking student homework **also** answer questions themselves for their own problem solving development and subject knowledge enhancement.





These graphs both show that teacher activity on Isaac has increased since its inception but also shows a periodicity in its usage. We need to do more to sustain higher levels of usage after the initial restart in September each year. It is pleasing to see that in academic year 2017 to 2018 the number of assignments set has remained steady at around 1000 homeworks per week. Similarly, the average number of correct question attempts by teachers has remained at ~ 2000 per week.

We have begun to use our teacher usage data to investigate what may cause a teacher to temporarily or permanently leave our site and what intervention is needed to continue to support their usage. This is fundamentally important to increasing student engagement as our research shows, unsurprisingly, that teachers are key to motivating regular use and practice by students.

HEADLINES

Teacher Activity Outcomes

1. In the last week of February 2018,
   a. **478** teachers were active on Isaac.
   b. **181** of them were answering questions.
2. The number of homeworks being set and tracked per week peaked at ~**1500** in the middle of September 2017.

   This is equivalent to 3,000 hours of marking time saved in a week if a teacher takes 10 mins each to mark 12 students work for 1500 homeworks.

Evidence

The evidence for these claims is shown in the charts on the right. We continually monitor site usage recording question attempts, hints viewed and setting and viewing of homeworks so that we can evaluate the performance and usability of Isaac online.

HEADLINES

Teacher Comments

"While it saves time on marking, I find myself spending longer solving the extra challenging problems myself so that I can help the students – my time is better spent! (And I enjoy the challenging problems too!)."

"We embed Isaac Physics on to the VLE and so there is a small amount of investment of time inititally. Following up on homework is quite straightforward and takes up very little time."

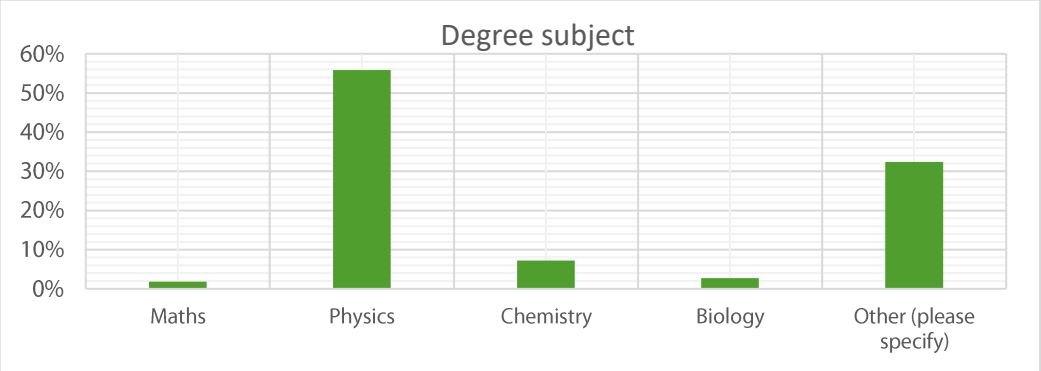
"The great thing is instant, honest feedback. If they give me stuff to mark it can be days after they did it they get the feedback. If I give them mark schemes or worked solutions they can be poor in their judgement (in either direction) of what constitutes a correct solution. They cannot progress until they have the right answer with IP, which is great. I like too that they have to use the correct sig fig. It then becomes part of every calculation, enahancing their skills not just one question on a test paper."

3.2 Teacher Survey 2017

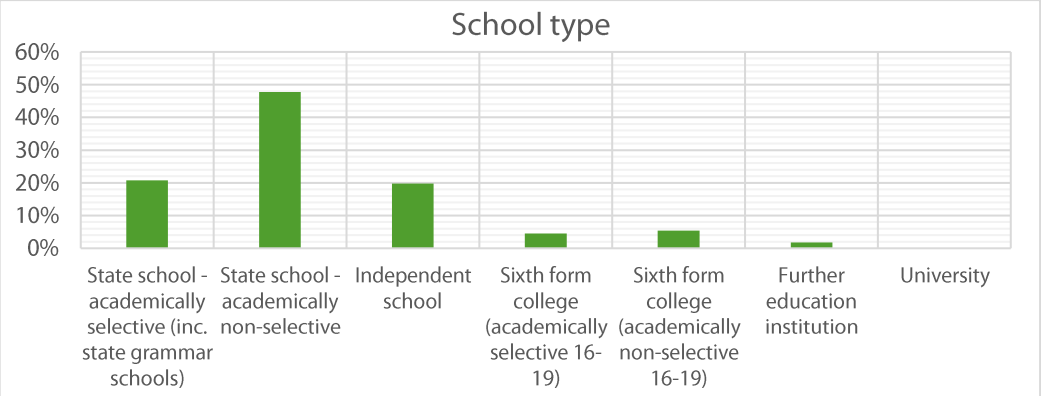
In June 2017 as part of our continual evaluation and usability studies we asked teachers to volunteer to complete an online survey of their impressions and use of Isaac Physics print and online resources. We received **129** responses from teachers and the distribution of respondent demographics was representative of the whole cohort of teachers using Isaac Physics.

Demographic distributions:

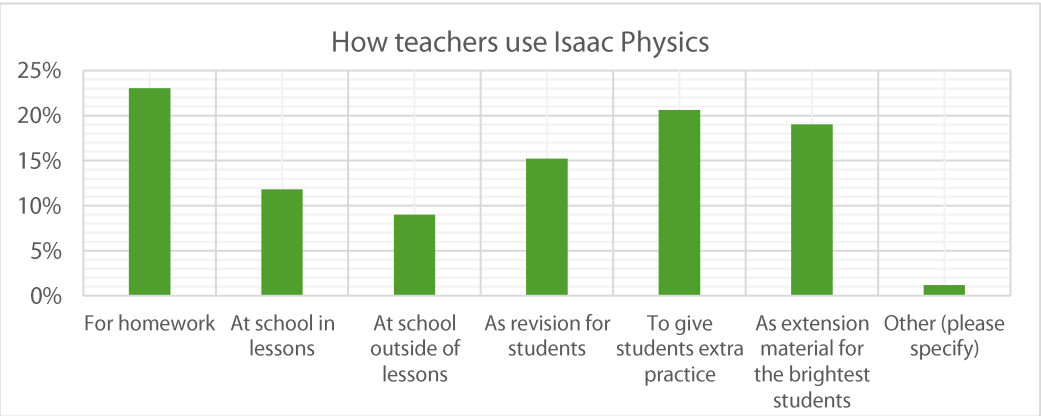
Male 64% Female 35% Prefer not to say 1%



In 2017 our major offering of resources were targeted at A level physics teachers and students. Despite this we see that **44%** of the teachers responding to this survey do not have a physics degree. Those that declared "other" as their degree subject were predominantly engineers.



Isaac usage spans from school to first year foundation courses at University. The distribution of our respondents by institution type was consistent with the teacher user distribution on Isaac. Nationally, 20% of students at A-level study in independent institutions. The percentage of respondents from independent schools in this survey was 19.8%.



Teachers were asked to tell us how they use Isaac and could select more than one use case. The graph above illustrates Isaac's broad spectrum of use cases.

HEADLINES

Teacher Comments

"Great for me as an AS physics teacher who does not have a degree in physics or engineering. Good to test myself with the questions as well and then I can guide my students towards progress in getting the correct answer."

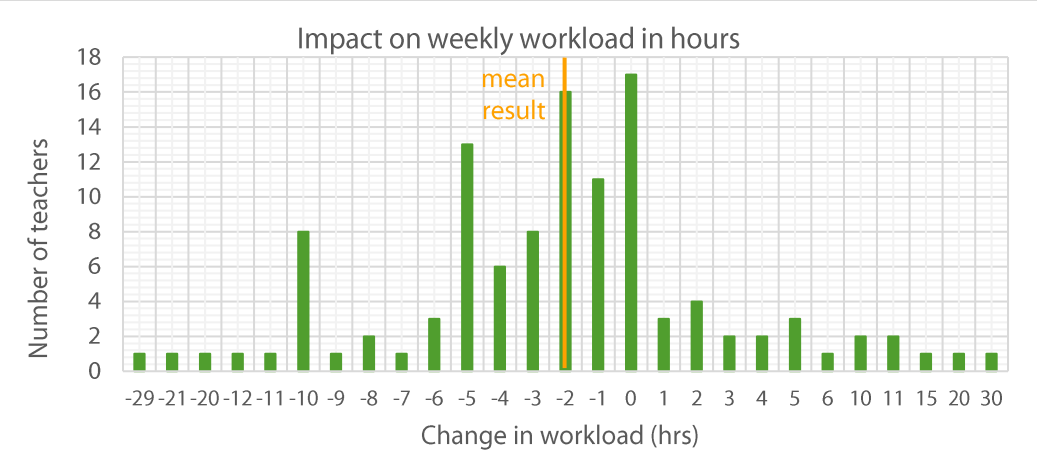
"Students that start Year 12 having completed the assignments I set over the Summer have better fundamentals and are more prepared to take on A level physics."

"Has been important in moving students to A* standard, but also in improving lower grades."

"Independence of mind improves; less dydactic reliance on me as a teacher: an excellent outcome!"

"The brightest and best KS4 race through worksheets they could have dawdled over, so they can get to the computers. One cheats, so he can get there sooner! The KS5 can go at their own pace, and I can focus on specific issues that each is having without leaving any behind or letting others run out of work."

One of the key tools and features that we provide teachers is the ability to set homework for their classes in just a couple of clicks. It has been our intention from the outset that Isaac was **not** to create work for teachers but to actually alleviate their workload.



Teachers were asked to estimate the effect of using Isaac on their workload in "hours per week". The distribution above illustrates a broad range of estimates with a mean result that teachers workload is **reduced by 2 hours per week.** There are many factors in this result.

1. The more homework that a teacher sets on Isaac the more time they save and the amount of homework each teacher sets varies significantly.
2. Teachers comment that the time that they save on marking homework they use to solve problems on Isaac to upskill and therefore they don't save time but their time is used more effectively.

There are still improvements to be made and we have already implemented suggestions from this 2017 survey, particularly with respect to how we display homework results to teachers so that they have more detail for each question and each student. Further software development will be a focus of the next phase of the project to ensure that we retain and increase the number of teachers that are actively and regularly engaged on Isaac.

"First and foremost, this has given me a chance to upskill and therefore it has a direct impact on my teaching practice.

It provides me a different perspective to teach and my students have benefited because they have been expand/deepen the understanding as they are exposed to different sets of problems.

My students have been able to identify their own misconceptions and as they solve and consider problems from the book, they are able to correct these as they progress with their studies.

I have seen a significant change in that they approach their tasks more carefully, have developed the most essential skill of drawing diagrams, simplify problems, make connections across cross-curricular topics and mathematics more easily.

They are able to plan their work and self-assess their work - which means that they are able to better manage their workload and time.

Class-room discussions now are more focussed on Physics and problem-solving. Increased competitiveness and the joy of working out correct solutions drive them to do more."

A-level physics teacher with a degree in chemistry, teaching in a non-selective state school

HEADLINES

Student Engagement

1. 25-30% of the current A level cohort are using Isaac Physics actively.

2. Since the introduction of the GCSE mastery book we have engaged 13,202 active students in year 9 to 11.

3. We continue, year on year, to see an upward trend in active registered users on Isaac. Reaching weekly peaks of

   - 2015-16 ~ 2,500 users
   - 2016-17 ~ 5,700 users
   - 2017-18 ~ 11,000 users

Student Comment from our 2017 survey

"I'm really not a very disciplined person when it comes to studying - if it comes to studying - which I'm not very good at either.

Anyway, Isaac is just a great 'bank' of well designed, well presented, well organised questions, which has really helped me, 'cause at least if I'm using Isaac I have no excuse for not doing very much.

Also, the equation editor is really impressive and I wish I could use it as like a word or OneNote addon or something - out of all the equation editors I've ever used it's by far the most fluent and efficient and when I'm making notes it's exactly what I wish I could be using."

Male year 13 student from an academically non-selective sixth form college who is taking A level physics with music and English literature – hoping to study a liberal arts degree.

4. Student Engagement

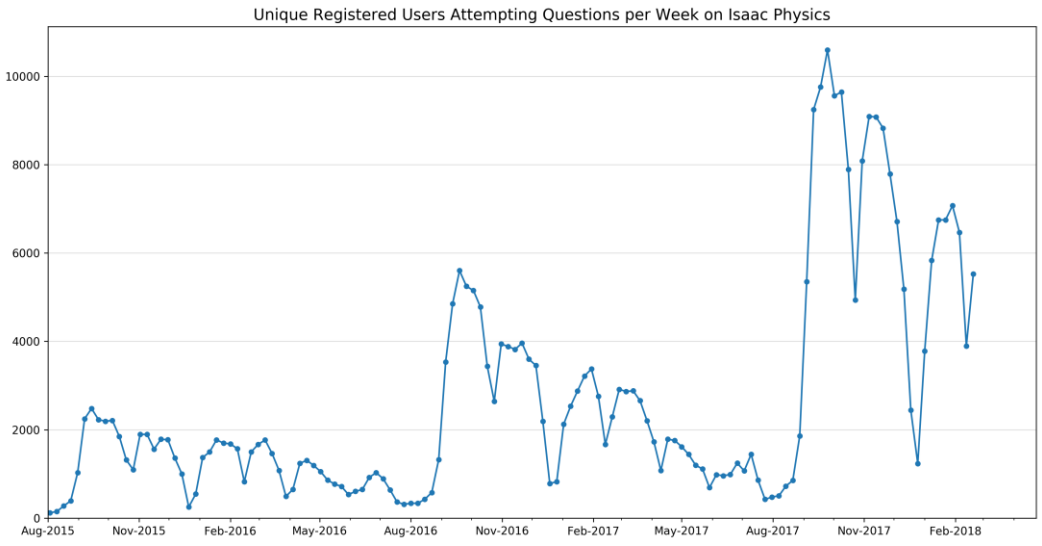
Our team infrastructure and platform are designed to continually monitor student engagement such that we regularly review data such as those presented below.

Active students at UK schools by school year group and activity on physics questions between August 2017 and January 2018.

School / University Year	≥ 50 correct	≥ 10 correct	≥ 3 correct	≥ 1 correct
4th year	9	22	28	32
3rd year	16	33	40	46
2nd year	50	100	132	146
1st year	306	654	827	897
13	2938	5530	6363	6758
12	5854	10093	11167	11604
11	2458	5277	6063	6382
10	1788	4343	4971	5208
9	372	1263	1497	1612

If we assume with the new linear A level that the number of students who take A level remains the same across the first and second year, we estimate that the number of students in stage 1 or 2 of A level physics is 73,000. This means that **we have reached at least 25% of the current A level cohort**.

This graph shows the number of unique users per week that are attempting questions on Isaac Physics. The peaks and troughs in the data can be directly attributed to 'global' events such as half-terms, Christmas and other holidays (like the long summer vacation). We also see from this data that the academic year is periodic in Isaac behaviour. In particular that we have a great surge each September when the new school year starts but there is a drop off in the number of users as the year passes. Each surge in the data can be attributed, in some part, to Isaac interventions such as the development of new books. In September 2015 we launched the first A level Physics book, in 2016 we released our Physical Chemistry book, and in September 2017 we released our GCSE Physics book.



HEADLINES

Developing Student Engagement

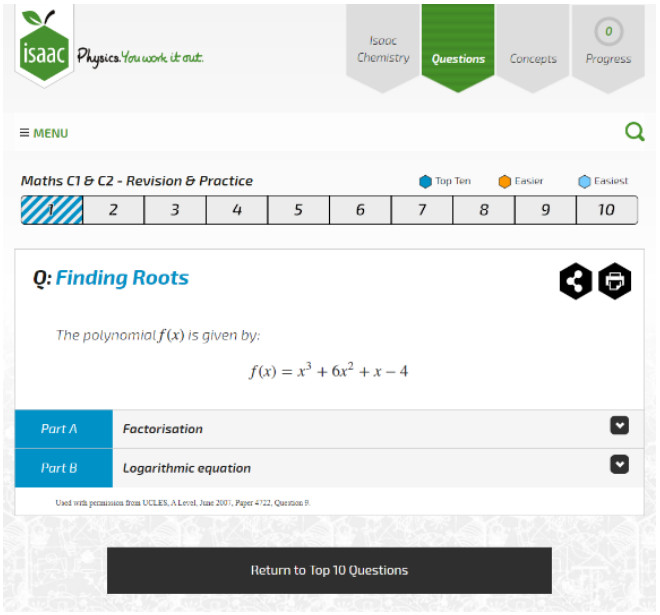
1. Our bespoke platform and ability to monitor activity enables us to continually improve the user experience.

2. Data science will enable us to individualise the student and teacher experience such that in the future we will be able to suggest homeworks to teachers that are tailored to their class and their previous work.

4.1 Understanding and Developing Student Engagement

The breadth of Isaac Physics resources is large and we have elements to address a variety of motivational targets for students. In particular, we have sets of questions that are designed for revision and for application to University that focus on mathematics skills that are needed for physics and other STEM courses.

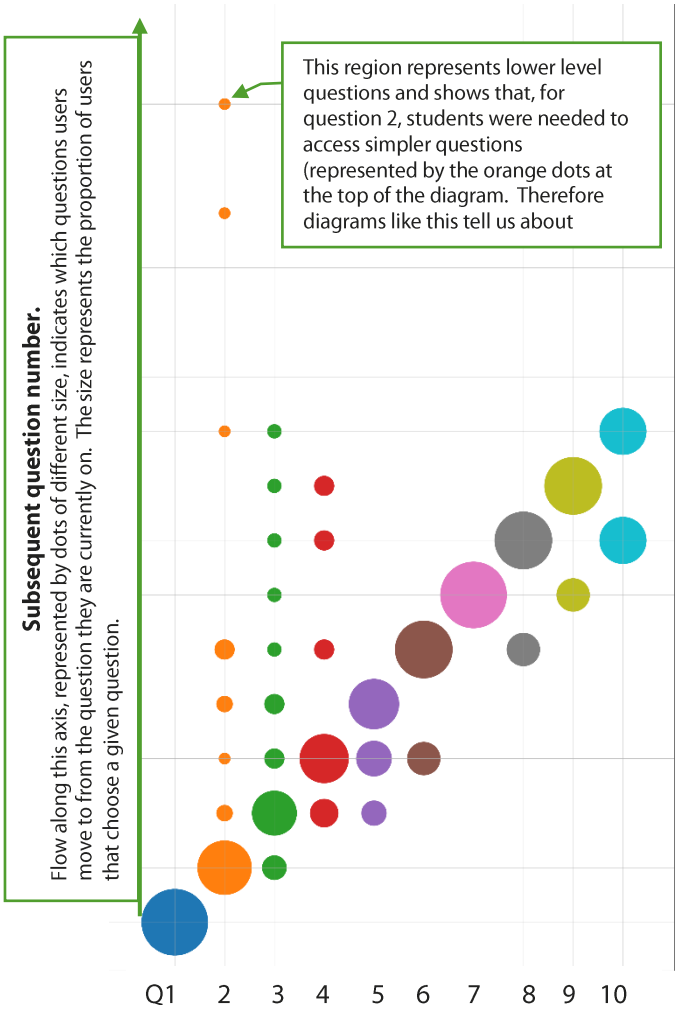
The structure of this revision tool is focussed on students correctly answering a set of Top Ten synoptic questions that draw on all of the skills in core 1 and core 2 A level maths (now stage 1 of the linear A level system). Below these 10 questions are two levels of easier, smaller questions for students to practise individual topics if they are unable to answer the top 10 questions, thus providing some scaffolding for them to revise alone. We have remodelled our user interface for these questions to make students more aware that these lower level questions are there to help.



Again, using data science we are able to evaluate the effectiveness of such interventions by looking at the routes that students take through such questions. i.e. their click stream data.

Teachers report that Isaac Physics helps their students to develop resilience and perseverance. This data however shows that students still need further help with fully completing tasks.

Going forward, we will be training our system to learn the paths that students find most succesful through our supporting questions so that we can individualise learning paths through this area of the site to present students with the appropriate amount of challenge and success.



HEADLINES

Developing Student Engagement

3. Our project physicists are engaging students in regular homeworks and problem-solving practice. On average 15.3% of students who start the scheme complete more than 60% of the homework.

5. Widening Participation: Student Engagement

Online mentor scheme:

To meet one of our key objectives, to support students who do not have access to specialist physics teachers, we began an online mentor scheme in the summer of 2016 for students in school in years 11, 12 and 13. Every week a member of the Isaac Physics team sets a piece of homework, typically around an 1 hour of work, and every fortnight then offers an online tutorial to go over questions that the students got wrong or found difficult. Our bespoke platform enables students to see their tutor, and her/his working, and to communicate with them live to ask questions. It also prevents communication between viewers thus preventing unwanted behaviours, significantly reducing potential child-protection issues.

Students who participate in the scheme are offered a certificate at the end of the year for attempting more than 60%, 75% and 90% of the weekly homeworks.

The number of students engaging with the mentor scheme since 2016 is given in the table below:

Age group (school year)	2016	2017	% of students attempting 60% or more of the homeworks (2017)
11	72	171	16.4
12	336	453	14.1
13	259	309	16.5

The average percentage of students attempting the work across the last 28 weeks as shown in the table, reflects the fact that some students participate every week and some fluctuate with gaps but then return and some join but do nothing from week one. We expect our new streak indicator and future badges will incentivise more regular usage.

Attainment Raising Bootcamps:

In January 2018 we worked with 295 students from widening participation backgrounds through two intensive attainment raising bootcamps. Students were selected for places if they attended a state school in England and met at least one of the following criteria:

- first generation of family to attend university
- have been eligible for free school meals, Pupil Premium, EMA and/or a 16-19 bursary during secondary school
- attend a school or college (or live in an area) with a low rate of progression to higher education.
- Attend a school or college with a below-average A level (or equivalent) point score
- live in an area with a high level of socio-economic deprivation.

To achieve a place students were also required to complete some Isaac work as a commitment to attending.

The demographic of students attending the residentials were such that:

- 45% of the attendees were female (compared with 21% female students taking A-level physics)
- <45% of the attendees were white British.

HEADLINES

Engagement in Priority & Opportunity areas

1. 9 Ogden-Isaac Widening Participation Fellows are located around England to provide regular intense interactions with schools and students in priority areas.

2. Engaging with students and schools in priority areas is challenging for a number of reasons:

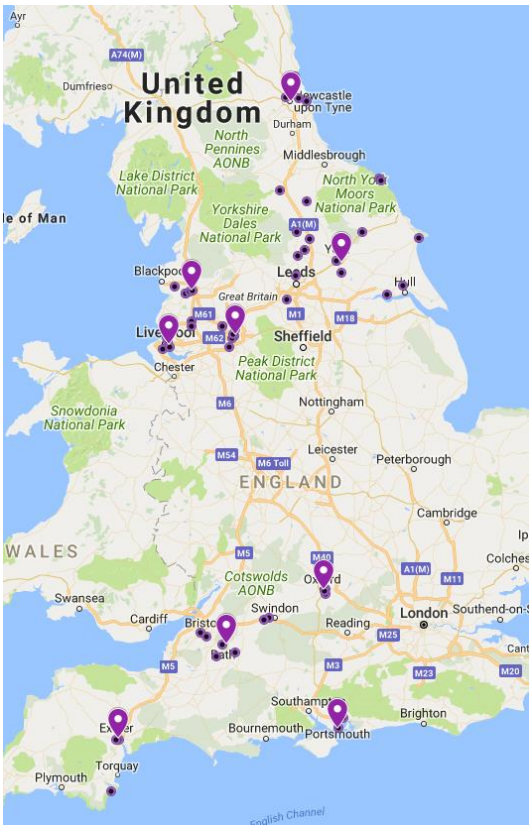
   a. unwillingness to commit to regular interactions (one off events are fine - but we believe that continual practice is required to make a difference)

   b. lack of organisation within schools in these areas that would give students the opporunity to engage.

   c. effort could be maximally effective if students were able to commit outside of the normal school day – some students have part-time work and caring responsibilities that makes this difficult.

5.1 Engagement in Priority & Opportunity Areas

Since May 2017 we have engaged widening participation fellows in universities across England to provide local support for students, teachers and schools. Fellows have been identified and funded in collaboration with their host university and The Ogden Trust. The individuals are employed by Isaac Physics for 50% of their time and by their host university for the remaining 50%, either as researchers, teachers or outreach officers.



We currently have fellows working with 7 universities:

York, University of Central Lancashire, Liverpool, Manchester, Oxford, Bath, Portsmouth

and two further fellows not employed by the universities but working in connection with them at Newcastle and Exeter.

The remit of these fellows is to work specifically with students who are in priority areas and are from socio-economic demographics that traditionally have low progression to higher education. Their two aims being aspiration raising and attainment raising.

It is vital that the first aim, of aspiration raising, is closely followed by meeting the second aim to ensure that students achieve the grades they need to apply to a STEM course at a high tariff university.

The nature of the target audience means high intensity, regular interaction with a relatively small number of students – homework set every week with face-to-face workshops at the beginning and end of every term. There are challenges to be faced, such as, the disorganisation of schools which makes it difficult to plan in advance and create a routine for the students on the programme. The students who we want to work with have other priorities to balance, such as part-time work, caring for relatives and some loss of motivation with learning.

The map above shows the locations of the Widening Participation Fellows (Ogden-Isaac Fellows) and the location of the schools that they are working with (marked as circular dots).

OIF	# Schools Y10	No students Y10	No schools Y12	No students Y12
BATH	3	34	7	12
LIVERPOOL	2	44	6	2
MANCHESTER	5	40	2	19
OXFORD	2	24	1	8
PORTSMOUTH	1	25	2	13
UCLAN	2	28	5	45
YORK	15	48	4	6
Totals (established OIFs)	**30**	**243**	**27**	**105**

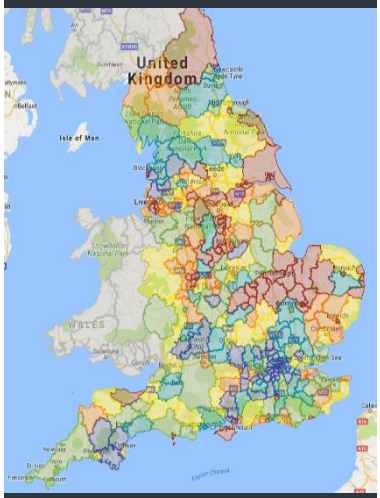
HEADLINES

Isaac Online - Reach

1. Our study of Isaac online use by geographical location has revealed that both teachers and students are using the platform across all of England.

2. Comparing the teacher and students maps we can identify where there are students using Isaac without the encouragement of a teacher and target teachers who are using Isaac but don't have students answering questions.

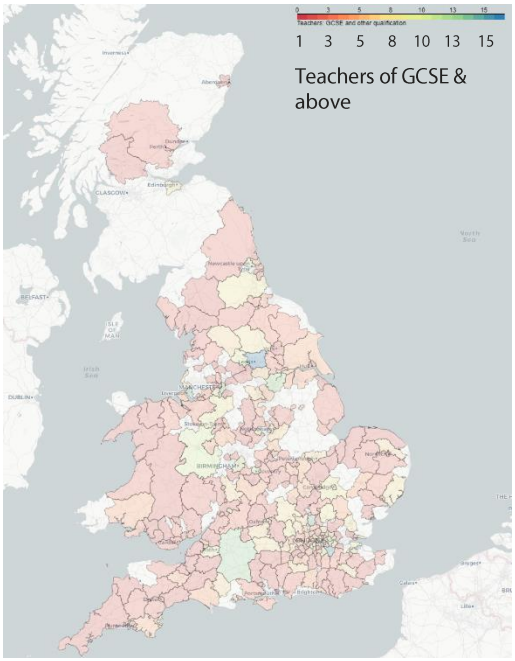
3. Further targetting will continue to increase engagement in priority 5 and 6 areas.

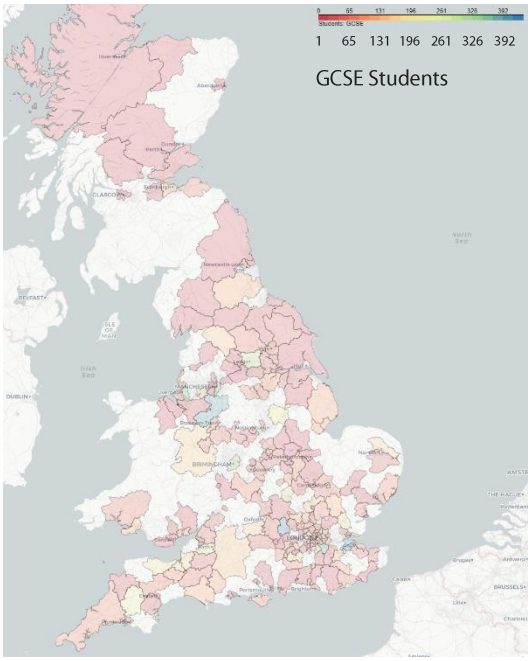


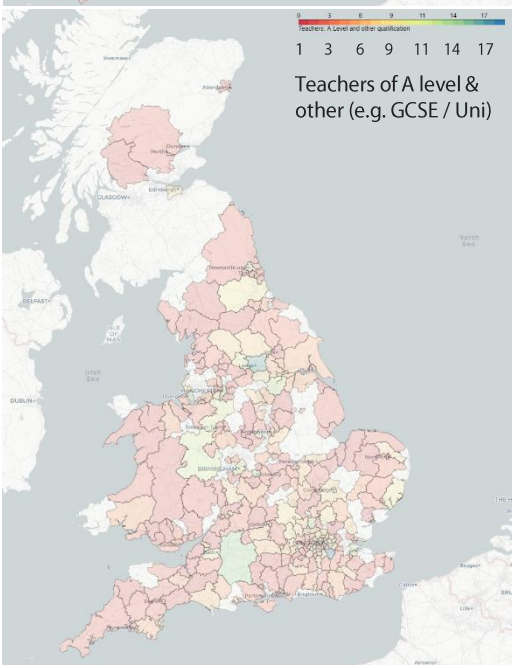
5.2 Isaac Online - Reach in Priority & Opportunity Areas

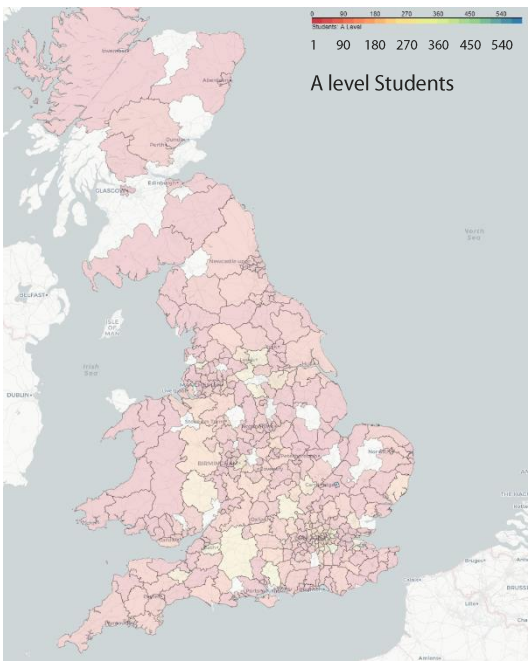
As a user registers on Isaac Physics, we ask that they declare their school for two reasons – the first is so that we can inform them of physics support in their local area (e.g. university fellows, events…), the second is so that we can continue to monitor our progress in engagement across priority and opportunity areas. One of the main aims of our project was to provide resources that were easily accessible to students and teachers independent of geographical location or school provision.

The map shown in the grey margin is a Google Map that we have created showing the local area districts (LADs), colour coded by priority. Red indicates areas that are level 6, and orange indicates level 5. Using our online registration data, we have produced maps showing the number of A level and GCSE, students and teachers, using Isaac in each LAD.









These maps highlight regions where students are engaging with Isaac but without a teacher in that region – for example, northerly areas of East Anglia and the Midlands. The A level student maps show that our reach is great across the whole of the UK. The GCSE maps show good progress given our very recent move to this age group and level.
The white spaces show that there are regions to target and penetrate and we aim to change the dominant colour on the map from red to green/blue.