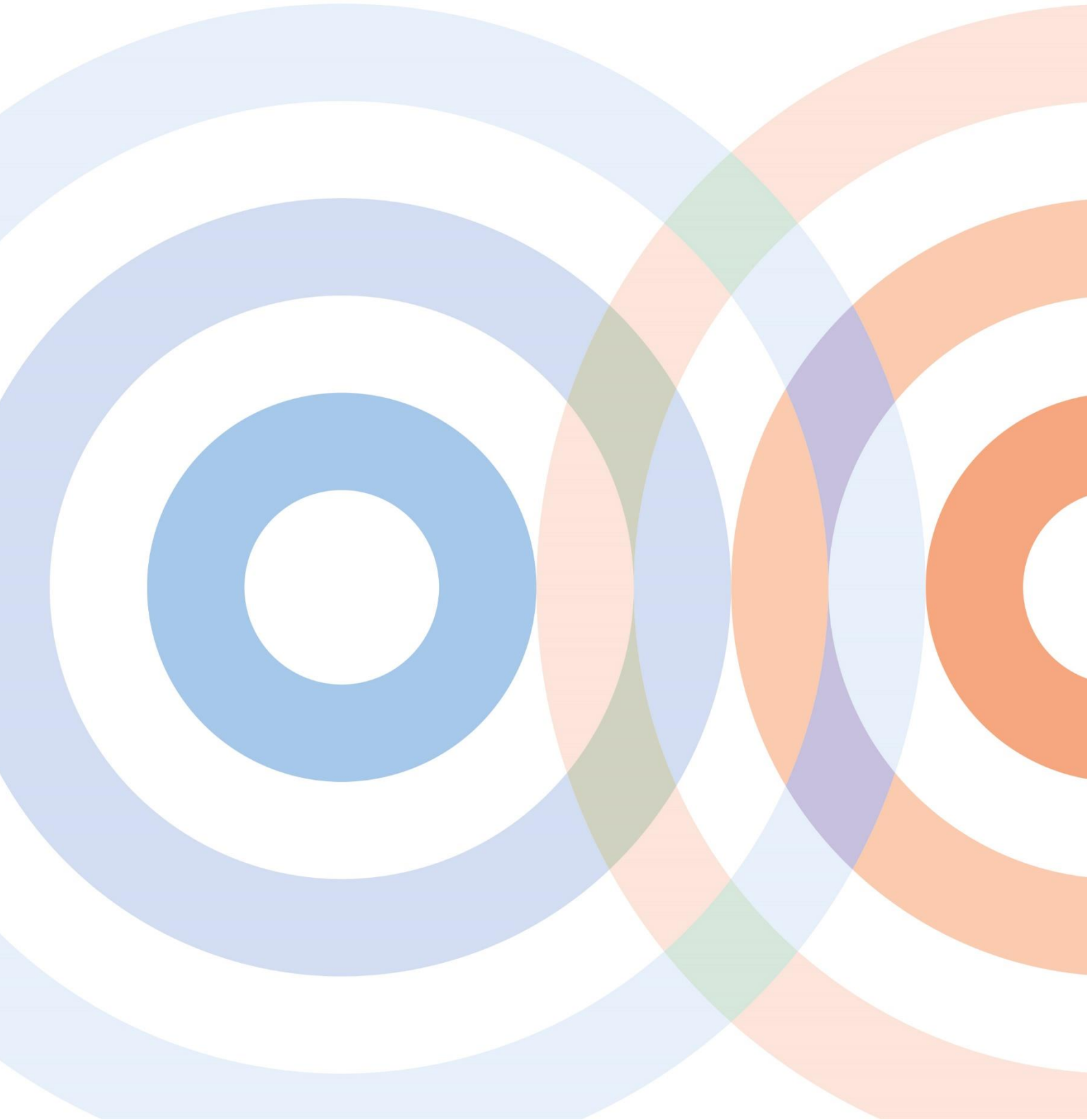
Ondata Research

Physics Mentoring Project Annual Evaluation Report

Laura Thomas, September 2024



1. Introduction

The Physics Mentoring Project continues to gather a wealth of evidence about the experiences and impacts of the project for the participants and stakeholders. The project consists of the following strands of activity:

- Growing Connections: this near-peer mentoring programme for Years 9 to 11 in Wales aims to increase uptake of Physics A-level (especially amongst female learners). Pairs of undergraduate or postgraduate mentors work with small groups of learners across six weeks, either in-person, online or a blend of the two approaches.
- Exploring Connections: this strand focusses on raising awareness of alternative routes into physics-related careers. The project hosts careers events where employers are able to engage learners in hands-on activities about the work their company does and how to progress into physics-related careers. Apprenticeships and alternative routes are a core focus of the sessions and resources.
- Advanced Connections: this is an online tutoring and mentoring opportunity for Year 12 and level 3 learners undertaking physics and engineering qualifications in Wales. Subject support is provided alongside advice and guidance about university applications.

This report looks at the evidence gathered in relation to Growing Connections and Exploring Connections. Exploring Connections ran for the first time in summer 2024 and for the original core programme, Growing Connections, this is its fifth year. The evaluation of Advanced Connections is being undertaken separately with initial findings available in 2025.

As has been established in the previous years' reporting[1], there are a range of benefits and impacts for participants (both mentors and mentees) and their schools and universities. Mentees are selected for participation following the completion of a pre-participation survey on their attitudes towards physics. Teachers use the results from this, focussing on those who are likely to take physics or are unsure, combined with their own professional assessment to choose the groups of learners to participate.

For mentees:

- The project is an opportunity for mentees to gain a better understanding of what post-16 physics is like and what careers it links to. As a result, mentees have shown an increased interest in Physics A-level and other post-16 options such as apprenticeships and an increased interest in a science-related career.
- Spending time with university mentors has raised aspirations of mentees and having a near-peer mentor has reassured them that they are receiving up to date information about what university is like.
- As a result of their participation in the mentoring sessions, mentees also report an increased understanding of how physics connects to their own lives and their awareness of the relevance of what they are learning in the classroom also improves.
- Mentees benefit from being able to develop their knowledge and skills in relation to physics which can contribute to an increased confidence and improved levels of engagement in their classes.

For teachers and schools:

- The project provides schools with an opportunity to develop links with Welsh universities. Through the range of events and activities on offer, teachers have also been able to reflect on their own practice and incorporate ideas and connections highlighted by the project through their involvement with local industry.
- Multi-year involvement can also contribute to a positive culture of physics within schools and can result in an increased uptake of physics post-16 and raised aspirations of their learners.

For mentors and universities:

- Through participating in this project, Welsh universities are providing their students with opportunities to develop their skills and enhance their employability.

[1] Multiple reports and case studies can be found here: https://physicsmentoring.co.uk/about/impact/

- Mentors are able to develop a range of skills, including communication, organisation and time management. They also developed their awareness of inclusion and diversity issues, approaches to working with young people and had the opportunity to identify whether a career in teaching was something of interest to them.

This year's annual report opens with a review of the evidence related to the Growing Connections strand. We look at a summary of the attitudes and intentions in relation to physics and science careers for over 2,500 learners in 26 schools participating in the project. This is followed by a discussion of the mentoring experiences and impacts in more depth. A final case study looks at the impact of the Exploring Connections pilot event and discusses this in context with some of the careers-related findings from the analysis of the Growing Connections evidence. Before going on to review the findings, we first outline the methodology for the evaluation.

2. Methodology

In order to assess whether the project has met its aims and to identify unexpected areas of impact a Mixed Methods approach is taken, using qualitative and quantitative methods and data. Table 1 below describes the data collected over the course of the 2023/2024 school year for the Growing Connections and Exploring Connections strands and covers mentoring cycles 9 and 10 for the project. Data collection is based on an evaluation framework established in 2019 which is reviewed annually based on evaluation findings and the project activities. There have been some amendments for 2023/2024 due to additional activities being added to the project. Longer term impact continues to be a challenging aspect to capture, especially in terms of individual participants and we will continue to work on ways to address this in 2024/2025.

	Method	**Purpose**	**Description**
Mentors	Post-session reflections	To provide mentors a structured space in order to reflect on how the session went and what they could do to improve for next time.	Set of questions completed after delivering the session.
	Post-participation survey	To provide feedback on their experiences in schools.	Mentors responded to questions about their experiences working with schools and how the mentoring has impacted on them.
	Teaching attitudes survey	To examine long term impact of student mentors now in employment or with those who have gone into teaching	Mentors were asked about their intentions with regards to teaching and what barriers were preventing them from considering it as a career.
Mentees	Pre- and post-participation surveys	To track any changes in attitudes and intentions in relation to Physics A-level and STEM careers for mentees and peers in the same school who didn't participate in the project.	The pre-participation survey is used to identify learners who are unsure about taking physics. Similar set of questions used at the end of the project to identify any change. Natural control group of non-participating peers drawn from within the schools to allow a comparison.

	Post-session reflections/feedback	To gain an understanding of their impressions of the sessions in terms of what they liked, what could be improved and what the key messages were that they took away.	Short set of questions on the session were completed at the end of the session or immediately afterwards.
	Focus groups	To gain further insight into their experiences of the PMP.	Multiple focus groups ran with mentees at the Awards and Recognition events.
	Observations	To gain insight into what happens in mentoring sessions and at the 'Exploring connections' event.	Mentoring session and careers event attended by external evaluator.
Teachers	Post-participation survey	To provide feedback on their experiences of the project in terms of the logistics and also the impact of participation on schools.	Survey was sent to teachers following the completion of the project.
	Interview	To gain insight into the impact of participation in the PMP with themselves and their learners.	An interview took place with one teacher who was attending one of the Awards and Recognition ceremonies.

Table 1. Data collection summary

Qualitative data has been analysed using reflexive thematic analysis[2] with descriptive statistics and the appropriate statistical tests used for the quantitative data (e.g. paired t-tests). Informed consent was sought from all participants. Audio recordings were transcribed with the assistance of AI, with the accuracy checked by the external evaluator. With regards to data analysis, AI was used in relation to the categorisation of qualitative data but the analysis and interpretation was wholly undertaken by the external evaluator. Data storage and collection adhered to GDPR requirements and to BERA's ethical guidelines[3].

[2] Braun, V., Clarke, V. (2019) Reflecting on reflexive thematic analysis, Qualitative Research in Sport, Exercise and Health. 11:4, 589-597

[3] British Educational Research Association (BERA) (2018) Ethical Guidelines for Educational Research, fourth edition, London. Retrieved from https://www.bera.ac.uk/researchers-resources/publications/ethical-guidelines-for-educational-research-2018

2.1. Growing Connections learner survey details

The following tables outline the number and demographics of the respondents to the pre- and post-participation surveys. The pre-participation survey is used to select participants and is often completed by whole year groups in a school. The post-participation surveys are targeted at mentees and schools are also asked to re-share this with their wider cohort in order to help us understand the changes amongst the mentees alongside a natural control group. As ever, we are very grateful to the schools for their efforts in gathering feedback from pupils. The groups making up mentees and non-participating learners only include those who have both a pre-participation and post-participation survey response so these can be directly matched.

	Pre-participation survey		**Post-participation survey**			
	All		**Mentees**		**Non-participating learners**	
	n	%	n	%	n	%
Male	1207	47.7%	44	40.0%	103	56.6%
Female	1249	49.3%	65	59.1%	72	39.6%
Prefer not to say/self-described	75	3.0%	1	0.9%	7	3.8%
Total	2531		110		182	

Table 2. Gender of learners responding to surveys

The gender split of respondents is available in Table 2, and we can see that there is an increased proportion of female mentees compared with the general population and the non-participation learners. This is because the project encourages schools to select female learners as participants as one of the project's core aims is to increase uptake of physics post-16 with female learners.

The project targets participation of Years 9 to 11 but there are a small number of younger ages being included in the pre-participation survey. However, only the target age groups are included as participants.

	Pre-participation survey		Post-participation survey			
	All		Mentees		Non-participating learners	
	n	%	n	%	n	%
Year 7	5	0.2%	0	0.0%	0	0.0%
Year 8	11	0.4%	0	0.0%	0	0.0%
Year 9	834	33.0%	39	35.5%	98	54.4%
Year 10	737	29.1%	22	20.0%	14	7.8%
Year 11	944	37.3%	49	44.5%	68	37.8%
Total	2531		110		180	

Table 3. Year group of learners responding to surveys

	Pre-participation		Post-participation			
	All		Mentees		Non-participating learners	
	n	%	n	%	n	%
BTEC Science	20	0.8%	3	2.9%	1	0.5%
Single Applied Science	173	6.8%	2	1.9%	9	4.9%
Double Award Science	1307	51.6%	36	34.6%	85	46.7%
Double Applied Science	155	6.1%	2	1.9%	23	12.6%
Triple Award Science/Separate Science	734	29.0%	55	52.9%	47	25.8%
Year 9 science	121	4.8%	6	5.8%	11	6.0%
None	5	0.2%	0	0.0%	2	1.1%
Unsure	16	0.6%	0	0.0%	4	2.2%
	2531		104		182	

Table 4. Science-related qualification of learners responding to surveys

As with previous years we see that the mentee group is most likely to be taking triple science, with double award science being the most common qualification for those not participating or for across the whole population. With the changes to the qualifications available in Wales, the range of qualifications will change in coming years.

The following sections now go on to examine the findings from the analysis of these survey responses along with the broad range of other data available.

3. Growing Connections

This section outlines the impact of participating in the Growing Connections strand, which is the six week mentoring scheme where learners work in small groups with a pair of undergraduate or postgraduate students. The project worked with 26 schools in cycles 9 and 10. Of these, three were bilingual, one was Welsh medium and 22 were English medium schools.

3.1. Studying physics post-16

The number of responses to the pre-participation survey grew to over 2,500 responses for mentoring cycles 9 and 10 in 2023/2024. This is an increase of almost one third compared to 2022/2023. In this section we begin by looking at the attitudes towards studying physics amongst all respondents to the pre-participation survey. We then move on to look at the responses from the mentee and non-mentee sub-groups, before and after the mentoring programme.

The following table gives an overview of what the starting position has been at the beginning of each year of the project in terms of attitudes towards taking Physics A-level.

	I definitely will	**I probably will**	**Unsure at this stage**	**I probably won't**	**I definitely won't**
Cycle 1 n=998	8.7%	7.4%	18.3%	24.5%	41.1%
Cycles 2 & 3 n=1835	5%	12%	29%	27%	27%
Cycle 4 n=540	3.8%	20.2%	29.8%	22.6%	23.8%
Cycles 5 & 6 n=1973	4.4%	11.7%	30.6%	25.8%	27.5%
Cycles 7 & 8 n=1908	3.9%	11.1%	33.4%	25.0%	26.7%
Cycles 9 & 10 n=2524	4.5%	12.1%	32.3%	24.3%	26.7%

Table 5. Pre-participation responses from learners across all years of the project to date

- In the most recent two years of the project we can see that the intentions in relation to physics have been fairly steady overall, with those indicating they 'definitely will' choose Physics A-level sitting at 3.9% and 4.5%.
- As was noted in the previous year's evaluation report[4] there has been a shift away from 'definitely will'/'probably will' to 'unsure' and this situation seems to have stabilised this year.
- It was also noted in the 2023 annual report that learners in returning schools were more likely to indicate they 'definitely will'/'probably will' choose Physics A-level when compared to schools joining for the first time. However, for cycles 9 and 10 there were a similar proportion of respondents indicating 'definitely will'/'probably will' in the returning schools and new schools at around 17%. Table 6 below outlines these results in detail.

	I definitely will	I probably will	Unsure at this stage	I probably won't	I definitely won't
New schools	5.9%	11.3%	30.4%	24.9%	27.6%
	(n=66)	(n=127)	(n=342)	(n=280)	(n=310)
Returning schools	3.6%	13.7%	32.4%	24.1%	26.1%
	(n=45)	(n=169)	(n=401)	(n=298)	(n=323)

Table 6. Pre-participation responses by whether the school is returning to the project or is participating for the first time to "How likely are you to choose Physics at A-level?"

[4] Thomas, L. (2023) *Physics Mentoring Project Annual Evaluation Report 2023.* Available: https://physicsmentoring.co.uk/wp-content/uploads/2024/02/English-Physics-Mentoring-C7-8-Annual-Evaluation-Report-2022-23.pdf

One of the core aims of the project is to increase the uptake of Physics A-level amongst female learners. Figure 1 below outlines how the responses compare in terms of gender. We can see that male learners (yellow) are more likely to opt for Physics A-level compared to female learners (grey).

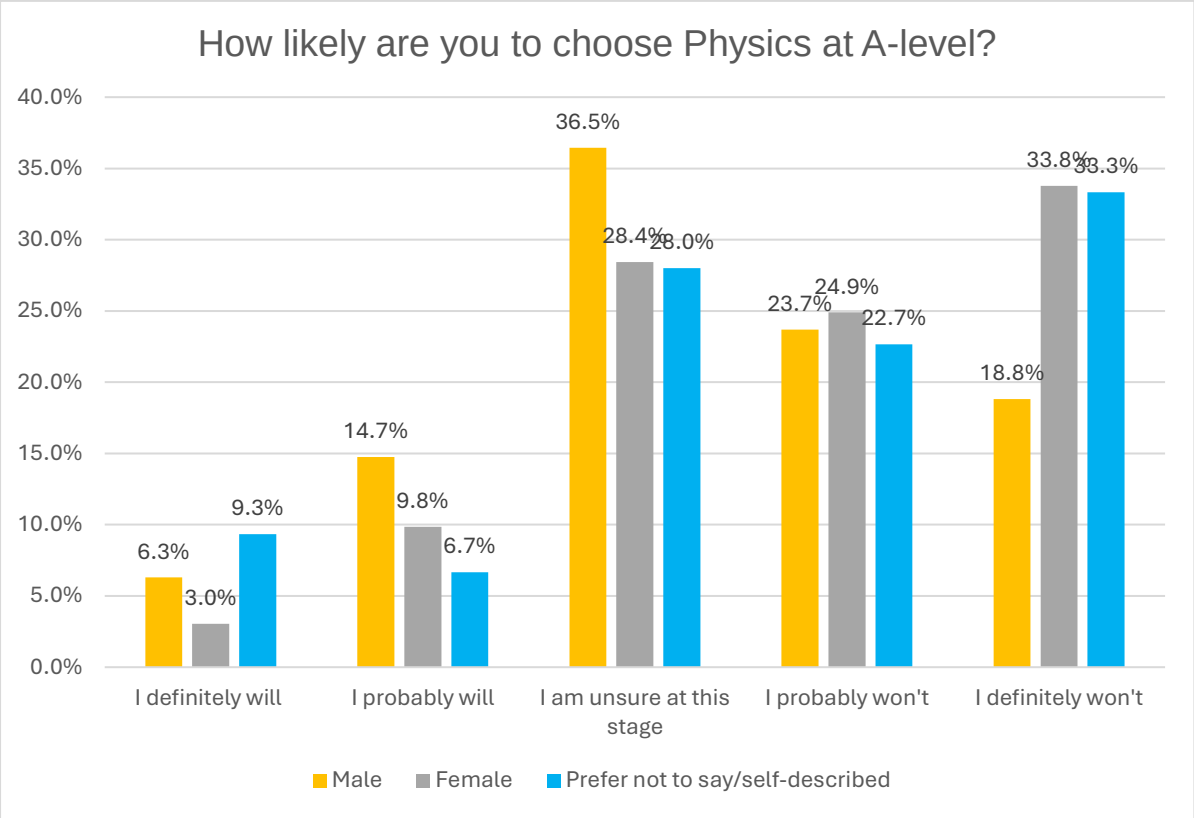


Figure 1. Pre-participation responses by gender to "How likely are you to choose Physics at A-level?"

The following Figure looks at this in more detail by considering the make up of each response.

We can see more clearly here how under-represented female learners are. Over time there have been some shifts in reported intentions amongst female learners.

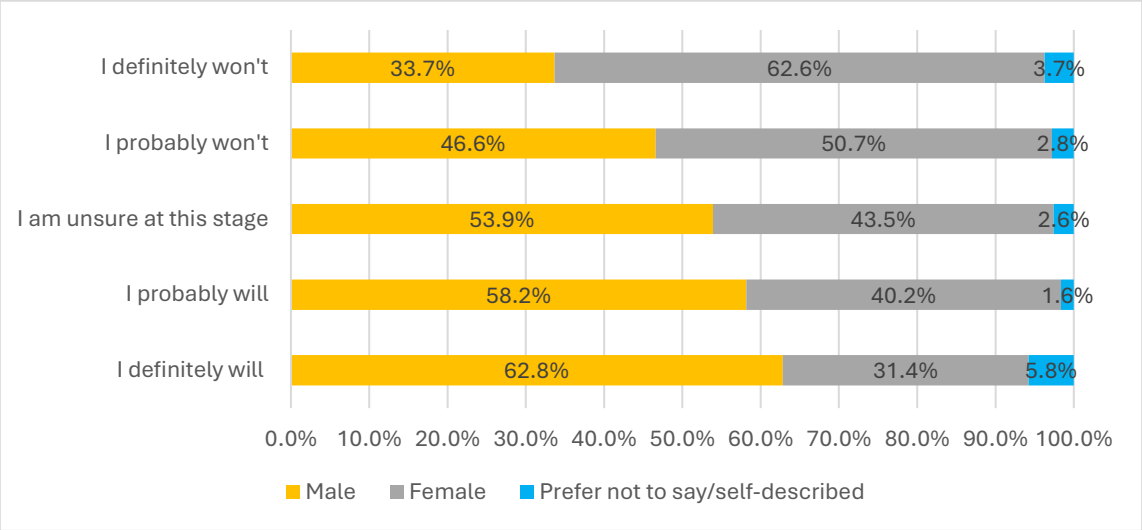


Figure 2. Pre-participation responses by gender to "How likely are you to choose Physics at A-level?"

- In cycles 7 & 8 we saw an increased proportion of females represented in the 'definitely' will' and 'probably will' categories compared with cycles 5 & 6. Whilst the results for cycles 9 & 10 remain above the cycle 5 & 6 levels by about 5% in each category there has been a fall compared to cycles 7 &8. See Table 7 below.
- The proportion of females in the 'definitely won't' category for cycles 9 & 10 has grown by around 5% and makes up over 60% of the responses in this group, almost twice as many as male respondents. This group has the largest gap between genders.

	I definitely will	I probably will
Cycles 5 & 6	34.9%	35.5%
Cycles 7 & 8	40.5%	45.5%
Cycles 9 & 10	31.4%	40.2%

Table 7. Comparing proportion of female learners across recent cycles and years of mentoring

We now consider the responses to the intentions of studying physics post-16 in terms of going to college, university or undertaking a physics-related apprenticeship.

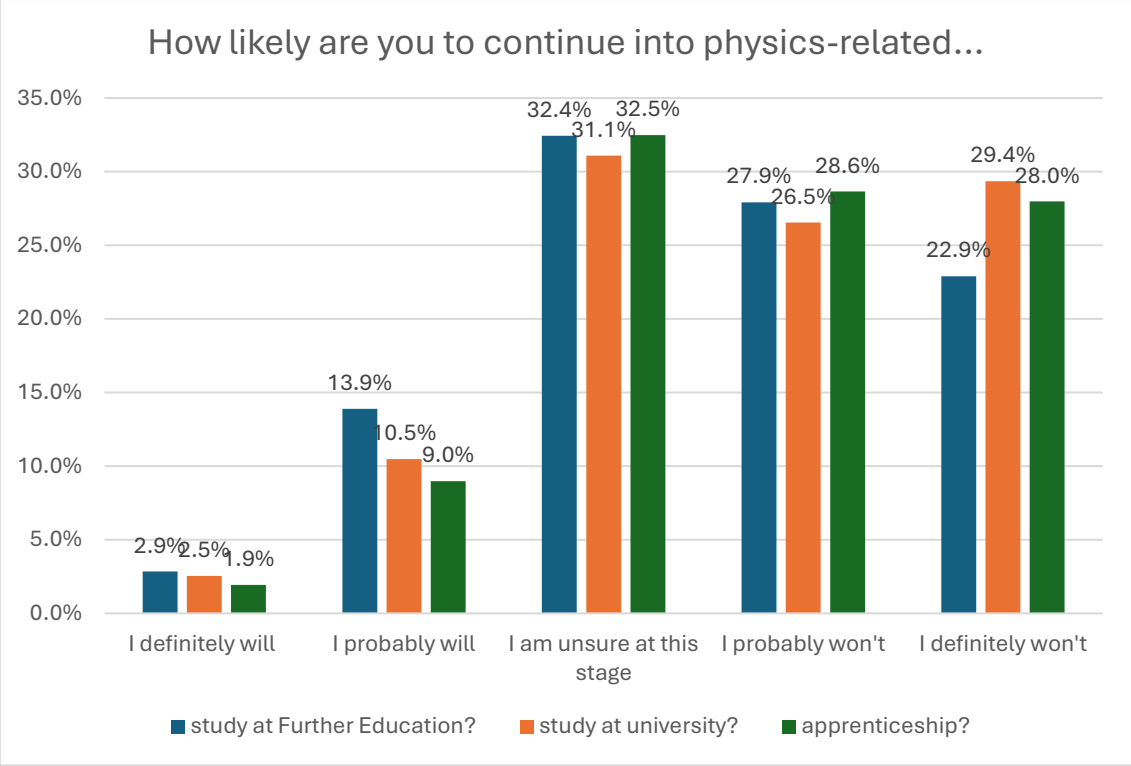


Figure 3. Responses to pre-participation survey "How likely are you to continue on to physics-related.."

- As in cycles 7 & 8 there is a significant proportion of respondents who are unsure about physics study post-16. As noted in the previous year's report, this means that there is the potential to raise awareness of these opportunities amongst Year 9, 10 and 11 learners, especially through the Exploring Connections activities, described further in Section 4.

Impact of participation on physics intentions

Moving on from the attitudes and intentions reported by all respondents to the pre-participation survey we now turn to the pre- and post-participation responses for two groups: mentees and non-mentees. The non-mentees form a natural control group as they are learners of a similar age group and in the same schools as the mentees but who were not chosen to participate. Mentees and non-mentee responses have only been included in the analysis if there is both a pre- and post-participation survey response. For this year's report we have 110 matched mentee responses and 182 matched non-mentee responses. When considering the mentee responses to the question "How likely are you to choose Physics at A-level?" pre- and post-participation we find that the results are statistically significant, with a p-value of 0.007. As Table 8 and Figure 4 shows us below, **amongst mentees there has been a 6.4% increase in those indicating 'definitely will' take Physics at A-level and an increase of 10% for those who have said they 'probably will'**.

	I definitely will	I probably will	Unsure at this stage	I probably won't	I definitely won't
Pre-participation	6.4%	19.1%	53.6%	15.5%	5.5%
	(n=7)	(n=21)	(n=59)	(n=17)	(n=6)
Post-participation	12.7%	29.1%	39.1%	15.5%	3.6%
	(n=14)	(n=32)	(n=43)	(n=17)	(n=4)
Difference	+6.4%	+10.0%	-14.5%	0.0%	-1.8%

Table 8. Pre- and post-participation survey responses from mentees to 'How likely are you to choose Physics at A-level?"

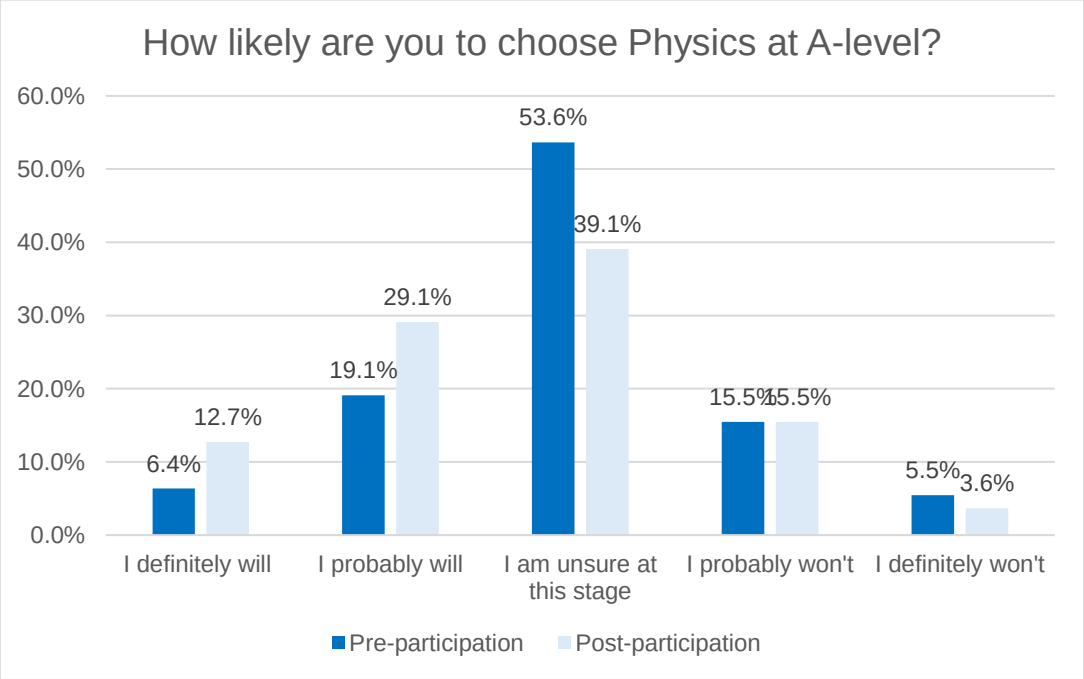


Figure 4. Pre- and post-participation responses from mentees to the question "How likely are you to choose Physics at A-level?"

This contrasts with the position of the control group of non-mentees who have recorded a decreased interest in Physics A-level, summarised in Table 9 and Figure 5 below where these results are shown alongside those of the mentees.

	I definitely will	I probably will	Unsure at this stage	I probably won't	I definitely won't
Pre-participation	7.1%	16.5%	28.6%	22.5%	25.3%
	(n=13)	(n=30)	(n=52)	(n=41)	(n=46)
Post-participation	4.4%	10.4%	33.5%	21.4%	30.2%
	(n=8)	(n=19)	(n=61)	(n=39)	(n=55)
Difference	-2.7%	-6.0%	4.9%	-1.1%	4.9%

Table 9. Pre- and post-participation survey responses from non-mentees to 'How likely are you to choose Physics at A-level?"

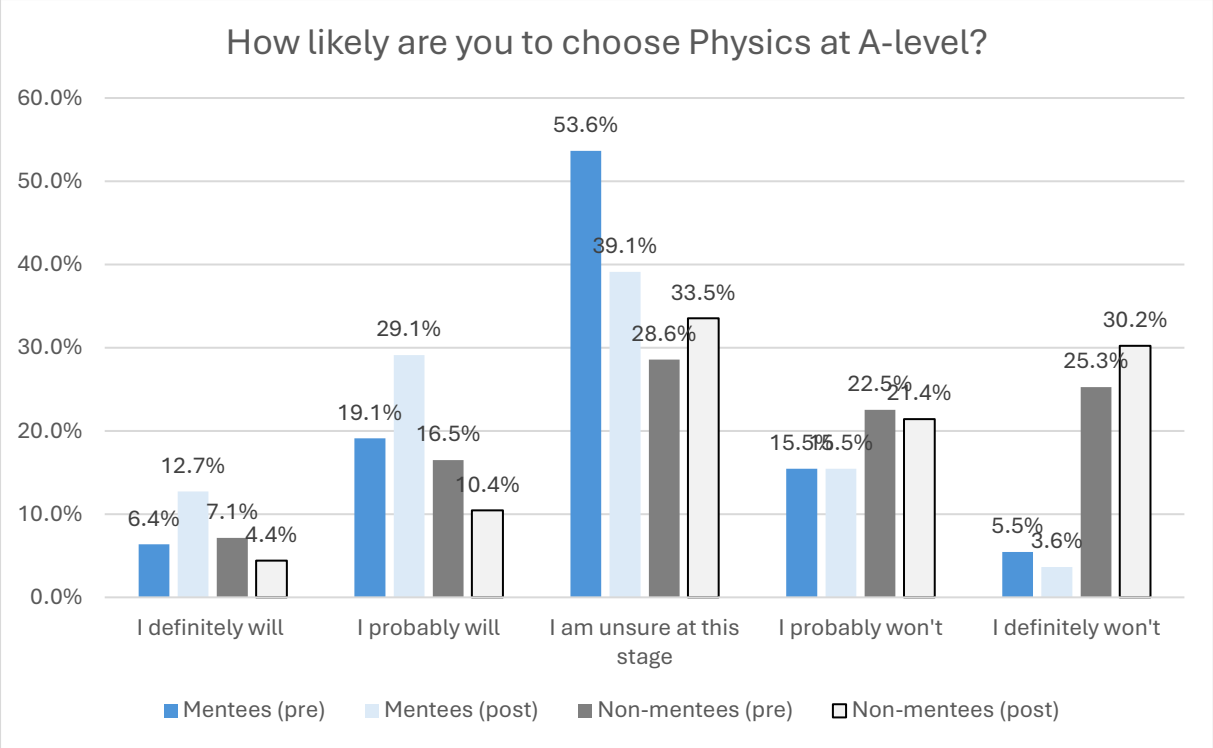


Figure 5. Comparing results from mentees and non-mentored learners

Once again we have consistency in results over the multiple years of the project where we see an increased interest in Physics A-level amongst mentees and a decline in interest amongst the natural control group who didn't take part.

Figure 6 shows the movement between the two surveys for the mentees in order to track where they started out. Each band of 100% is the post-participation position of the mentees and then the colour coded categories within the band show the pre-participation response of the mentees and therefore where they shifted from.

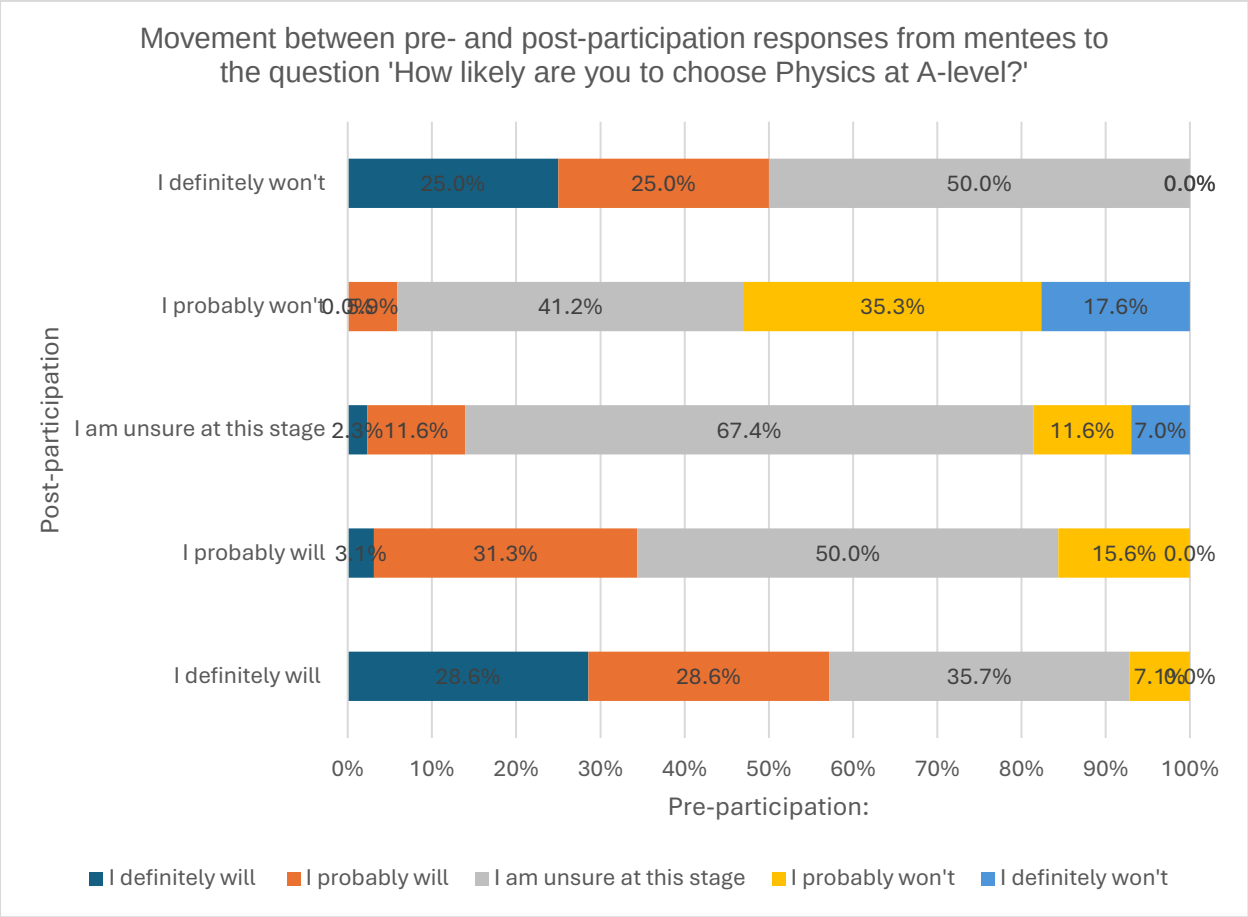


Figure 6. Movement between pre- and post-participation responses from mentees

We now discuss the chart, working from the bottom towards the top:

- "I definitely will": within this category, over one quarter have stayed in place, with a similar proportion moving up from probably will. The largest group have moved from being unsure (35.7%).
- "I probably will": As the previous category, the largest group represented here are those who were unsure in the pre-participation survey (50%). Around one third provided the same response with a small amount of movement from the group above and from 'probably won't".
- "I am unsure at this stage": there still remains a lot of uncertainty with over two thirds of this group staying where they were when compared to their pre-participation response. There are almost equal levels of small movement down from definitely and probably will/won't.

- “I probably won’t”: There has been a small shift from ‘definitely won’t’ into this group (17.6%) but again, the largest group represented are those who were originally ‘unsure’ (41.2%).
- “I definitely won’t”: due to the nature of selection for this project, only 4 respondents are in this group and they started out spread across the definitely/probably will groups (25% each) and unsure (50%).

It’s unsurprising to find that those who were unsure are significantly represented in each category post-participation. One of the positive outcomes for the project is helping learners to better understand what physics involves and whether it is something that they want to pursue further.

In terms of gender differences, there are larger increases for male mentees between the pre- and post-participation surveys. Whilst there was an increase of 9.3% amongst female learners indicating ‘definitely will’/’probably will’ choose Physics at A-level there was an increase of 25% for male learners. It is unclear as to why this is the case. Looking at the two groups there seems to be a significant proportion of the female mentees who remain unsure (47.7%) compared to the male mentees (27.3%). Given one the aims of the project is to particularly support female mentees in opting for physics there may be the potential for a further targeted activity or approach which could be used to engage with female learners to help reduce the continued uncertainty. Depending on the time of the year when the post-participation survey is received, those indicating they are unsure could be invited to a further session or activity.

Despite these gender-related differences, this was another successful year for the project in terms of shifting attitudes in relation to physics at post-16 study. The following discussion looks at the experiences of schools more closely and the other benefits of participation.

3.2. Increased sense of belonging in relation to physics and science

Careers

In this section we look at impressions and attitudes related to a sense of belonging in physics (and science) and intentions around science careers. The section concludes with a case study focussing on the experiences on one school which has been involved in multiple years, including a comment on longer-term benefits of participation.

In terms of career intentions, around one third of respondents to the pre-participation survey indicated they were considering a career involving science.

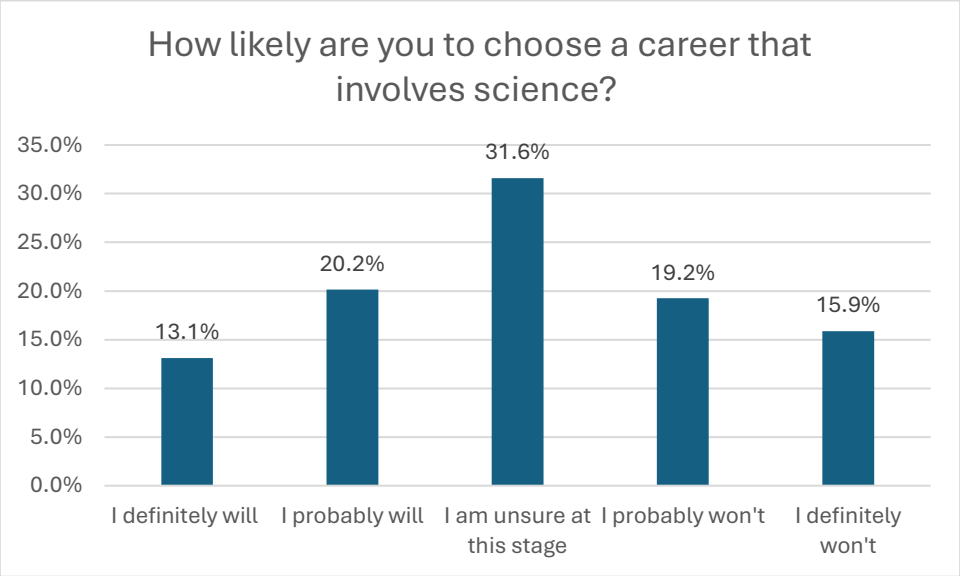


Figure 7. Pre-participation survey responses to the question "How likely are you to choose a career that involves science? "

	I definitely will	I probably will	Unsure at this stage	I probably won't	I definitely won't
Pre-participation	24.5%	36.4%	28.2%	10%	0.9%
	(n=27)	(n=40)	(n=31)	(n=11)	(n=1)
Post-participation	30%	30%	25.5%	12.7%	1.8%
	(n=33)	(n=33)	(n=28)	(n=14)	(n=2)
Difference	+5.5%	-6.4%	-2.7%	+2.7%	+0.9%

Table 10. Mentee pre- and post-participation survey responses to the question "How likely are you to choose a career that involves science?"

We can see from Table 10 that the mentees already had a strong interest in a science career and following participation this has solidified. The mentors incorporated significant amounts of information about routes into physics careers and in the sessions they tended to begin by talking about their own backgrounds, school qualifications and current study. Whilst this doesn't necessarily mean that all of the mentees were able to declare themselves ready for a

physics career, they were certainly more informed about the opportunities available to them and several commented about how the sessions were helping them to consider taking Physics at A-level.

> "*I understand that my knowledge of physics can help me nearly anywhere in the world of work*" (Mentee reflection).

Improving physics knowledge

Throughout the mentee reflections, there were significant numbers of comments about how much the sessions were enjoyable and that they had improved their physics knowledge and skills. The mentors discussed a broad range of different physics topics with the groups, responding to their interests but also introducing them to new areas such as string theory.

- *"I learnt that, I shouldn't shy away from physics content, they're naturally curious and were quite familiar with the stuff I was speaking about. They liked the big questions."* (Mentor reflection).
- *"[I] Enjoyed the questions we could ask and how deep we dived into physics"* (Mentee reflection).
- *"I've found this experience really enjoyable, it's been fun to learn more about physics and learn better skills that we can use forever.* (Mentee reflection)
- *"I enjoyed how they [the mentors] made physics really fun to study and explained really really well"* (Mentee reflection).

Based on their self-reflection feedback, it was clear that mentors were confident in their own knowledge of physics as they allowed the conversations and discussions to move around and change direction in response to the topics and questions of interest from mentees.

Sessions and activities

The mentees particularly enjoyed the opportunity in the final session to look back over what they had done previously and to identify what they have learned about physics and how they feel about the subject.

> *"During this time, I have learned that physics is everywhere. From marshmallow towers to chefs in restaurants which was really interesting. I boosted my confidence in teamwork skills and communication skills during these sessions which will help me now in the future."* (Mentee reflection).

Several of the mentors observed that the feel of the final reflective session was more informal, which they considered to be positive. As a result of this the mentors felt that the mentees were comfortable talking to them about their feelings towards physics as they considered what they might do in the future.

Some mentors had a very structured review session at the end and these too were effective. For example, one mentor pair put together a quiz with questions related to the topics in the

preceding weeks and a task that built on previous activities. Through this mentors were able to see that mentees had retained their knowledge of the physics discussed and had developed their skills, which was demonstrated in the successful completion of the task. Compared with the start of the programme, mentors saw clear development of knowledge and skills accompanied by an increased interest in science-related careers. The success of this was underpinned by the mentors having a good rapport with the mentees in their group.

The following description from a mentor outlines an example of what a session involves and how careers content was included:

> *"In this session we did Where Physics Can Take Me and I led this session. […] The first discussion was on what careers they think would need a physics A Level or where it would be beneficial - this seemed to go really well, there were a lot of interesting discussions about the skills used at A Level and some of the answers were different to what we were expecting, we didn't just get the typical teaching, research, engineering answers which was great. We then moved on to the main activity which was watching the video of people in different careers that took A Level physics - this was great and the mentees really seemed to enjoy this activity. We had a brief discussion after each person's clip had shown to see what their guesses were and their answers again were pleasantly surprising and they seemed to be very attentive towards the smaller details mentioned in the video, and very talkative during the discussions. We finished the session by discussing what surprised them about the different career opportunities that you can go into by taking A Level physics."* (Mentor reflection)

Building confidence

There were several different instances where mentees talked about feeling more confident and comfortable in relation to physics and teachers also made this observation. By having this extra time outside of regular lessons to spend going more in-depth into physics mentees deepened their understanding of physics topics but were also able to develop their problem solving skills through the different activities they worked with.

> *"I have learnt how different physics terms can be applied in questions."* (Mentee reflection).
>
> *"All of our pupils that have taken part have increased in confidence and have enjoyed the process greatly."* (Teacher post-participation survey).

Two thirds of the teachers responding to the post-participation survey (n=9) commented that they felt the mentees had grown in confidence, with the remaining third (n=3) noting an increased interest in physics as a topic and a potential study route. There was also an element of ongoing impact within lessons, as noted by this teacher:

> *"Improved confidence. Better relationship with me as a teacher- willing to put hands up in class more and contribute more fully in lessons."* (Teacher post-participation survey).

Other skills regularly mentioned included teamworking and collaboration, communication and critical thinking. Mentees were also encouraged to recognise how transferable these skills were to a range of different career options.

Belonging

Another element which could contribute to helping mentees feel more comfortable in relation to physics was the opportunity to get to know some of their peers better, especially in relation to their hobbies and interests. Mentees regularly commented on how much they enjoyed learning about their peers. This has the potential to contribute longer term to the mentees' feeling of belonging in physics, especially where they have ongoing classes with mentees they have come to know better through this experience. They have not only had a shared experience but have been able to explore a shared interest. In the final session where mentees were encouraged to talk about their impressions of all of the sessions, mentees also commented on how much they enjoyed talking about their opinions in relation to physics and what they and their peers thought of the sessions. Again, this will help to build stronger social connections between mentees and help them to feel more comfortable discussing physics in wider contexts and not just in relation to answering questions or undertaking practical activities.

Engaging mentees

In terms of the interactive elements, using menti.com and Kahoot were popular with the mentees. This aspect was something which was apparent in the online session observed by the external evaluator. Having an interactive element helps to maintain engagement with the mentees. Working in pairs, mentors can have some conversation back and forth between them if the mentees are reluctant to engage but having scaffolded activities and prompts pushes mentees to be involved in some form of interaction. Using menti.com or Kahoot helps to provide some form of anonymity for mentees if they are still building confidence.

As has been discussed in previous reporting, the mentor and mentee relationship is crucial to the success of the project and it is clear from the mentee feedback that the mentors were being very successful in establishing a positive foundation from session one. The comments made by mentees in relation to the mentors were positive and mentors recognised where they had built a positive relationship with mentees and how that underpinned their success.

> *"I relaxed and built rapport with them by chatting with them between exercises and found we have quite a few shared interests!"* (Mentor reflection)

Teachers also noted the success mentors had with the groups when asked about their impressions of them:

> *"Really professional, great at working with the students, taking on a teacher-like role when needed but then speak at the level of the students whilst working so that it felt like mentoring rather than a physics lesson"* (Teacher, post-participation survey).

Unfortunately there was one instance where a school had issues with scheduling and communication with their assigned mentors. This affected the experience of the mentees in that the teacher wasn't sure that there had been any impact. The teacher noted that the support from the project team was excellent but that it does highlight the importance of the role of the mentors and that despite all efforts being made, some aspects will be outside the control of the project team.

There was lots of evidence within the self-reflection returns of mentors responding to the feedback and differing levels of engagement with mentees. For example, when a mentor recognised the group were more engaged in a hands-on activity they adjusted the following session to ensure that there was a suitable activity for them to do. There were also other instances where there were situations occurring which were outside the control of the mentors, for example enrichment days for other subjects or mock exams. The mentors were able to recognise the external pressures on mentees and adapt accordingly. Lastly, mentors understood that mentees are individuals and they needed to spend time getting to know them and that some would need more encouragement and support in order to engage with the activities in the sessions. Linked to this, teachers also noted that mentors were able to ensure all mentees were included.

> *"[I enjoyed] Seeing the students engage well in sessions and the mentors being proactive enough to ensure that everyone in the group felt valued and that they could contribute in some way".* (Teacher, post-participation survey).

For the mentors who felt their sessions could have been more effective, they noted that they wanted to tailor the content more closely to the mentees' interests. There were some common barriers reported which limited the effectiveness of some sessions and for those online, there were often technical issues meaning that the sessions weren't necessarily the planned length. For mentees who took part in both online and in-person sessions as part of the blended model, some felt that mentees were more engaged with the in-person activities and this was also the observation of some teachers. For those in-person in school, there were often other activities and events which meant not all mentees were available to attend.

Making connections

Mentors were able to use a variety of ways of engaging mentees in order to see connections to physics in the world around them. For example, in one of the final sessions mentors focused on hobbies:

> *"We also tried to ask the mentees what they did as a hobby and if they could link that to science or perhaps even physics. Many were surprised to find out how much physics is involved in their daily life - such as sports, singing, dancing, rock climbing etc"* (Mentor reflection).

All of these different aspects can help contribute to increased confidence of the mentees and some found this important and helpful even beyond the sessions, increasing their feelings of familiarity with physics as well.

- *"It's made me a lot more confident that was really helpful going into the exam."* (Mentee focus group).
- *"Yeah, physics felt less alienated as a subject [and] becomes much more familiar."* (Mentee focus group).

For teachers, the main benefit of participating in the project has been building links with universities and improving their own understanding of the career opportunities related to physics. One school noted that following the success of the Physics Mentoring Project their colleagues in other subject areas were looking for similar programmes.

As part of their feedback on participating, at the end of the delivery period mentors were asked about their favourite parts of the experience. Overall, mentors enjoyed being able to make a difference as a result of working with the mentees. The measure of success varied between mentors but generally was linked to a change in attitude towards physics, whether that resulted in a decision to pursue physics further or that mentees were more able to make connections between physics and their own lives. Mentors also got a lot of enjoyment out of building relationships with their mentees and their host school as well as working alongside their co-mentor. They also talked about their enjoyment in relation to physics, where they were able to share their passion for the subject by introducing mentees to knew topics or helping them to better understand areas they were already familiar with. In terms of challenges, some mentors had difficulties working with their co-mentor and there were common issues in relation to scheduling and travel. These aspects are outside of the control of the project team and mentors were very positive about the support they received when they asked for guidance.

The following case study looks at the experiences of one school in more depth.

School case study

This school has been involved with the project for over two years. We spoke to the teacher about their impressions and experiences of the mentoring for cycles 9 & 10. They had a group of mentees participating in each cycle, with some sessions in-person and others online in a blended approach. Within this school science classes are arranged as mixed ability and learners were selected from across all of the classes. The teacher felt the first group went into the experience feeling much more positive than the second one as they started off a lot more reluctant to take part whereas the first group were all quite motivated when it came to science.

Once both groups of mentees engaged with the sessions, the teacher felt they all enjoyed them. When working with the mentors, the learners *"got on really well with all the mentors […] [and the] mentors did a really good job getting them involved".* The first session was used by the mentors, and the teacher, to get to know the mentees better in terms of their interests and hobbies and the teacher felt this worked really well to establish a good foundation for the rest of the sessions.

When asked about longer term impacts from participation in the project, including their thoughts about impacts on learners from previous years, the teacher noted that learners are *"definitely a lot more confident, especially at doing more practical activities".* The teacher has some of the previous year's mentees for GCSE and noticed that they are very confident around practical activities, are able to follow methods and *"almost teach others how to do it as well"*. This has made a difference to the teacher as this year they felt it was more straightforward to get through the practical activities whereas previously they had to provide learners with much more support.

The teacher also noted that learners showed more inquisitiveness and were more able to identify links between what was in front of them in the classroom and what they had done previously. They were also able to see the relevance of their physics studies to other areas such as engineering.

In terms of wider impacts, the teacher felt their participation in the project had been good for the department. The school has had the chance to have additional science content delivered in a targeted way to their learners and they've had the additional opportunities such as the Exploring Connections events which supplement the careers support and guidance available. The event also provided the chance to bring a mixed group, whereas often trips can be used as a reward for the most able, this event has given everyone in the group the same opportunity to enjoy science and it also extends the impact to others in the year who weren't selected for the mentoring project.

Having participated for more than two years as the lead teacher, they feel confident when talking to younger learners about their potential future involvement in the project, as learners have heard about the mentoring project from their peers and want to know more. It has also worked as a conversation starter with others who come and ask them about what the project involves and it gives the teacher a chance to get to know the young person a bit more in terms of their interests.

3.3. Attitudes towards teaching

One of the core aims of the Physics Mentoring Project is to encourage mentors to consider a teaching career. In this section we look at the evidence around attitudes towards teaching. This evidence comes from a short survey distributed to physics students in Wales who are not participating in the project and also responses from mentors. In addition to the survey responses there were also end of project surveys for mentors and we reviewed their post-session reflections for references to career aspirations and teaching.

The level of responses to the surveys from the mentors is unfortunately not sufficient to make an assessment about whether the mentor attitudes have shifted over the course of this year's project. However, there are some key themes arising from the surveys when mentors and physics undergraduates were asked about what would encourage them to consider a career in teaching and what the barriers are.

The common themes arising in relation to barriers preventing them or putting them off a career in teaching included:

- Pay and conditions. Respondents were concerned that pay was low compared to other graduate roles and that there was a high workload, resulting in a poor work-life balance. Some of the physics undergraduates in particular expressed how they knew they had a broad range of options and potentially high paying careers open to them.
- Limited opportunities for career development. Several people were concerned about the lack of training and support available to teachers.
- Lack of engagement from pupils and poor behaviour. Some respondents were uneasy about dealing with young people and their poor behaviour. There was reference to some of the recent news coverage relating to poor pupil behaviour.
- Curriculum reform and subject specialism. There was some concern about the limitations on what you can teach in terms of physics topics and the freedom available to teachers. Others expressed worry about teaching biology and chemistry as part of the science requirement. There was one mention of curriculum reform and the potential negative impacts it could have.
- Negative perception of profession. Several people commented about how their own experiences at school had negatively impacted them in terms of considering teaching as a career. This also extended to some people who had family members who worked as teachers. One person commented that the lack of funding for the sector was a factor.

Looking across the responses from mentors and undergraduates, there was only one who expressed the barrier as being something personal to them (lack of confidence) rather than a perception of the profession.

Some of the themes which came up during the review of the responses to the question "What might attract you to a career in teaching?" are common to those found in the barriers but the respondents have the opposite perception of them.

- Pay and conditions. Several people felt that teaching had an "*attractive salary*" and that the length of the school holidays was a positive. There was also a perception that physics teachers were in demand and that they would have some career stability.
- Career development. For one respondent they recognised the opportunities available to them and that teaching would offer them *"Continuous learning and growth by the dynamic nature of teaching ensures ongoing personal and professional development".*
- Making a positive impact and subject specialism. Several expressed a view that being able to make a difference to young people would be fulfilling. The majority of responses across all of the themes linked to the respondents being able to share their passion and enthusiasm for physics and showing that *"physics is not such a daunting subject"*.

However, there were a small number that expressed there would be no approach or scenario that would encourage them to consider teaching.

As part of their end of project feedback mentors were asked about the careers they were interested in and over 20% (n=9) indicated they had an interest in teaching. This included primary, secondary and tertiary level teaching. The most popular other careers of interest to mentors included research (25%, n=11), engineering (19%, n=8) and software engineering (12%, n=5).

For mentors, there have been instances where they have indicated the impact the experience has had on them in terms of understanding of the teaching profession:

> *"This has been very enjoyable and beneficial for me. It's taken me out of my comfort zone, and given me an added appreciation for the teaching profession. The mentees were great, and it helped my own understanding of basic physics, and it was great hearing new ideas from them."*
>
> (Mentor end of session feedback)

The Physics Mentoring Project provides mentors with the chance to develop a range of employability skills, which can apply to a range of different future roles. Through the experience mentors have the chance to gain a better understanding of what teaching involves and to develop their skills working with young people.

4. Exploring Connections: Career-focussed events

In June 2024, the Physics Mentoring Project held an event for schools at Coleg y Cymoedd in Nantgarw. Three schools attended, two of which had participated in the mentoring project in 2023/2024 and one school which had not. The groups of learners attending from the schools who participated were a mixture of mentees and non-mentees. The event was an opportunity for teachers and learners to find out more about physics-related opportunities available to them locally. A number of employers ran workshops during the event, which learners moved around in a carousel style across the day. The employers participating were Axiom, Balfour Beatty, Bute Energy, GE and Space Forge. Companies were keen to highlight the different routes into careers and apprentices also took part in the sessions with learners.

Each session typically involved some kind of physics-related hands-on activity. For example, Space Forge, an advanced materials company based in Cardiff, opened with a description of their satellite technology and goals for operation before setting the learners a rocket launch challenge. The Bute Energy session focussed on electricity supply and used a range of demonstrations to remind leaners of the relevant parts of the curriculum they would have already covered before going on to set them a task closely linked to the type of work undertaken by the company in relation to location of wind farms. Across all of the sessions, learners got to meet a range of people in a variety of roles. It was often the case that staff from the different companies were keen to highlight their route into their career, which was not necessarily what the learners would have expected.

One teacher commented that *“All sessions included activities which were simple but helped make the science in the workplace come alive”* (Teacher post-event survey). Alongside these sessions, learners were also taken on tours of the Coleg y Cymoedd campus and this experience was commented on by another teacher*: “The learners enjoyed the whole day and all the activities. They particularly enjoyed the hands on activities. Several learners have mentioned how much they enjoyed the visit to the engineering workshop.”* The tour was so popular with students that an additional opportunity was added on the day.

Based on the responses to the Physics Mentoring Project's pre-participation survey in 2023/2024 there is a strong expectation that the career route to be followed is that of A-levels and university. Those who answered that they had a career in mind were asked to indicate what route they planned to take. The most popular option was A-levels or College followed by university. Only a small proportion indicated going into an apprenticeship (3.6%, n=42 of respondents to pre-participation survey) or directly into a job (1.5%, n=18).

Response	n	%
Yes	1183	46.7%
No	545	21.5%
I don't know	803	31.7%
	2531	

Table 11. Pre-participation survey responses to the question "Do you have a career in mind?"

There is still a significant amount of uncertainty amongst respondents about what career they intend to go into with over 50% indicating no or they were unsure.

For those who participated in the Growing Connections strand of the project as mentees, they were asked about the specific sector they were interested in going into. The following Table outlines the areas of interest for the mentees and this has been split out in terms of gender and we can see very clear differences between interests.

Sector	Female mentees	Male mentees
Accountancy and financial services	0.0%	4.2%
Armed Forces and Security	2.9%	12.5%
Construction	2.9%	0.0%
Creative Arts and Culture	8.8%	0.0%
Digital sector	2.9%	16.7%
Engineering	2.9%	8.3%
Health	41.2%	12.5%
Hospitality, leisure and tourism	2.9%	4.2%
Legal sector	0.0%	8.3%
Public Services	2.9%	4.2%
Science and research	17.6%	8.3%
Teaching and education	8.8%	8.3%
Transport and logistics	2.9%	12.5%
Vet	2.9%	0.0%

Table 12. Career interests of mentees by gender[5]

The most significant difference can be seen for the health sector where over 40% female mentees have an interest in a career in this field compared to 12.5% of male mentees. For

[5] Sectors coded according to those described by Careers Wales: https://careerswales.gov.wales/job-information/industry

male mentees, their interests were more broadly spread across the sectors whereas the female mentees' interests were more concentrated.

Returning to the Exploring Connections event attendees, they were asked about their own impressions of the relevance of physics to their everyday lives and whether they will use physics in their future careers. Learners were asked about whether they thought they would use physics in their future careers and those who responded positively to the survey commented that they were considering careers in engineering (electrical, formula one) and medicine. For some others they weren't sure about which exact career but that they felt *"physics is crucial and is practically required for a lot of things"* (Learner post-event survey).

At the beginning of the event and then again at the end, attendees were asked to indicate whether they thought physics was useful in everyday life by responding to a 1 to 10 scale where 1 was not at all useful and 10 was extremely useful. At the beginning of the day, the average of the responses (n=19) was 6.6 and at the end of the day this had increased to 7.3 (n=18). When asked whether they had changed their minds about their answer, there were several who indicated that they had:

- *"It has changed due to the certain things I have learnt today and I've enjoyed myself thoroughly thank u".*
- *"It's more useful as it can protect others in jobs such as aviation."*
- *"I have become more aware of how and why it is utilised in everyday life".*
- *"After viewing the multiple activities, I have been shown that physics is much more useful in practically everything".*

The range of sessions and the interactions with the employers has helped to shift their perspective of physics. The majority of respondents thought the employer activities were "Excellent" (n=10, 56%).

- *"They really sparked my interest [in physics]".*
- *"I felt that the employer activities were interesting and gave good context on the field of physics as a whole. I also feel like overall the event was very well planned and executed."*

This position was consolidated through feedback received from teachers: *"The learners looked at science in a wider view. Speaking to more people who have developed these skills and applied them in their life has been useful ."* (Teacher post-event survey).

During the day focus groups ran with mentees and non-mentees in order to get feedback about the event. The non-mentees enjoyed the sessions with employers just as much as those

who had been part of the mentoring programme. The non-mentees particularly highlighted their enjoyment of the different challenges across the sessions and the opportunities to be creative. Those participating in the group discussion already had clear ideas about what careers they wanted to go into and didn't feel that the sessions themselves were swaying them towards a physics-related option, although the did say they felt more positive about their perceptions of physics and acknowledged that they felt there was quite a negative attitude towards physics amongst their peers in general as it was felt to be difficult.

Following the event, learners were in a position *to "make a more informed decision about learning pathways, perhaps encouraging them to study physics at a higher level"* (Teacher post-event survey) and the mentees commented in their focus group about how helpful it was to be able to meet people who had gone through alternative routes. In terms of attendance at other careers-focussed events, apart from this one, the mentees had only attended one other engineering event in Cardiff.

The contribution to the day from the mentors was also acknowledged by the learners, with one person commenting in the feedback that "*The mentors were highly knowledgeable and passionate in what they do also made everyone feel really comfortable".* Teachers were very positive about the experience and would be keen to attend another event like it in the future: *"the kids loved it and have been talking about it for days"* (Teacher post-event survey).

The event has been an excellent opportunity to raise awareness of the alternative routes into physics-related careers with the hands-on activities and interactions with local employers being received very positively by teachers and learners.

5. Conclusion

The Physics Mentoring Project continues to be successful in engaging schools in order to develop a positive culture of physics and encourage learners to consider physics post-16. The project's aims for cycles 9 and 10 in 2023/2024 are as follows:

- Increase the number of year 9 – 11 students intending to study physics-related subjects post-16, especially female learners.
- Increased numbers of year 9 – 11 students intending to pursue STEM careers.
- Increased confidence/sense of belonging/engagement related to STEM in mentored students.
- Development of employability skills in student mentors attributed to mentoring experience.
- Positive impact of mentoring experience on consideration of the teaching career among student mentors.

The project has been successful across these aims. Mentees have indicated an increased interest in physics post-16 with a 6.4% increase in those indicating 'definitely will' take Physics at A-level and an increase of 10% for those who have said they 'probably will'. There has also been an increased interest in science careers, with a 5.5% increasing indicating they 'definitely will'. This is an increase amongst a group who already had expressed a strong interest in science-related careers.

Alongside these increases there is also a clear impact on mentees' confidence and sense of belonging within physics. Teachers, mentees and mentors are all reporting increased confidence, with teachers noting the longer term impacts of this being observed in the classroom. Mentors have been considered by teachers to be highly professional and well trained. This experience has helped mentors to develop a range of employability skills and provided an opportunity to have a better understanding of what working with young people involves.

Based on the findings from cycles 9 and 10 there are a short set of recommendations.

- Consider how to reduce the proportion of female mentees in the 'unsure' category at the conclusion of the project. This could involve a further event or activity.
- Review modes of engagement for the online sessions to ensure there are always some form of interactivity via quizzes or similar hosted on platforms such as Kahoot or menti.com. This is to encourage ongoing engagement with mentees who may be reluctant to participate via the chat function only.
- Explore ways of working with schools in order to better understand the longer term impact of participating in the Physics Mentoring Project.

About the author

Ondata Research collaborates with clients to help them understand project impact, whilst also providing mentoring and support through the phases of project development and delivery.

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