London Schools Excellence Fund

The "Flipped Classroom" for GCSE Physics

Southwark Schools' Learning Partnership

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What is the flipped classroom?

The ‘flipped classroom’ is a teaching methodology in which homework tasks are frequently set where students learn new material, which is then followed up with practice in the next lesson.

It is to be contrasted with a ‘traditional classroom’ in which students learn new material in lessons, and then practise it for homework.

In reality all classes are unique, and probably defy such simplistic categorisation; many ‘traditional’ teachers probably set homeworks from time to time that that could be described as ‘flipped’. The difference in practice is that a ‘flipped’ classroom uses this type of homework frequently, and the method of delivering new material for homework is often via online video.

To give a concrete example, a ‘traditional lesson’ about scalars and vectors might involve the teacher doing some demonstrations, and the students making some notes and doing some example questions. They might then be set a homework to complete some more questions about scalars and vectors form their textbook. The teacher would mark the homework, then go over common problems in the following lesson.

A ‘flipped’ approach might be to set a homework in which students watch an online video and use their textbooks to make notes about scalars and vectors - they have not learned anything about the topic yet, and are learning new material for their homework. In the lesson the teacher may then set a quick task to check understanding, do some demonstrations, then set some questions to be done in class. The teacher checks students’ progress through the questions, and feedback is given where necessary.

At the end of the process, students from both classes will have made notes on scalars and vectors, seen some demonstrations, practised some questions, and received feedback on their work from their teacher. However, the two approaches are clearly very different. The purpose of this project was to evaluate the advantages and disadvantages of the ‘flipped’ approach, and provide resources to assist other teachers who might want to experiment with and develop the technique.

Why investigate the flipped classroom?

Many teachers are interested in the flipped classroom approach, but there is not a large body of research about its efficacy at the moment. Clearly there are a number of potential advantages and disadvantages.

At our first group meeting, we came up with a list of pros and cons from the perspective of students, teachers, parents, and the whole school. There were enough pros for us to decide that the technique was worth investigating further. Some thoughts included:

- developing students' independent learning skills
- may get better questions from students (having had longer to think before lesson)
- room to be more creative in lessons
- more time to interact with individuals
- much easier for students to catch up on missed work
- less marking for teachers

Project Evolution

The Physics wing of the project kicked off with a meeting at Southwark Cathedral on 14th February 2014, where ideas abounded. Three working groups were formed, all using on the idea of the "flipped classroom", focusing on a particular topic of the KS4 curriculum. Physics teachers attended from nine schools from the independent and state sector: Alleyn's, Bacon's College, The Charter School, Dulwich College, Hilly Fields College, JAGS, Kingsdale, St. Saviour's and St. Olave's and Thomas Tallis. As the academic year progressed, teachers met as smaller groups, to discuss projects and aimed to observe a teacher at a minimum of one other school. The whole subject team came together again 10th June 2014, 6th October 2014 and 23rd March 2015 at either JAGS or a convenient central London venue. A new academic year led to some inevitable attrition and consequent re-adjustment of groups. The final project team consisted of four schools: Alleyn's, The Charter School, Dulwich College and JAGS.

Project Methodology

Teachers at five Southwark schools tried using the ‘flipped classroom’ approach with classes in Years 10 and 11. Those schools were:

Alleyn’s School (co-ed independent school)

The Charter School (co-ed state school)

Dulwich College (independent boys’ school)

James Allen’s Girls’ School (independent girls’ school)

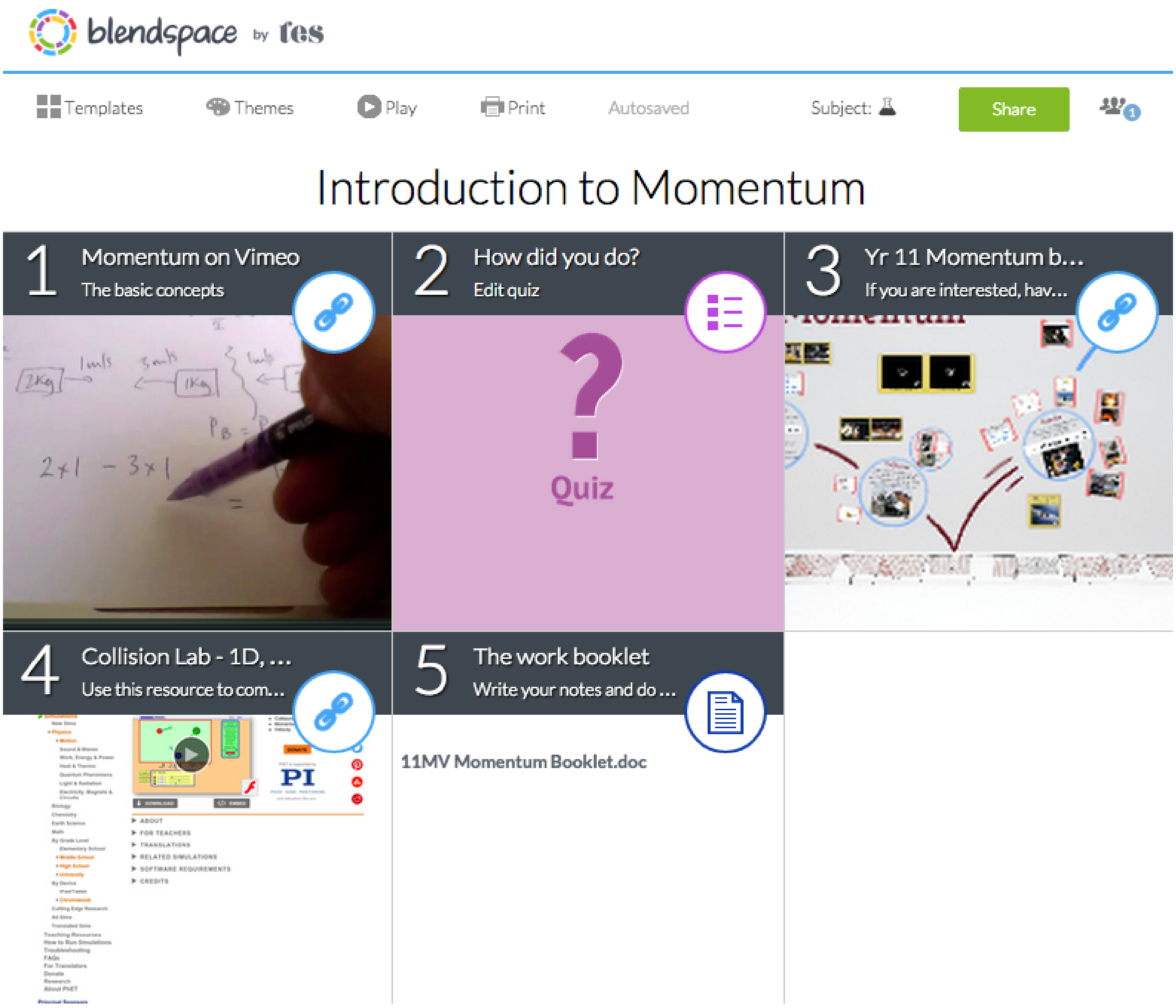
Thomas Tallis School (co-ed state school)

Before the project began, the students and teachers completed an attitudinal survey (see Appendix). At various stages throughout the project, teachers recorded students’ predicted GCSE Physics grades. At the end of the project, the students and teachers completed the same attitudinal survey. In summer 2015 the students’ actual GCSE results will be known. The analysis of the surveys and examination predictions and results are not yet available.

It should be reiterated that no two classrooms are the same - different teachers implemented the flipped classroom in different ways, and some used it for a greater proportion of homework tasks than others. However, in all cases the common theme was the use of online video to deliver new content to students which was then followed up on the next lesson.

Alexandra Galloni, Dulwich College

At Dulwich College I used a Year 10 class, containing boys with a range of abilities, approximately three of whom wanted to study Physics beyond GCSE. Starting after the Year 10 examinations in June 2014, I trialled the online tool “Blendspace” blendspace.com/lessons for the topic of Momentum. This tool enabled the swift construction of an online lesson, which could then be available to anyone online, although I could create classes which students could join.



The general idea was that the students had full access to all the resources used for a topic, with extension material available. Typical homework tasks entailed watching and taking notes from a simple video outlining the key concepts with some examples, and then taking a quiz of ten or so multiple choice (MC) questions (automatically marked online) based on the video. This would be followed up in class by issuing the same quiz, as a group task, where any misconceptions could be ironed out, initially by peers and, finally by the class teacher.

For this topic, teams used in class were selected in a way informed by the Team-Based Learning Collaborative goo.gl/x769nw. Having covered the theory at home, time was freed up in class to do extended practical investigations, such as using pasco tracks to investigate the conservation of momentum in collisions and explosions and broader consolidation activities such as translating the principle of conservation of momentum into the wide variety of mother tongues within the group. Most importantly, however, there was time for the boys to complete written problems that they would historically have completed for homework. This allowed me to differentiate by support, and mark work with instant feedback.

As the boys moved into Year 11, unreliable access to multiple-choice questions on Blendspace interrupted use of these for the topics of Electromagnetism, Waves and Moments. Pending a solution, students accessed directly the on-line video lessons produced in-house by Damian King at goo.gl/xuVzHw, in order to produce notes. These videos were set into the context of the wider topic using Prezi presentations, produced by staff at Dulwich College, available at: goo.gl/HHZfEM. The prezi presentations provided enrichment in the way of links to videos and simulations. The students were then tested using MC questions in class. Investigations are ongoing to find or create reliable on-line MC quizzes with the following functionality:

- A “scratch card” format (to encourage students to persist until they have the right answer)
- The ability to upload quizzes, including questions with images
- The ability for teachers to access and download results (including number of attempts per question)
- The ability for teachers to share quizzes with other teachers and classes.

Such a tool would be invaluable for teachers using the flipped classroom.

Ben Jones, Alleyn’s School

I have used flipped-learning on a few occasions, asking students to review particular topics at home - using a variety of types of video from Youtube. Most successful have been the rather formal videos of the style of ‘DrPhysicsA,’ videos especially developed for UK KS4 students, although well-chosen documentaries with carefully-worded support questions have given students a broader, more applied view of a subject. The use of computer models - such as those from the Phet website - have also been hugely effective allowing pupils to consider practicals that we would otherwise not have had time to offer during class-time.

The great advantage of such an approach has been that at worst, students arrive at lessons with at least an introduction to a subject enabling us to ‘hit the ground running’ and at best students being fully au fait with the topic in question, enabling us to rapidly move into more advanced areas and or approach practical work or written-problems with a greater understanding of the Physics.

Alleyn’s has recently implemented a FireFly-based VLE together with an online video distribution system, Planet e-stream (an inhouse Youtube equivalent). These together have meant that this year, for the first time, flipped learning has become an availability reality for us.

Peter Gravell, JAGS

I tried the flipped approach with two mixed ability Year 11 classes. Around half of the homework I set was flipped, and involved students making notes on new material using online videos, sometimes using their textbooks as well. The other half of homeworks set were ‘traditional’ practice questions, revision, etc.

I recorded the flipped homework tasks and video links on a simple website at phys.mrgravell.com that students could access from school and home. In addition to setting the flipped homeworks online I also recorded all classwork and normal homework tasks online too - this led to benefits that were additional to those that may have arisen from the flipped classroom approach alone.

Here is an example of was recorded for a week with a Year 11 class. The record shows both homework and classwork tasks (with links to any videos or worksheets given out):

Wednesday 24-09-2014

Circular Motion

Classwork

- We went through the homework on moments and stability.
- We started circular motion with a few examples, and thought about the velocity, acceleration and resultant force on an object moving in a cricle.

Homework

- Watch this video about circular motion and add to your notes from the lesson.
- In particular make notes on the factors that affect the centripetal force, and how they affect it.
- As he says, you don't need to know the formula $F=mv^2/r$ for GCSE, but it doesn't hurt for you to see it.

Thursday 25-09-2014

Investigating circular motion

Classwork

- We did some circular motion past paper questions.
- We did an experiment to investigate factors affecting the centripetal force on a rubber bung on a string.

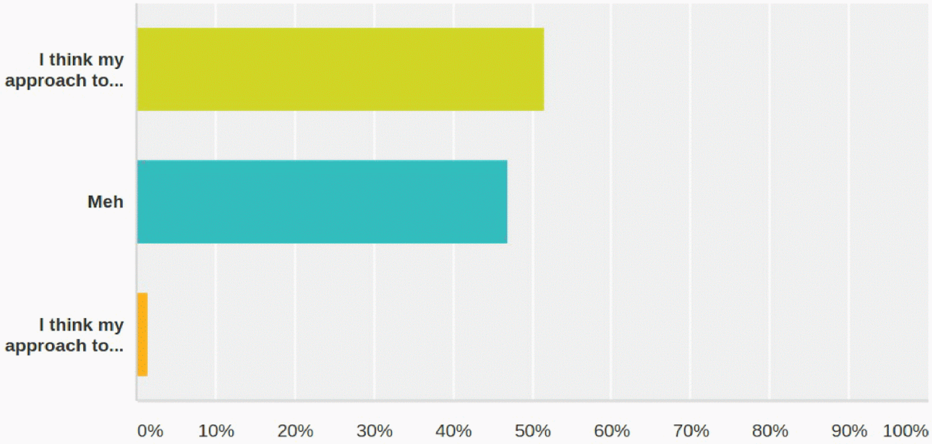
Homework

- Plot a graph of your results, hand in Monday before registration.

I found that the flipped approach gave me more time in lessons. As a result we did more practical work, and when the students were answering questions or doing a practical activity I gave them less support than I usually would, since they had longer to try to figure things out and fix problems for themselves.

In addition to the survey and exam data, I did a survey part way through the project with my Year 11 groups and two Year 10 groups with which I had then started using the approach. The full results can be read at phys.mrgravell.com - here is an extract showing how girls thought their approach to learning physics had changed as a result of my use of the flipped classroom method.

Answered: 66 Skipped: 0



Answer Choices	Responses	
I think my approach to learning Physics has improved since we started doing these types of homework	**51.52%**	34
Meh	**46.97%**	31
I think my approach to learning Physics has got worse since we started doing these types of homework	**1.52%**	1
Total		66

Comments (11)

Some stuff on the Internet isnt true
Yeh normally after u tell us to search a specific video, it leads me onto a trail of a couple others which relate to it, and our world is becoming more technological anyway - we all might as well keep up with the youngsters!
Yes, because outside of lessons I enjoy expanding my physics knowledge by researching online and doing external reading
More engaging to learn from a living person rather than the voiceover of a video - videos better for extra research out of enthusiasm
I agree but i think it should not be totally independent learning- there should be a balance.
I completely agree.
A very good idea!
Independent learning can be challenging especially regarding concentration. I prefer class lessons and discussions.
this sounds like a good idea but I don't understand how it works.
However, I would like to do a brief summary of the notes we did for homework in class. This way I can make sure I have not misunderstood anything.
This idea is especially conveyed through watching videos for homework. I feel like I learn more from them and they really show the possibilities in the world of physics.

Brian Reid, The Charter School

I used the flipped classroom method with one KS4 and one KS5 class. Although it was outside the scope of this project, I found that it worked particularly well with the smaller (Year 12) class given the smaller number of students and consequently the greater support I could give to individual students in explaining exactly what was expected of them. For both classes it was particularly successful when the class was set homework to research a particular section of a broader topic (the one that worked the best was materials properties) and prepare a short presentation for the rest of the class. I was quite surprised how classes which had previously been quite passive and happy to be taught from the front, took ownership of their learning and enjoyed the experience of teaching each other. Another benefit was that they felt they would be letting each other down if they did not produce their 'bit' to the standard of the others.

In addition to the actual presentations given in the lessons it was possible to use the school's VLE to attach all the presentations and enable all students to access each other's work. Discussions with students led me to believe that they did look at each other's online work to aid their learning.

I also found that looking at their peers' work (mostly in the lessons) did genuinely increase their engagement with the content.

Another benefit from the flipped approach was that students had a head start in taking on new topics, and that more able students often understood them so well that they were able to act almost as teaching assistants in the lessons. (This also helped to create a more collaborative culture in lessons). During the lessons themselves it was definitely true that more time was spent in practical activities to support a deeper understanding of the topics.

Flipped Teaching Examples

Year 9 Electric Circuits

The students were asked to make notes on basic electric circuits using the video vimeo.com/53782306. Then in class they were asked to devise and enact a role play where the students played the part of "Cells", "Coulombs of Charge", "Ammeters", "Lightbulbs". The "Coulombs" (laminated signs around their necks) had to collect Joules (laminated pictures of weetabix) from the 1V "Cell" (another person holding a tray of Joules) and work out how to deposit them in the "Lightbulb" trays, given a number of different series and parallel configurations. The "Ammeters", placed in different locations counted the "Coulombs" in a time period and worked out the current. Students then completed questions on series and parallel circuits, which were corrected in real time.

Year 10 Momentum

With a middle ability class, goo.gl/ZNZlct. The homework was to watch the video, writing their own notes, and then complete 10 Multiple Choice questions. In class the same quiz was issued as a hard copy in groups. Following this, the students completed a practical on "Collisions and Explosions" - they each had a copy of the booklet attached to Blendspace. The following homework was to complete an IT worksheet on Phet Collision Lab (goo.gl/xYjsY) and the subsequent lesson was to complete the booklet questions on Collisions and Explosions with teacher and peer support. This was invaluable as I had previously found students always got stuck with this homework, but, after some support, the misconceptions were addressed more efficiently.

Year 11 Converging Lens Ray Diagrams

Homework was to watch and make notes on the first half of goo.gl/oYzvuz (up to 6:20), making sure they drew all the diagrams.

The follow-up activity in class was to check knowledge of key terms (e.g. 'principal axis') and then get straight on with some questions to construct ray diagrams, which extended to producing virtual images.

Students' progress was monitored in real-time, mistakes were corrected, and those who finished quickly were given a task to draw a ray diagram for a curved mirror (beyond our syllabus). We then reinforced the conclusions about the image properties for different object distances.

Having saved time by not having to explain how to draw the ray diagrams, plenty of time was then available to do a practical to verify the results from the ray diagrams. Students drew an object on tracing paper which was illuminated with a lamp, then used a converging lens of known focal length, a screen, and a metre rule to investigate the properties of the image for different object distances.

Year 11 National Grid

Homework was to watch and make notes about the National Grid using goo.gl/oswRqk and the textbook.

Follow-up task was a mini-whiteboard quiz to check knowledge of parts and approximate voltages, then a demonstration model of the national grid. Power loss in the pylons was then measured with and without an increased voltage across the pylon stage.

Even this simple flipped homework had unexpected benefits - there is a conflict about mains voltage between the video and the textbook (240V or 230V), the explanation for which is interesting.

Year 11 Moments

Homework was to explore the Phet Balancing Act simulation goo.gl/O7Zpks. As the simulation was used, students were asked to consider if there was more than one way to get two objects with identical masses to balance? They were then asked to get two objects with different masses to balance. In completing this exercise, pupils were building a recognition that what might be common sense given experience of levers or time on see-saws - could be explained numerically.

In the follow-up lesson, pupils were immediately presented with meter rules pivoted at the centre with moveable masses to be placed at various points. Firstly pupils were asked to calculate where known masses could be placed to allow the ruler to balance, and then, as a final challenge, to establish the mass of an unknown object.

The same topic could be taught using, for example, a Pathe video clip of double-decker bus topple-testing. Using an interesting real-life example, pupils can be asked questions about concepts such as centre of mass, toppling point, stability and units without previously covering them in class. Any follow-up practical in class, or written problems set, are then quick to implement with pupils having already been introduced to the ideas.

Peer Observations

Brian Reid

I observed Pete Gravell with a GCSE group covering the topic of transformers. They had clearly spent some time going over this topic, starting with some ‘flipped’ independent research to get them warmed up to the topic. The lesson time was used to do a set of practical activities to clarify the main ideas in students’ minds and some board-based quiz-type questions to check ability to do full exam-type questions.

I also observed Ali Galloni with a class of Year 9 Physics students, where the task was for students to mark another student’s test answers and analyse the findings. It was a very useful exercise (according to the boys) in understanding how marking is carried out and in avoiding the pitfalls themselves which might cause them to drop marks.

Alexandra Galloni

I observed Anna Gilmour with a Year 10 group at Thomas Tallis School, Kidbrooke and Brian Reid at the Charter School in Dulwich. Anna had fully implemented flipped learning with a Triple Science group. Anna found that in the initial stages, it took a while for students to take the ‘video lessons’ seriously, resulting in several students coming to lessons and finding themselves at a disadvantage. However, given the on-line availability of the videos, students could catch up and subsequently use the videos for revision. At the time of the observation (May 2014), 80% of the students had done the homework and the routine was bedding in. Student’s opinions of the videos and methodology were positive, and they appreciated the freedom to go at their own pace. Students explored several demonstrations on Work, Power and Energy, and then worked through problems in class time, aided by the teacher and peers. At Charter I observed Brian teaching a revision lesson with a Year 11 Triple Science group which was very much driven by the students’ independent needs - this gave me the opportunity to talk to many students, who were clearly engaged and ready to work independently and coach their peers.

Peter Gravell & Ben Jones

We both observed Brian Reid teaching a Year 11 Triple Science group who had worked independently in small groups to produce short presentations about various aspects of waves. It was clear that the students had engaged with the task, and were accustomed to being given a range of homework types including flipped homework. The students presented well, and every group came prepared with their presentation (there were none of the usual excuses about forgotten USB sticks) indicating a mature approach to this sort of work. There was also plenty of time to discuss how the project was progressing, and to share our experiences of the flipped classroom to date.

Project Outcomes

The main outcomes of the project were a deeper understanding of the possibilities offered by the flipped classroom method, a clear idea as to the conditions to be met for it to have a realistic chance of success, and an appreciation of the variety of tasks and lesson planning ideas that can be incorporated into a flipped teaching.

Teachers' experiences

The following are what the teachers rated as the main benefits following their experiences with the flipped classroom:

- Fostered independent learning by students
- Gave more opportunities for practical activities in lessons
- Having an online record of resources meant that pupils were in the habit of independently reading ahead or catching up on work missed, and made revision easier
- Students were guided towards high-quality resources
- Well-chosen computer models help students consider Physics principles at their own pace without the real-world issues associated with classroom practical work [not at the expense of classroom practicals, of course]
- Students have 'slept' on a new concept before going further in class
- Played to many students' enjoyment of screen-based activities
- Encourages advance planning of homework by teacher, and ensures that homework is always useful and relevant
- Teachers' time spent marking homework is reduced, but students still get individual feedback on their work during lesson time
- By searching for existing videos and watching them, teachers see lots of different approaches to teaching the same topic.
- Conflicts of opinion between the teacher or textbook and the video can be effective sources of discussion and learning

And the cons:

- Hard to track that a video has been watched, either at all, or in full
- A culture change that requires more time to bed-in
- Issues with students not having access to computers at home
- Initially lots of excuses from students about technical difficulties
- Homework can take students much longer than you expect
- Desire for more ways to test students' understanding at the start of the lesson (e.g. scratch cards)
- Occasionally, students who did not do the homework fell further behind and lost confidence
- Initial time investment for teacher planning the homework and finding or creating a suitable video
- Students cannot ask you questions while watching the videos

Resources Produced

To support other Physics teachers who would like to experiment with the flipped classroom technique we have put together a package of resources on a website at flip-your-class.co.uk.

The site contains advice on implementing a flipped classroom based on our combined experience, and also links to help and advice from other teachers who have used the method over a number of years.

The site also links to a number of resources created by teachers during the project which will be invaluable to any teacher setting out to flip their physics classroom. In particular, categorized lists of videos that have been vetted by us will save other teachers a lot of searching time, and there are also lots of ideas for follow-up tasks to do in class, which is another area that can initially take up a lot of planning time.

Acknowledgements

All of us would like to thank our SSLP colleagues (especially Mrs Gibbs and Dr Bishop) for their methodological rigour, ideas and suggestions, which kept us going over the length of this project.

We would also like to thank our Physics colleagues who for one reason or another were not able to stay the course to the end.

Finally, thanks to our student guinea pigs, who hopefully enjoyed the experience!

Appendix: Teacher and student surveys

Teacher Survey	Always	Often	Sometimes	Never
1. I am confident in planning effective lessons				
2. I often work with others to help in planning my lessons				
3. I am confident in my subject knowledge				
4. I find changes to the examination specification challenging				
5. I have the time to improve my practice on a regular basis				
6. I spend more than five hours a week planning lessons				
7. I am well supported in planning for excellent learning				
8. I believe it is important to teach my subject more widely than the exam specification				
9. I believe that lessons should have an element of fun				
10. I would like more opportunity to observe others teaching				
11. I am confident in stretching the most able students				
12. I am confident in supporting students with SEND				
13. I find it easy to differentiate all my lessons to support individual learning				
14. Disruptive behaviour puts me off allowing discussion, active learning and role play				
15. I feel confident that within my own classroom I have the freedom to teach in my own style				

Student Survey	Strongly agree	Agree	Disagree	Strongly disagree
1. I believe studying Physics is important				
2. I find learning Physics easy				
3. I find learning Physics interesting				
4. I find learning Physics fun				
5. I believe that doing experiments is an important part of learning Physics				
6. I would like to continue to study Physics at a higher level				
7. I know what I want to do post-16				
8. I think that my study of Physics will be useful to me in later life				

Do you have any idea yet as to what job you would like to have in later life? **YES/NO**
What would that be?
What are your favourite activities in Physics lessons?