March 2023 | Issue 64

Classroom physics

The magazine for IOP affiliated schools and colleges

Limit Less campaign takeover issue

Making physics fully inclusive

Whole-school approaches: how to start the conversation

Grade concerns: examining the basis for the 'physics is hard' myth

Force for good: inclusive teaching tips for the classroom

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IOP Institute of Physics

This issue

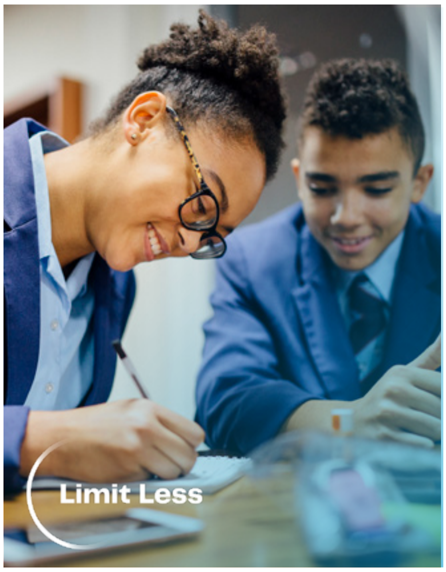
Welcome to the Limit Less takeover

Limit Less is the campaign, launched by the IOP, to remove barriers to post-16 physics by taking on some of the unhelpful tropes and limiting narratives that have prevented many young people from choosing to study physics.

We have identified five groups that are currently under-represented in the physics community: girls, young people from economically disadvantaged backgrounds, disabled young people, LGBT+ young people, and young people of Black Caribbean descent. Young people within these groups (and the many intersections between these groups) are less likely to do physics and more likely to face a hostile environment when they do.

The campaign focuses on influencing the influencers – those that are helping young people to form opinions at this crucial time – at home, at school, in communities, in the media and on social media.

A big part of that influencing agenda has to happen in schools, and our pull-out section (pages 9–12) gives some examples of how 'regular' physics lessons can be inclusive. In fact, extending the ways we think about the physics curriculum can make a big difference to the inclusiveness of lessons, a point argued by many of the contributors to this issue. But, as our lead feature shows (page 6), creating a welcoming environment for physics doesn't stop at the classroom door,



and we report on the impact being felt from whole-school approaches to inclusion.

Elsewhere in this edition of Classroom Physics we're focusing on the themes of diversity, equity and inclusion that lie at the heart of the Limit Less campaign. Alongside our regular contributors, we've invited guest authors to raise awareness of some of the other brilliant organisations working in this field. We think there's a lot here to spark ideas about what we can all do to make physics a more welcoming and inclusive place. Enjoy the read, and be sure to share your thoughts with us by email or the social media channels below.

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IOP affiliated schools and colleges will receive with this issue...

Two copies of our new 'Top Tips for Inclusive Science Teaching' booklet and an extra copy of the physics pull-out to share with colleagues.

Email **campaigns@iop.org** to request further copies.

Our Top Tips are also available in Welsh.

Follow us on Twitter
@IOPTeaching

Read Classroom Physics online and access previous editions at **spark.iop.org/classroom-physics**

New SI prefixes introduced

In November the General Conference on Weights and Measures met in Paris to approve four new prefixes describing units at the very largest and smallest scales.

The International System of Units (or SI for Système International) is the globally agreed system of measurement units. By adding new prefixes, the system is able to adapt to the changing needs of disciplines such as astronomy and particle physics, which require ever increasing (or decreasing) unit sizes.

"One of the beauties of this system is that as measurements get larger or smaller the use of SI prefixes allows us to vary the size of the units used without inventing new unit names – unlike other traditional unit systems," says Professor Richard JC Brown, Head of Metrology at the National Physical Laboratory. "Many of these SI prefixes are already very familiar to us and in daily use, such as centimetre (cm), millilitre (ml) and kilogram (kg). Using SI prefixes in science means the numerical values expressed remain manageable and easier to understand."

For example, the nano- prefix enables us to express 0.000,000,001 m as 1 nanometre (1 nm), while 1 terawatt (1 TW) saves us the trouble of writing out 1,000,000,000,000 W.

The four new SI prefixes are ronna (10^{27}), quetta (10^{30}), ronto (10^{-27}) and quecto (10^{-30}).

Multiplying factor	SI prefix	Symbol
10^{30}	quetta	Q
10^{27}	ronna	R
10^{24}	yotta	Y
10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y
10^{-27}	ronto	r
10^{-30}	quecto	q

IOP inclusion and equity network

More than 50 schools, teaching colleges, university ITE departments, regional bodies and learned societies have come together to form an inclusion and equity network for Wales, as part of the IOP's Physics Teacher Support Project, supported by the Welsh Government.


Credit: Shutterstock

The Welsh Senedd

During the school year to date, the network has recruited early career teachers and newly qualified teachers, who attend its half-termly online meetings. The focus last term was 'poverty-proofing the school day', exploring the advice and guidance on offer to schools through the Welsh Government's Price of Pupil Poverty project.

The network will next explore potential networking opportunities with RADY (Raising Attainment in Disadvantaged Youngsters). Also, through IOP's collaboration with EngineeringUK, physics teachers in Wales are now contributing to focus group sessions on how best to use STEM 'out of school' learning opportunities to improve engagement and aspirations and to raise the students' science capital.

A resource bank of support materials is available to network members and the online sessions are recorded and made available to support members' individual and local needs.

Project Manager and IOP coach Keith Jones commented: "The work of the network is an integral part of our teacher support offer for Wales. We continue to support the nation's physics teachers, especially those teaching the subject out of their specialism, whilst also facilitating collaboration through, for example, the Price of Pupil Poverty project, to mitigate some of the barriers impacting schools and communities facing social deprivation. In the current socio-economic climate, this type of support will be key in helping schools to deliver an inclusive experience to their learners."

STEM glossary created for Irish Sign Language

The IOP has partnered with Dublin City University on the Irish Sign Language STEM Glossary project.

The project brings together scientists, science communicators and the deaf and heard of hearing (DHH) community to create a free online glossary of STEM terms for Irish Sign Language.

There are 5,000 people in Ireland for whom Irish Sign Language is their first language. The lack of signs for common scientific terminology create a significant barrier for this community to engage with science. While teachers, students and science communicators find workarounds – creating signs of their own or fingerspelling words letter by letter – this can be cumbersome, difficult and confusing.

The project has so far delivered new signs for physics terms such as ‘photon’ and ‘density’, which have been created and filmed alongside terms with existing signs such as ‘star’ and ‘moon’, to develop an ever-growing resource for the DHH community.

Fiona Longmuir, Learning and Skills Manager for Ireland at IOP. said: “The DHH community have been under-represented in science for far too long. Currently in Ireland, there are no DHH sign language users with a PhD in science. Some DHH students have reported feeling discouraged from pursuing science because of the terminology involved. We hope this project goes some way to breaking down this barrier and encouraging DHH students to pursue their passions and achieve their full potential.”

more...

Visit the STEM glossary: **dcu.ie/islstem**


Credit: Shutterstock

IOP Apprenticeships report launched

To mark National Apprenticeship Week in early February, the IOP published a report on physics-related apprenticeships.

The report, ‘Solving skills: Powering growth through physics-related apprenticeships’, is based on a survey of nearly 300 apprentices, as well as interviews with employers and training providers. It identifies a number of challenges to getting more young people to take up apprenticeships, which offer great opportunities for paid training and development, and hold significant potential for business and the wider economy.

A significant concern raised by the report is that young people are not always aware of the options available to them. Engagement between local businesses and schools is patchy in some areas. Training providers and employers of apprentices reported that schools are incentivised to promote traditional academic routes over vocational training at age 16. This is despite the finding that over a million physics-related roles typically do not require a university degree.

There are also some important misconceptions around physics-related apprenticeships among young people, who report that physics is seen as too academic, while apprenticeships themselves are seen as too ‘hands-on’. These may be contributing to the low numbers of women taking up physics-related apprenticeships.

The IOP is beginning national conversations with government, industry and training providers to find ways to increase exposure of young people to apprenticeships and local businesses, improve engagement with employers, and tackle unhelpful stereotypes.

more...

Read the report here: **bit.ly/3XdcZPD**

Credit: IOP

IOP staff and volunteers at the BT Young Scientist and Technology Exhibition 2023 in Dublin. From left: Brendan Owens, Elora McFall, Fiona Longmuir, Osas Eghaghe and Anna Sweetman.

BT Young Scientist and Technology Exhibition

IOP staff and volunteers welcomed over 700 young visitors, teachers and family members to a Limit Less campaign stand over the three days of the BT Young Scientist and Technology Exhibition 2023, held in Dublin in January.

Visitors to the stand were met with a collection of small demonstrations directly tied to role models featured in the Limit Less Careers booklet. Over 500 booklets were given to families and teachers to enable discussion about the opportunities open to young people in physics and engineering, and to showcase that physics is for everyone.

As part of the exhibition and competition, Public Engagement Manager Brendan Owens presented the IOP Special Award for best physics project to Aaron Waldron and Conor Quinlivan from Mungret Community College in Limerick, Ireland. They also won 3rd place in the Chemical, Physical and Mathematical Sciences senior group.

Their project was titled 'Factors Affecting Muon Flux Density'. Both students intend to pursue a career in physics after secondary school.

Access the Limit Less Careers booklet at **bit.ly/3ZdjpQ7**

Lewis Hamilton's Ignite Partnership supports Gender Action

Gender Action, a programme which works to transform school and nursery environments so they are places where societal stereotypes and biases are challenged, is one of three recipients of new grants announced by the Ignite Partnership.

Ignite was founded by racing driver Sir Lewis Hamilton and the Mercedes-AMG-PETRONAS Formula 1 team to boost diversity in motorsport. It does this by enabling pathways into the sport for under-represented groups, particularly women and black people.

Georgina Phillips, Gender Action Steering Group Member, commented: "With this new funding from Ignite, Gender Action hopes to reach hundreds more schools and aspires to reach more than 60,000 students. We've learned from decades of research from across the organisations that founded Gender Action, that trying to challenge individual issues in individual subjects doesn't have a sustainable effect which is why we are championing a whole of school approach."

At present, gender inequities in early education, including a lack of female role models in the STEM curriculum and teacher behaviours, can lead to a lack of encouragement for women and girls to pursue STEM careers. These barriers are evidenced with only 22% of Physics A level students in England being female.

Gender Action was launched in 2018 by the IOP, King's College London, the UCL Institute of Education and the University Council of Modern Languages.

Credit: Shutterstock

Credit: https://youtu.be/YHD8tNLxFDk

Inclusion and equality – a whole-school issue

For this Limit Less takeover issue, we're highlighting the campaign to remove barriers faced by many young people to post-16 physics – a campaign built on changing how physics is portrayed to young people. Beth Bramley, Strategic Lead for Inclusion in IOP's Learning and Skills department, writes that change needs to happen throughout the school – not just in the physics classroom – if we are to see real impact.

I know that readers of Classroom Physics will be aware of the challenges facing physics and the injustice faced by thousands of young people who are missing out on the life chances that the discipline of physics can provide. Newly analysed data from 2021/22 paints a stark picture of the scale of the problem in our schools. The data analysed is from A-levels in England, so whilst not a full analysis of every post-16 physics pathway across IOP nations, it nevertheless provides fresh insight into the persistent challenge of ensuring diverse participation in physics post-16.

Taking disadvantage as an example, in 2021/22 only 11% of physics students were from disadvantaged backgrounds (as defined by the DfE). This is far lower than chemistry or biology, lower than maths, and lower than the overall proportion for A-level. Physics accounted for 3.5% of all A-levels taken by disadvantaged students, and 4.65% of all A-levels taken by everyone else. If we could increase the rate at which disadvantaged students take physics to match the non-disadvantaged population, 1,000 extra students a year would take and complete physics A-level.

Another example is gender. In 2021/22, 77.2% of physics A-levels were taken by male students. In total there were 154,000 A-levels taken in subjects with at least 75% of students of a single sex, including English, sociology, art and design (>75% girls) and physics and computer science (>75% boys). Physics was the second largest of these subjects after sociology.

It's sobering to be reminded of how far we still have to travel. Just as important as the numbers are the voices of young people who have spoken to us during the campaign. Just some of the things we've heard: *"My dad told me not to study physics because it wasn't for women and the maths was too hard." "My A-level teacher told me that girls didn't tend to be very good at physics, so I might struggle at uni." "I was told by a close female family member that physics was boring and a waste of time."*

There are, however, some green shoots to share. We have begun to see a real breakthrough in terms of girls' progression post-16 by working throughout schools in order to reinforce the work happening in the physics classroom.

Work led by the IOP at a whole-school level has been recognised by governments across Great Britain as the right way forward to increase physics uptake by currently under-represented and underserved groups. We've seen the approach adopted, for example, by Education Scotland through the Improving Gender Balance and Equity programme, which has issued guidance for whole-setting approaches from age 3–18. In Wales, the government has recognised the IOP-led work on whole-school approaches, adopting a whole-school framework for emotional health and wellbeing, funding the Improving Gender Balance Wales pilot and supporting activities such as the IOP's school inclusion and equity network (see page 3).

While these examples are encouraging, we need to see these practices embedded across the system, in all parts of the UK and Ireland. That's why this year we are campaigning to get whole-school approaches and planning made the norm in schools.

One of our main demands for governments is to ensure that every school has in place whole-school planning for equity and inclusion. This needs to involve everyone – teaching and non-teaching staff, those involved in school governance, parents – and at its heart should be the experience of students. This work needs to be evidence- and data-led and woven into existing school development or improvement plans so that actions, timeframes and people are allocated and mapped out.

We've invited several organisations to participate in this issue of Classroom Physics to highlight some of the new tools available to support inclusive teaching. On the page opposite we include insight from the Association for Science Education, who have produced guidance on some of the 'ways in' to whole-school work on equity and inclusion.

But we hope this issue will also prompt you to initiate a wider conversation in your school – perhaps with a colleague in a subject which has a similarly stark gender imbalance, like performing arts or modern languages, or with senior leaders. It is when inclusive practice is part of the fabric of the school that we will see the biggest difference.

Watch our video about whole-school inclusion:
bit.ly/3I6DP7A

Developing whole-school inclusion

Vicki Parry, Inclusion in Schools Consultant at the Association for Science Education, describes a process for adopting a whole-school approach to inclusion.

The Association for Science Education's Inclusion in Schools programme is a tool to help schools stop, reflect and take action on what their students are telling them about inclusion at their school. It offers 1:1 consultant support, extensive CPD and networking opportunities with other schools. The programme is fully funded for state secondary schools in England by the Department for Education.

The process works by asking questions around four focus areas that encompass all aspects of school life. We can then suggest and help implement different strategies which we align with the school's needs, improvement plan and time they have available.

Due to our bespoke approach, how this looks in schools varies hugely. Some outcomes from previous projects include:

- Using Black History Month as a prompt to develop closer links with local business leaders, which led to stronger community and careers links.
- A focus on literacy looked at the authors and themes of books in the school curriculum, to ensure diversity.
- Auditing attendance at extra-curricular activities highlighted that some students can't attend after school, or don't feel welcome enough to join. In one case this led to a complete change in the school timetable, bringing activities within the school day. The result was a more diverse group of students at the clubs and much better equality of opportunity.

Participating schools are encouraged to share their experiences and learn from others at regular networking events.

Some examples of questions, and some of the actions that lead from them, are included here.

School Environment

Do all families feel welcome in the school?
Add welcome signage in different languages at reception. Local community groups may help schools identify and a overcome any cultural barriers that some families may encounter.

Are underserved groups safe from discrimination and micro-aggressions in school? Train staff to recognise, challenge and report discrimination and micro-aggressions in actions and language.

Leadership

What does the data show? Analyse data around attainment, behaviour, subject choice and attendance at extra-curricular activities by underserved groups,

Who is responsible for leading inclusion? Having at least one senior leader and a governor responsible for inclusion across the school ensures it is a priority. Leaders need to give staff training and time to make the necessary changes to ensure they are impactful.

Teaching and Learning

Do staff have high expectations of all students?
Identifying any unconscious bias and improving inclusive teaching techniques will give all students a chance to reach their full potential.

Are the curriculum and learning resources diverse and do they challenge stereotypes? Use opportunities across the curriculum to challenge stereotypes. This could start with increasing the diversity of role models, but ongoing reflection can lead to careful scrutiny of the perspective the subject is taught from and assumptions that may be made about groups of people within that subject.

Future Pathways

Are staff confident in referring to a wide range of career and education pathways?
Keep staff training up to date with post-16 and post-18 options. Develop links with local employers, sixth form colleges and universities.

Are staff challenging stereotypes through curriculum careers links? We provide training and support in embedding careers into the curriculum, identifying stereotypes and how to use careers as an opportunity to challenge them.

more…

If you think your school would be interested in finding out more, please share this with your senior leadership team and get in contact for more information:

ase.org.uk/inclusion-in-schools-programme

Grade concerns

A vital role of the Limit Less campaign is to counteract unhelpful narratives about physics, which put off some students who feel that physics isn't for them. Charles Tracy, Senior Advisor, Learning and Skills at the IOP, explores perhaps the most damaging myth of all: that physics is harder than other subjects.

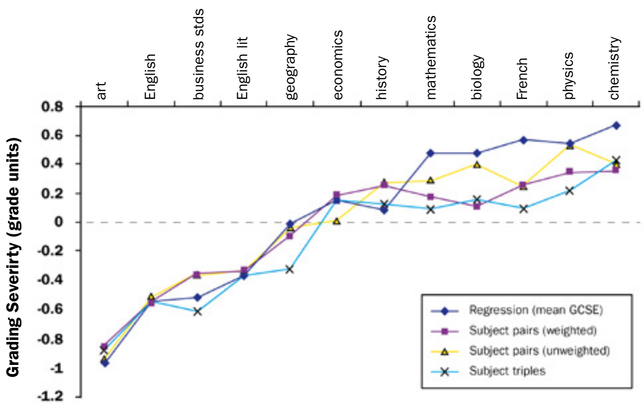
The relative 'difficulty' of physics is often talked about but is an unhelpful myth. If we ask, 'is sprinting more difficult than swimming?', the question obviously has no meaning – they require different capabilities and aptitudes. The comparison only becomes valid when you set standards for each and compare the numbers who achieve those standards. We can ask, 'is it more challenging to run 100m in 15 seconds or swim 100m in 60 seconds?' and draw conclusions from the world records for each.

In the same way, it is meaningless to ask whether physics is more difficult than biology. We can meaningfully ask whether it is a greater challenge to get an A at A-level in biology or physics. The answer is that they are about the same. But that is not true for, say, English.

The issue is not the inherent difficulty of a subject, but how exams are graded. Put simply, physics, along with French, biology, maths and chemistry, is graded more severely than subjects like English, business studies and art. A-level grades in these groups of subjects are therefore not comparable.

In 2008, the Curriculum, Evaluation and Management Centre at Durham carried out some analysis using a range of methods, shown below. The most obvious is a regression analysis to GCSE grades (in blue). (It is worth noting that there is academic challenge to this analysis, based partly on whether it is possible to have a baseline of general capability at GCSE, but this is the best tool that we have.)

Credit: Coe, R, et al., Relative difficulty of examinations in different subjects, CEM Centre, Durham University, July 2008



Regression analysis linking A-level scores to GCSE performance.

The effect of this differential severity is frustrating. For a given set of GCSE grades, predicted outcomes will be lower for physics than for English, business studies and so on. Students whose grade requirements are not tied to specific subjects are incentivised to select courses that offer an increased chance of a high grade – irrespective of the skills they may want or need for the future.

It has also made physics more self-selecting: candidates tend to have high average GCSE scores, so more of them get the top grades at A-level – in 2022, 40% of candidates got A/A*. This reinforces the notion that physics is only worthwhile for those with high prior attainment. Nothing could be further from the truth: like any discipline, physics can be practised at many levels and all grades at A-level have value.

While we can identify the problem, there are barriers to solving it. The obvious response is to lower the grade boundaries in more severely graded subjects, but this would further exacerbate the lack of discrimination between top grades. And, of course, the alternative – to raise grade boundaries in other subjects – is a hard sell to practitioners in those subjects.

As things stand, Ofqual is required to make each year's grades comparable with the previous year, within (but not across) subjects. Any small adjustment from one year to the next would require special dispensation. In the most recent consultation (2018), Ofqual asked whether to seek such permission. The IOP and others pushed strongly for adjustments to make grading more comparable between subjects, but Ofqual, concluding that the differences in grading severity have no effect on student choice, chose not to address the issue.

We continue to contest this position and will be doing some research on student choice to support our view that change is needed. The most likely correction would be a one-off adjustment with periodic realignments – possibly at the same time as changing the grading system to a 1–9 structure to match GCSEs.

In the meantime, we must keep fighting against the discouragement that students can feel about taking physics beyond 16. Here are some suggestions:

- Avoid any suggestions that physics (or maths) A-level requires higher prior attainment, ability or confidence.
- Have an equitable sixth form entrance policy. Avoid different entry requirements for different subjects.
- Celebrate all grades in all subjects at A-level, not just the top grades. An A-level course in physics is valuable in itself, and a C or D grade is a success.
- Avoid the term 'difficult', especially when applied to a whole discipline.
- Avoid comparing the difficulty of subjects (and ensure that teachers of other subjects do the same).
- Avoid equating specific capabilities (mathematical/scientific/academic) with being better or cleverer.

more...

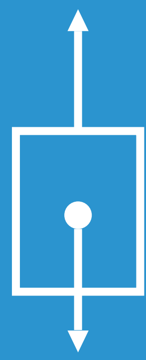
Grading severity was highlighted recently in a blog by Education Datalab **bit.ly/3YcsTel**

Pull out and keep!

Forces (11–16)

Inclusive teaching

Inside this issue:



Taking the fear out of forces

In physics lessons, many students experience barriers to learning. They may feel they are not good enough to study physics or that the curriculum isn't relevant to their lives and aspirations. This is particularly an issue for schools in lower socio-economic areas, mixed schools with a high proportion of girls and for certain ethnicities for whom confidence in science may be lower than other groups.

Building an inclusive classroom doesn't have to be a big undertaking. Getting to know your students' interests is an important first step. Asking a colleague to monitor interactions during a lesson and tweaking the way you ask questions can also make a big difference. For more details on these and other ideas on creating an inclusive classroom culture and making the learning relevant, see our 'Top Tips for Inclusive Science Teaching' booklet, included with this issue of Classroom Physics.

Inside this pull-out you will find two activities that show how to use some of the nine inclusive teaching tips for teaching forces.

The first activity (page 10) is an alternative to the classic Hooke's law investigation. Instead of stretching or compressing springs, students investigate sweets. This illustrates that physics applies to everyday materials and so lays the groundwork for introducing other everyday compression forces for which the deformation of the surfaces in contact may not be so obvious. It also links nicely to STEM careers in the food and other industries.

The second activity (page 11) is designed to take the fear out of making force diagrams. Instead of drawing force arrows, students make them using cardboard. Using arrows that can easily be moved or swapped gives them the flexibility to change their mind and creates a safe space to develop their understanding.

You may have also noticed that some students dominate practical work. They rush to grab equipment and leave others to record results. We've included cards on page 12 so that you can allocate responsibilities and then rotate them for future practical work to ensure that everyone develops a full range of skills.

more…

Find out about our campaign to support young people to change the world and fulfil their potential by doing physics at **iop.org/limit-less**

Creating an inclusive classroom culture	1	Enable all students to participate
	2	Model inclusive language and expect it from students
	3	Examine and challenge stereotypes, biases and assumptions
Making the learning relevant	4	Value students' existing knowledge and experience of science
	5	Teach about a range of jobs and careers that use science and science skills
	6	Give students opportunities to make links between their learning and their lives, interests and local area
Building numeracy and literacy for science	7	Build scientific vocabulary
	8	Get students talking and listening
	9	Make time for maths

Activity 1: Squashing sweets

In this activity, students investigate the change in height of a marshmallow under different loads.

Credit: IOP

Equipment:

Each group of four students will need:

- Copy of experiment role cards (see page 12)
- Scissors
- A marshmallow (giant ones work best – note that vegan options are available, and may be more appropriate for your class)
- Two plastic drinks cups (ideally transparent)
- Six 100 g masses
- Ruler

Procedure

To develop experimental planning skills, you could ask students to plan the investigation from scratch. Alternatively, provide partial or complete instructions, such as the ones below.

1. Cut out role cards, place them face down, shuffle and pick one each.
2. Place the marshmallow inside a plastic cup and then place the second cup inside the first, resting on the marshmallow.
3. Measure the distance between the rims of the two cups to find the initial height of the marshmallow in millimetres.
4. Add a mass to the second cup and then measure the new distance between the rims of the cups.
5. Repeat to collect data for different heights (mm) and masses added (g).
6. Calculate compression force (100 g is equivalent to 1 N) and change in height (original height – new height)
7. Plot a graph of compression force against change in height and work out the gradient including its units.
8. Think-pair-share: Who would need to understand compression forces in their job?

Inclusive science teaching	Implementation
Give students opportunities to make links between their learning and their lives and interests	Compress objects that students will be familiar with (marshmallows). Think-pair-share STEM careers linked to compression forces
Enable all students to participate	Use role cards to assign responsibilities for practical work
Make time for maths	Discuss units for gradients of graphs
Build scientific vocabulary	Discuss other names that students may see online or in books for compression forces (reaction, support, normal contact or push off table/ground)

Teaching notes

Marshmallows deform plastically. They won't return to their original shape. If students want to repeat the investigation, provide fresh ones.

We used a giant marshmallow to get the results below. You may want to test your marshmallows to see if they also give (approximately) linear results. If not, reduce the number of masses you provide.

Mass added (g)	0	100	200	300	400	500	600
Height (mm)	50	48	46	44	42	40	38
Force (N)	0	1.0	2.0	3.0	4.0	5.0	6.0
Change in height (mm)	0	2	4	6	8	10	12

The gradient of a force against change in height graph has units of Newtons per millimetre (N/mm). Discuss the meaning of the word 'per'. The gradient tells us how many Newtons are needed for every millimetre change in height. It is a measure of the stiffness of a material.

Credit: Mecmesin

Careers info...

Compressing marshmallows to check their stiffness is part of a real-world quality control process. The machine in the picture enables engineers to test for texture (find out more at **textureanalyzers.com**). As well as 'sweet tester', other fields that may require an understanding of compression forces include vehicle safety, sports equipment manufacture and furniture design. Examples can be found at **neonfutures.org.uk/case-study**

Activity 2: Cardboard force arrows

Drawing force diagrams can be daunting for some students. Use cardboard arrows and discussion frameworks to lower the stakes and scaffold learning.

Preparation

Before the lesson, ask students about their interests or hobbies. Choose some objects in everyday situations to draw force diagrams for. Include at least one linked to students' interests. Search online or prepare props to illustrate each.

Download a set of colour-safe cardboard arrows from **spark.iop.org/cardboard-arrows**. Print and cut out enough so that each pair of students has a set.

Equipment

Each pair of students will need:

- Set of cardboard arrows
- Paper and pen (or mini-whiteboard and marker)
- Blu Tack

Inclusive science teaching	Implementation
Value students' existing knowledge and experience of science	Find out about students' interests or hobbies before the lesson and use them in examples
Enable all students to participate	Low stake approach: students working in pairs using cardboard force arrows
Give students opportunities to make links between their lives, interests and local area	Use everyday examples and include at least one linked to student interests
Get students talking and listening	Use a forces description framework to support student discussions

Procedure

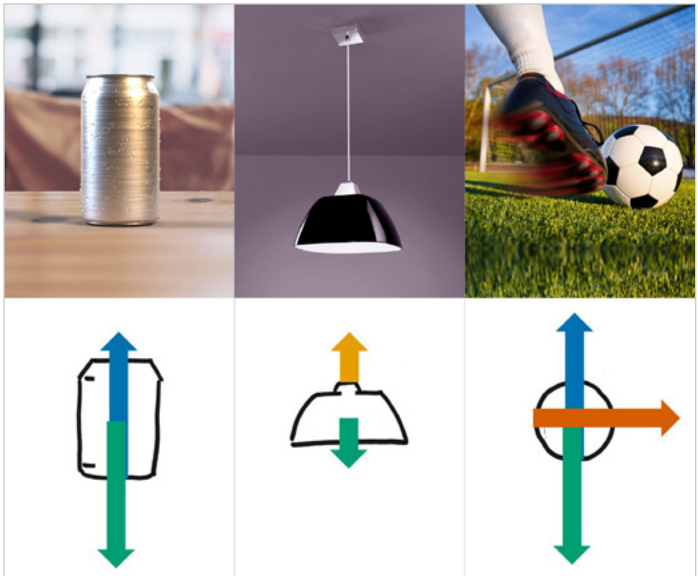
1. Write the following description framework on the board: *"The ___________ arrow represents the _______________ force that acts on the ____________ due to the _____________"*

2. Show a photo or demonstrate one situation (you could start with a drinks can sitting on a table).

3. Ask students to:

- Identify the object and draw it by itself
- Use same-sized arrows if two forces are the same size
- Point each arrow in the direction of the force
- Stick the base of each arrow to the place where the force acts (it's okay for their arrows to overlap)
- Use the description framework to discuss what each arrow represents with their partner

4. Repeat steps 2 and 3 for all situations.



Credit: IOP

Cardboard arrow force diagrams for everyday situations. Blue arrow = normal contact/support/compression force to ground/table; Yellow = contact/tension force due to cord; Red = contact/compression/kicking force due to foot; Green = gravitational/weight force due to Earth

Teaching notes

As students build force diagrams, circulate and use questioning to encourage them to explain and progress their thinking. For example:

- *"Why have you chosen those arrows?"*
- *"What force does that arrow represent?"*
- *"What causes it?*
- *"Where does it act?"*

This activity can also be a useful introduction to Newton's third law. Ask students to draw diagrams of the other object involved in the interaction (e.g. Earth) and use the same colour of arrow for matching force pairs (e.g. green arrows for the gravitational force on both Earth and the football). Using the description framework will help students see that if there is a force on object A due to B, there is an equal and opposite force on B due to A.

more...

For lots of other great ideas for careers and everyday contexts for teaching forces why not watch our 'Everyday Forces' video at **spark.iop.org/forces-cpd-videos**

Roles for practical investigations

EQUIPMENT

Selects and sets up the apparatus, making sure it is safe to use

iop.org/explore-physics

QUALITY CONTROL

Makes sure the experiment is a fair test

iop.org/explore-physics

OBSERVER

Makes observations and takes measurements

iop.org/explore-physics

RECORDER

Writes down observations and measurements

iop.org/explore-physics

EQUIPMENT

Selects and sets up the apparatus, making sure it is safe to use

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Stories about physics: Limit Less issue

For this special edition, Richard Brock is joined by Carole Kenrick to introduce stories that may broaden people's perceptions about who can do physics.

Fleming's focus

The long life of John Ambrose Fleming (1849–1945) – probably best known in school physics for his eponymous left and right hand rules – contained many twists and turns. He dropped out of university for financial reasons and worked as a teacher before he could resume undergraduate study aged 27. Less well known is that in middle age he began to lose his hearing. It didn't stop him from lecturing; his students held him in high esteem and it is reported he took advantage of his deafness to ignore any comments he didn't like. At scientific meetings he took an assistant to take notes. One of Fleming's biographers argued that his deafness enabled him to work with a high degree of focus, ignoring his surroundings and concentrating on the problem at hand.

Belated recognition for Carolyn Beatrice Parker

One of the first African Americans to complete a postgraduate degree in physics, Carolyn Beatrice Parker (1917–66) was an under-recognised contributor to the Manhattan Project. After her undergraduate studies, Parker taught in school before completing MScs in both maths and physics. During the Second World War, she worked for the Dayton Project, a section of the Manhattan Project that produced polonium for use as a neutron initiator in the atomic bomb. After the war, she began a doctorate at MIT, but died of leukaemia – potentially caused by her work with polonium – before being able to defend her dissertation. In 2020, in the context of the Black Lives Matter protests, an elementary school in Florida was named in her honour.

The animated Plateau

Joseph Plateau (1801–83), a Belgian physicist and mathematician, overcame many hardships to become a pioneer of optical research and animation. Orphaned as a teenager, Plateau supported his sister by teaching alongside his university studies. During his doctoral research, he stared directly into the sun for 25 seconds, harming his vision for several days, but he nevertheless completed the first doctoral dissertation at the University of Liège, which examined how light interacted with the eye. Though only 27 pages long, his thesis was the first to describe the duration of the perception of colours on the retina, the geometric superposition of curves, and the perception of moving images. He subsequently developed the phenakistiscope, an early animation device.

Plateau went on to face more challenges. His first son died and, in his late thirties, he began to go blind – a result of chronic uveitis, rather than his experiments with the sun. Plateau became a popular teacher at the University of Ghent and continued to research into his 70s, making significant contributions to the field of surface tension. An obituary by his son-in-law provided fitting commendation for a remarkable life:

"… the awareness of his mind was better than ever, and supported by the dedication of several collaborators he set course for his most brilliant discoveries and reached immortal glory within Belgian science."

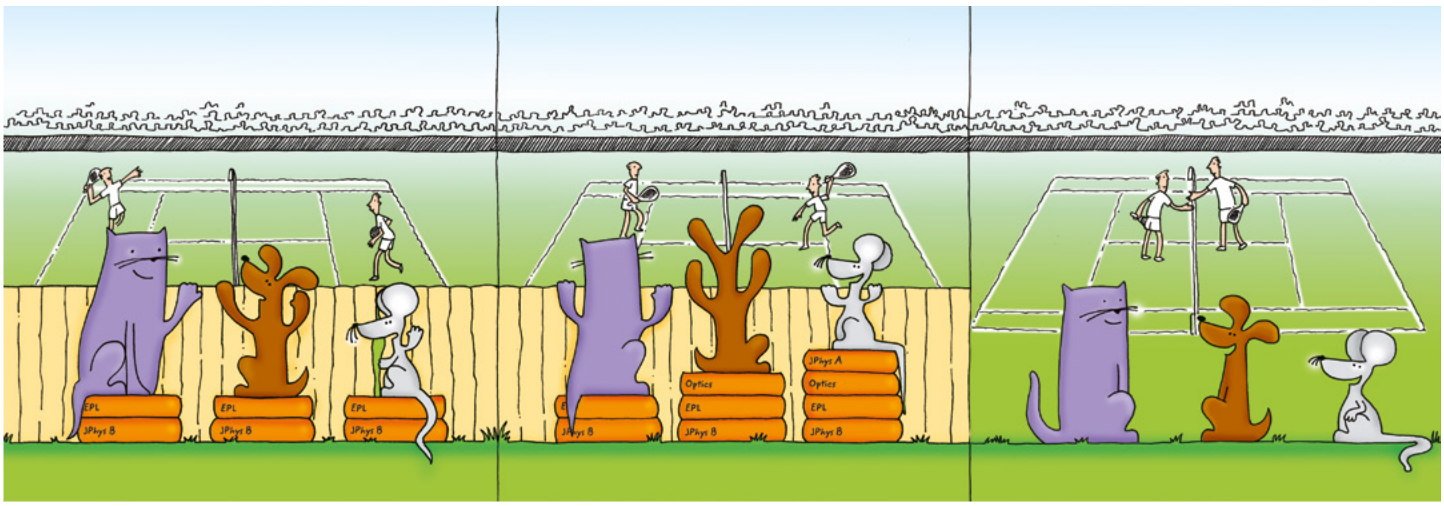
spark.iop.org/stories-physics

Compiled by Carole Kenrick and Richard Brock.

Follow them on Twitter at: **@HelpfulScience** and **@RBrockPhysics**

Marvin and Milo

Equality | Equity | Inclusivity



Credit: IOP

Physics*education*

Gary Williams, editor-in-chief of *Physics Education,* recommends articles addressing areas of under-representation in post-16 physics.

Physics Education is our international online journal for everyone involved with the teaching of physics in schools and colleges. Access over 50 years of articles at **iopscience.org/physed**

Affiliated schools have free access – email **affiliation@iop.org** for a reminder of your log-in details.

Gender equity

A good place to start in the Physics Education archive when thinking about gender is the paper by Barbara Hodgson,"**Women in science – or are they?"** from 2000. Similarly, looking back at Martin Monk's paper **"The flight from physics education: searching for reasons by comparisons across the curriculum"** from 2008, it's clear that equity issues were being raised several years ago. Progress has been made in the years since these publications, but change is slow.

More recent articles show growing awareness of stereotyping in textbooks. "**The representation of women in Irish Leaving Certificate Physics textbooks",** and **"Textbook images: how do they invite students into physics?"** reveal that images in textbooks are sometimes repeated for centuries. Given that the pool of textbooks might be small within a locality, like Wales or Ireland, or a topic, like aerodynamics, students may be subjected to a very limited range of examples of people to identify with in a physics context. There is also an increasing evidence base for inclusive teaching methods, such as those described in **"Gender response to Einsteinian physics interventions in school".**

"Women in science – or are they?"
bit.ly/3DOfz7w

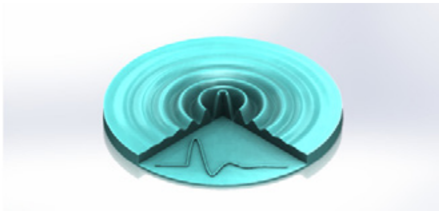
"The flight from physics education..."
bit.ly/3x2c35l

"The representation of women..."
bit.ly/3RCTlva

"Textbook images..." **bit.ly/3X7jkMt**

"Gender response to Einsteinian physics..." **bit.ly/3I7a7PG**

Visual impairment



Credit: IOP

A tactile wave model

Physics Education has over the years included a wide range of articles addressing visual impairment. David Featonby has long raised awareness of **"Colour vision deficiency and physics teaching".** Most teachers will have a student who is colour blind in every large class they teach. I know from personal experience that some students cannot see coloured graphics properly. Teachers can better appreciate these problems by getting an app that allows the user to see what those with different forms of CVD see when looking at a colour image.

Several papers offer novel ideas for teaching children with CVD that students without impaired vision could also benefit from. In **"Colorblind cybernetic eye: an inclusive analogy for color vision",** an eye is built using LEDs as sensors. Tactile models of waves are shown in "**Improving physics teaching materials on sound for visually impaired students in high school".** Imagine passing a 3D model of a wave around the class rather than hoping that your 2D drawing has conveyed the meaning you hoped for!

"Colour vision deficiency..."
bit.ly/3YswwNv

"Colorblind cybernetic eye:.."
bit.ly/3YbU3Sz

"Improving physics teaching materials ..." **bit.ly/3lgTet7**

Quick links:

"Surveying Kazakh high school students' attitudes and beliefs about physics and learning with the Colorado learning attitudes about science survey"

Linking student attitudes with success, and noting differences between genders

bit.ly/3Im5atK

"Science motivation by discussion and controversy (SMDC) model"

What makes students disengage from science in class?

bit.ly/3IjOzX7

"Adapting a solar photovoltaic panel experiment for blind students"

An inclusive approach to teaching about renewables

bit.ly/3YxRVnT

"Simple pendulum for blind students"

Translating a pendulum's periodic oscillation into a speaker

bit.ly/3YjmvCc

"Analysing the physics learning environment of visually impaired students in high schools"

What is studying physics like in a Dutch high school and how can the environment help support participation?

bit.ly/3DOwlyc

"Adapting diagrams from physics textbooks: a way to improve the autonomy of blind students"

Tactile symbols make mechanics diagrams accessible

bit.ly/3Xeuhfd

Physics education research

For this special edition, **Carole Kenrick**, a physics teacher and IOP professional practice coach, has taken over the Physics Education Research column to share her thoughts on a paper about culturally relevant physics teaching.

Get involved with physics education research discussions by joining the **Physics Education Research** group on Talk Physics at **talkphysics.org/groups/physics-education-research-per** or email **research@teachphysics.co.uk**

Cultural relevance in physics teaching

In this article from 2019, Angela Johnson takes the idea of culturally relevant pedagogy, popular in the US among teachers who want to make their classrooms more inclusive, and applies it to a physics context.

Culturally relevant pedagogy was first proposed by Gloria Ladson-Billings in the 1990s, and grew out of studies of excellent teachers of black children in the US. Ladson-Billings concluded that teacher effectiveness wasn't just about what they did but about three key beliefs the teachers held:

a. "Students must experience academic success",
b. "Students must develop and/or maintain cultural competence" – meaning that they must be able to work with people from different cultural backgrounds to themselves without losing their own sense of identity – and
c. "Students must develop a critical consciousness through which they challenge the status quo of the current social order."

What does this mean for physics teachers? In addition to teaching that accounts for students' different starting points, Johnson suggests that we question our own understanding of what it means to be good at physics. Rather than always praising and rewarding students who are first to answer a question correctly or who are good at maths, celebrate those who aren't afraid to make mistakes, who persist when struggling and who demonstrate curiosity through their questions.

Johnson recommends creating a culture in your classroom where students can be themselves and see themselves celebrated and reflected – so they don't perceive a conflict between being themselves and being a physicist. Get to know your students – for instance, I invite mine to write me letters of introduction – finding out about their interests and motivations, and creating opportunities to explore how what they learn in physics relates to what's important to them. Highlight that success in physics is dependent on effort, as opposed to 'natural ability'.

Johnson encourages teachers to critique the culture of science. She is clear that this doesn't mean critiquing physics knowledge, but rather questioning the status quo, the ways of being and doing that we take for granted, and yet which so often entrench social inequality and keep certain people out. You could show students a photo of the 1927 Solvay Conference (which includes many of the most famous physicists, of whom only one is a woman – Marie Curie) and facilitate discussion around the physicists who feature in textbooks. If students are constantly surrounded by images of physicists who look a certain way, without any conversation about why, they'll come to conclude that only that kind of person can be a physicist – and if that person doesn't happen to be like them, will conclude that they don't belong in physics.

Alongside that you can show them examples of non-stereotypical historical and modern-day physicists, and networks and opportunities such as the Blackett Lab Family, Conference for Undergraduate Women in Physics, and the Bell Burnell Graduate Scholarship Fund, to highlight that progress is being made. By doing so you will show them that they can be part of the change. And, if they go into physics, they will be prepared for the reality that it isn't the most diverse field, but things are looking up, and they won't be on their own.


Credit: https://rarehistoricalphotos.com

Attendees of the Solvay conference in 1927. Marie Curie, the sole woman, is third from the left on the front row.

more...

Read the article here:

Johnson, A. (2019), A model of culturally relevant pedagogy in physics, *AIP Conference Proceedings* 2109, 130004

bit.ly/3jBRASg

talkphysics

David Cotton, editor of our online discussion forum, shares TalkPhysics discussion threads looking at **diversity and inclusion.**

Log in or register to join the conversation at **talkphysics.org**

Part of the Limit Less campaign is about increasing the number and diversity of students studying physics. Physics can lead to promising careers both through A-levels and BTEC, leading to apprenticeships and degree courses. Knowledge of careers and courses is good for encouraging student engagement. Some careers are explored here:

bit.ly/40FhMMH

Increasing access to physics for disabled students is important and this thread has some good ideas, including a reference to the CLEAPSS guide G077. The post is on advice for modifying practices and risk assessment for wheelchair users in the physics laboratory:

bit.ly/40GnjSX

Many of the resources from the pandemic online IOP sessions are on TalkPhysics, including the sessions relating to increasing diversity. The resources for a session highlighting black female physicists includes some powerful stories, such as that of the black female NASA computers who worked on the Apollo programme. The astronauts demanded that these women calculated their orbits! There is also a reference to Dr Jess Wade who advocates for female scientists:

bit.ly/3jF2tCU

The current discussion on the Limit Less campaign explores ideas on how to engage everyone with physics. The solutions to problems such as global warming lie with the physicists of tomorrow. Students need to know there is hope, and physics-based solutions are waiting to be discovered. They can be part of this process by developing their knowledge of physics, which starts in the classroom:

bit.ly/3HzCp44

UNIVERSITY OF CAMBRIDGE

Haira Gandolfi, a lecturer at the Cambridge University Faculty of Education, considers what it means to talk about 'diversity' and ‘decolonisation’ when thinking about physics teaching.

bit.ly/3JPLwR0

Diversity and decolonisation in physics teaching

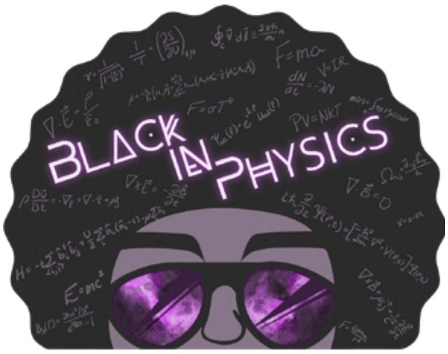
In recent years, discussions about inclusion, diversity, and decolonisation have become more common in schools across the UK.

When we talk about ‘diversity’ in physics teaching, we are thinking about the representation of different stories, narratives, ideas and actors in our lessons. That could include, for instance, challenging the lack of stories of contributions of women, black, indigenous and non-European/US communities, among many others, to the field of physics. One example could be looking at the work of Mary W Jackson, Katherine Johnson and Dorothy Vaughan at NASA’s space missions in the 20th century. Other interesting examples could be exploring the astronomical knowledge developed by the Maya, Inca and Aztec peoples in the Americas, or the Islamic communities of the Middle East and the Iberian Peninsula.

However, when we talk about ‘decolonisation’, we are thinking beyond representation by also bringing critical thinking into our lessons. It involves taking an extra step from ‘diversity’ to supporting students’ critical engagement with the complex, and often unequal, social, cultural and historical legacies linked to scientific development across the world. For instance, it could involve not only introducing the story of Jackson, Johnson and Vaughan, but also discussing the social and cultural context in the USA at that time, which hindered most women’s and people of colour’s participation in scientific communities. Here, we can think of decolonisation as an area that can support physics educators even beyond issues of inclusion, as it can also help us to critically address the ‘working scientifically’ sections of the National Curriculum, such as 'appreciating the power and limitations of science and considering the ethical issues which may arise'.

physicsworld

Stories from our magazine for the global physics community.
Visit **physicsworld.com**



Pursuing joy in an alien world

This article from October last year was one of a series of essays by black physicists about their experiences, published to mark #BlackInPhysics week (24–28 October 2022).

Larissa Palethorpe is an astrophysicist specialising in exoplanets. She writes: "Being from a diverse background in a not-so-diverse place or field can sometimes seem like setting foot on one of these hostile worlds, but I believe that if we choose to thrive in these areas we will."

bit.ly/3RFxinr

For more from the #BlackInPhysics series, including essays and podcasts, visit **physicsworld.com/p/collections/BlackInPhysics/**

Instead of celebrating the lone genius in physics, we should focus on collective efforts

In an opinion piece from January, Amy Smith, a PhD student at Imperial College, argues against the hackneyed stereotype of the physicist as the 'brilliant loner'. The perception is not only inaccurate but damaging – both to students and academics who feel they can't live up to the 'genius' badge, and to the public perception of physics, which is driven by collaboration and relies on the interpersonal skills of its practitioners.

She writes: "… next time you discuss the Nobel prize, the newest scientific discovery, or the award for best physics undergraduate – think about what you really want to praise and what message you are sending. Are you praising a skill or an effort, a group or an individual, and is what you're celebrating achievable for anyone with the right support?"

bit.ly/3x64f2W

Jonathan Lansley-Gordon, education consultant and managing director of The Blackett Lab Family – the UK's network of black British physicists – on creative approaches to incorporating inclusion in physics lessons.

theblackettlabfamily.com

The disrupted physics curriculum

As curriculum leaders explore themes around diversity and inclusion, and how these might be weaved into lessons, we physicists may be tempted to quietly check out of the conversation. Let's be real – simple harmonic motion has nothing to do with gender equality, right? A history lesson might reasonably explore the lasting effects of colonialism, but there's little overlap between empire and electromagnetism.

Such scepticism is justified; topics shoehorned into schemes of work bear the hallmarks of inauthenticity and rarely achieve the learning outcomes intended. However, against a backdrop of major sociological upheaval, is it time to reassess the pervasive notion that physics is neutral with respect to personal and societal identities and issues?

As it happens, the concept of a 'physics identity' has received much attention in recent years. Researchers and educators exploring this idea recognise the barriers that exist to participation in physics and how these affect diverse groups of students.

A systematic approach to tackling these barriers through the curriculum remains a challenge.

Diversity and inclusion can and must be introduced by means other than subject *content*. A broader consideration of the curriculum could point to different lenses for exploring identity and culture. Some physics departments purposely seek instances where a lack of diversity creates teachable moments. For introductory lessons on waves and light, for example, the famous 1927 Solvay Conference image allows students to pick out the usual headliners – Einstein, Planck, etc. – but also to consider the under-representation of women (see page 15).

Expand your thinking about diversity and inclusion in the physics curriculum beyond the confines of its content. Think about what student voice might tell you, and how you can diversify your students' physics identity. And disrupt the traditional narrative of the curriculum wherever you can!

Understanding disadvantage in education

Fiona Fearon, policy and projects manager at the National Governance Association, writes about the importance of school governing boards engaging with educational disadvantage.

nga.org.uk

Access the NGA toolkits here: **bit.ly/40wRUTb**

One of the most important responsibilities of governors and trustees is to ensure that all pupils are offered a rich and engaging curriculum, regardless of their background.

Educational disadvantage, which many children experience, is a potential barrier to achieving this. Disadvantage in education is consistently reported as one of the biggest challenges that schools and trusts face. The DfE's pupil premium bracket is not the only indicator of this persistent issue. The National Governance Association has recently published a collection of toolkits that boards can use to support their school or trust in tackling disadvantage. The toolkits relate to five key pupil groups who are statistically more likely to experience disadvantage: pupils experiencing poverty; pupils with special education needs or disabilities (SEND); certain ethnic minority groups; pupils with emotional and/or mental health problems; and vulnerable pupils (including looked after children and child carers). While we don't want to create more labels, it is important to identify any barriers that exist within our classrooms that hinder inclusivity.

A key role of governing boards is to align the school or trust's vision with the curriculum. Coupled with the value placed by boards on stakeholder engagement, this creates a perfect opportunity to engage with your board on the issues that matter most to you and your pupils.

Making physics matter

Mel Gardner writes about the Ogden Trust's work to expand access to physics for under-represented groups.

Visit **ogdentrust.com** to find out more about the Trust's programmes including Subject Knowledge for Physics Teaching CPD, early career mentoring, Senior Teacher Fellowships and School Partnerships.

Physics can underpin many career paths and opportunities in diverse sectors and industries. The critical thinking skills learnt through studying physics can be transferred into many areas of life and work, and are increasingly important in navigating the scientific, social and political landscape.

Inspiring and committed teachers in the classroom are fundamental to encouraging more young people from under-represented groups to take physics further. The Ogden Trust's programmes nurture and empower teachers of physics throughout their careers, equipping them with subject knowledge, resources and confidence to deliver a positive physics experience.

Among the resources published on the Ogden Trust website are stories of people who have forged careers on the back of their physics studies. One such is Shivani Dave, a broadcaster and journalist with Virgin Radio Chilled and OpenlyNews on TikTok. Shivani is also a producer for the award-winning, independent LGBTQ+ history podcast, The Log Books. They commented: "Studying physics helps me be a better journalist – not just when covering science news – but in any scenario. Analysis and data comprehension are vital skills in my industry, and they are key skills taught when studying physics."

Physics education and career pathways should not be limited by social or economic factors and the Trust is working hard to deliver sustainable, effective, inclusive programmes that make physics matter to more people.

The Trust provides funding and support so schools can ensure opportunities, activities and events are available to all students, especially those who may feel disenfranchised from physics because of social or financial circumstances.

We encourage and facilitate enrichment through extra-curricular activities, family and community group engagement, and through networking with local employers, which all show the positive benefits of physics and provide broader physics experiences for pupils.

Connect, Create and Belong

"You can't be what you can't see."

If you're a young person from a Black, Asian, Minority Ethnic or disadvantaged background, or a girl or disabled, it can be quite hard to imagine yourself working in physics.

Planet Possibility aims to disrupt that – and help physics teachers – by **connecting** people with physics careers, **creating** physics experiences and opportunities, and helping young people feel they **belong** in physics.

We are a consortium of five organisations working together to bust some of the myths about physics. Funded by the IOP, we aim to encourage more young people to study and work in physics.

The Planet Possibility platform is a one-stop shop for all our activities, which reach young people and their teachers and parents through advice, events, games, and digital content including podcasts and TikTok videos.

Highlights for teachers:

- Check out the free support on offer in the form of 14 different online CPD sessions provided by **Physics Partners.**
- Enrich your physics provision at school through Connect, Create and Belong, a free online **Physics Club** with hands-on experiments and inspirational talks given by role models from different backgrounds.
- Book a **STEM truck visit,** focusing on the physics of sustainable motorsport. We park up at your school and guide your students through an exciting 90-minute exploration of 3D printing and computer aided design (CAD), electronics and aerodynamics.

Register to connect with Planet Possibility and keep updated with news of all our activities and how you can get involved:

planetpossibility.co.uk/register

planetpossibility.co.uk

IOP Institute of Physics

Be where you are celebrated, not tolerated

Diverse Educators Ltd launched in 2020, evolving out of the grassroots network, #DiverseEd.

We are committed to moving the agenda forwards on diversity, equity and inclusion (DEI) in our school system. We work with state schools, independent schools and international schools to support DEI strategy and training needs.

We believe that we are stronger, and can go further together, in collaboration.

Our vision: Everyone is celebrated in every classroom in every school.

Our mission: A collaborative community that celebrates the successes and amplifies the stories of diverse people.

Our values: Promoting acceptance. Increasing visibility. Encouraging celebration. Creating belonging. Enabling learning.

Our approach: Growing consciousness. Building confidence. Developing competence.

For more information check out our digital brochures:

Professional Learning
bit.ly/3RDFOn9

Resources
bit.ly/3YgfzWg

Services
bit.ly/3jF5C5G

diverseeducators.co.uk
Twitter: @DiverseEd2020

Upcoming Talk Physics events

talkphysics

Visit **talkphysics.org/events/** for full listings and event details.

28 March
Physics Central 11–19 – Tips for Inclusive Science Teaching

27 April
IOP Scholars now Early Career Teachers (ECTs) CPD Programme – Optics

10 May
IOP Scholars CPD Programme – Make and Take

31 May
IOP Scholars CPD Programme – Electricity KS3&4

7 June
IOP Scholars CPD Programme – Practical work in physics

28 June
IOP Scholars CPD Programme – Waves KS3&4

IOP Scotland – Stirling Physics Teachers' Meeting

Thursday, 25 May 2023

The 48th Stirling Physics Teachers Meeting will be on the theme of 'Making the most of Physics Education Research in your classroom'.

iop.eventsair.com/spt48-2023

CONGRATS

Charles Tracy OBE

Many congratulations from all of us on the Classroom Physics team to the IOP's Senior Advisor on Learning and Skills, Charles Tracy, who has been awarded the OBE for services to education.

After working as a head of physics in Hertfordshire, Charles joined the IOP in 2006, where he has played a leading role in championing high-quality physics teaching and learning across the UK and Ireland.

(Don't miss Charles' article on page 8 of this issue.)

Seen elsewhere:

BBC Young Reporter: Why don't more teachers look like me?

Check out this interesting article by a young black reporter about diversity in teaching, featuring the advocacy group Black Men Teach.

bbc.in/3Yrrct4

The Amazingly Enormous STEM Careers Poster

This informative poster from Ada Lovelace Day (@findingada) shows the incredible range of jobs taken by a cohort of STEM graduates, linking their roles back to degree courses and A-level choices.

bit.ly/3Ex2aBt

The Guardian: Target Oxbridge scheme expands to nursery schools

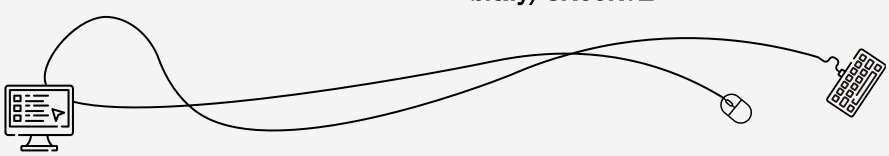
A scheme that's had success in supporting black students to apply to Oxbridge has begun to work in nurseries.

bit.ly/3Ik9cTr

FE News: Impact of qualification reform on students

This analysis of the Department for Education's reform of level 3 qualifications asks whether proposed changes will fully meet the needs of students on vocational courses.

bit.ly/3XeeKvZ



Useful resources for young people considering physics

Choosing physics: A-levels, Highers and Leaving Certificate

Advice on post-16 physics in schools across the UK and Republic of Ireland.

bit.ly/3RJom0E

Choosing physics: a family perspective

An interview with a physics student and her mum about what it's like when, as a parent, you don't understand what your child is studying.

bit.ly/3x2pdzF

Vocational qualifications, technical routes and apprenticeships

Comprehensive information about the range of physics-related careers that don't all require going to university.

bit.ly/3jLJ82R

Classroom Physics is published by Institute of Physics, 37 Caledonian Road, King's Cross, London N1 9BU, UK. Tel 020 7470 4800.