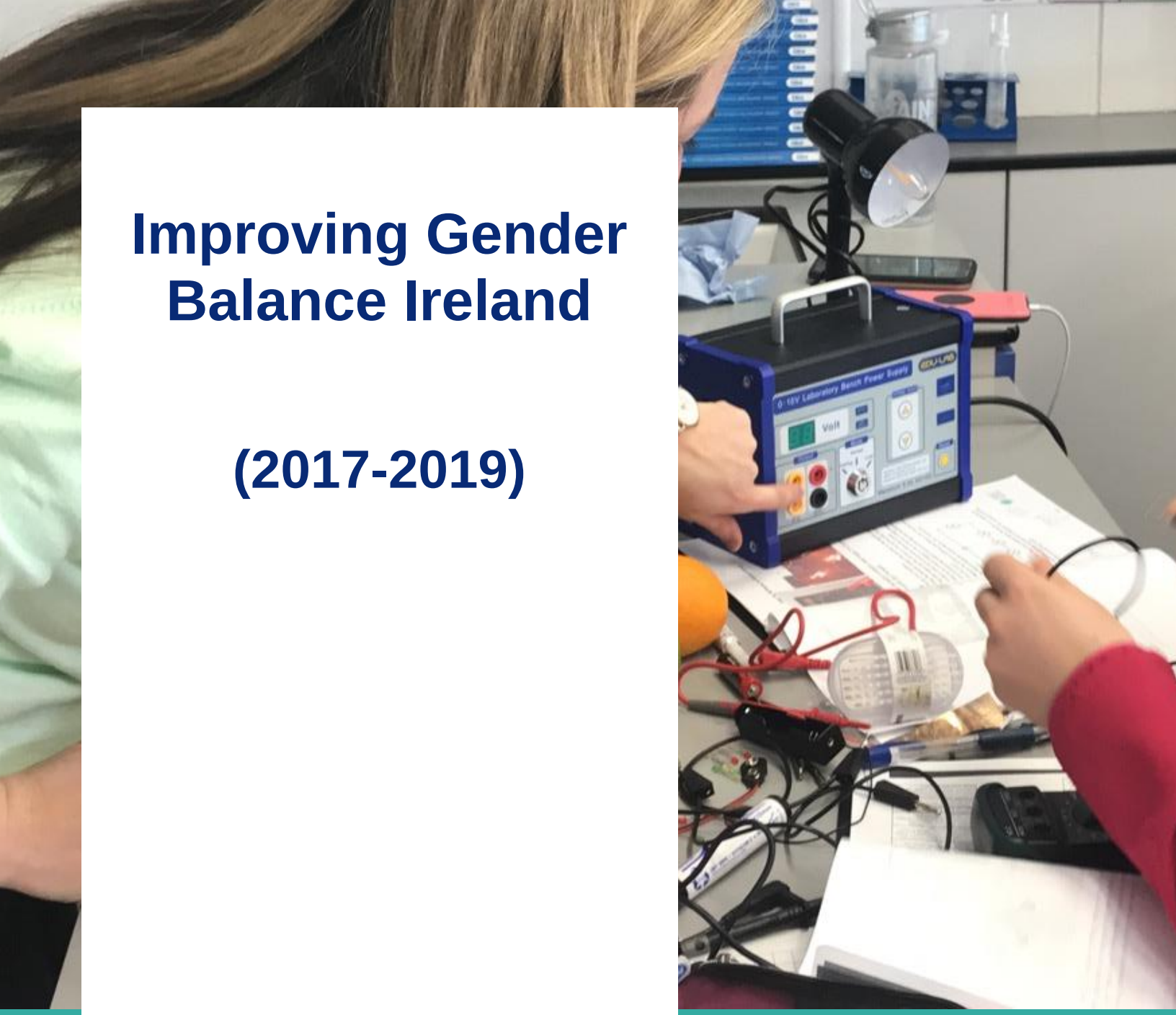


Improving Gender Balance Ireland

(2017-2019)

26 FEBRUARY 2020

Eilish McLoughlin, Deirdre O'Neill and Georgina Fagan
CASTeL, Dublin City University

IMPROVING GENDER BALANCE IRELAND

Contents

Executive Summary

Improving Gender Balance in Ireland aims to increase the engagement and understanding of students, particularly girls, studying physics at second level. This programme sought to take a holistic approach to changing students' experience with physics and works collaboratively with schools, teachers and students to change perceptions of who can study science and tackle the inequities that prevent students from engaging in physics and STEM careers. The specific objectives of this project were:

I. Deepen science teachers' confidence and content knowledge for teaching physics.

II. Adopt a whole school approach to addressing unconscious bias and gender stereotyping and build confidence and resilience for students, particularly girls, to continue with Physics.

III. Increase awareness of STEM and careers in STEM.

A three strand approach to address these objectives was implemented over two phases during 2017-2019. In Phase I, seven secondary schools were identified and recruited to partner in this programme for a two year period. This included 2 all-girls, 5 coeducational and 2 designated-disadvantaged schools with a total of 405 teaching staff, of which 51 were science teachers. In Phase II an additional 21 secondary schools: (13 coeducational, 5 all-girls and 3 all-boys) with a total of 1163 teaching staff were recruited from across eight counties. The impact of the programme was evaluated using qualitative and quantitative data collected and analysed by both internal and external evaluators.

The findings of this programme identified nine essential steps for achieving Equity and Inclusion in STEM Education. These nine steps present a robust framework for national implementation of the Improving Gender Balance in Ireland programme, to support teachers and students of physics in all Irish second level schools.

- Commitment of School Management and Leaders: School leader engagement in workshops was effective in advocating and supporting teachers to address unconscious in the school. School leaders are key drivers in sustaining this programme and dependence on them to relay information to all staff and follow up on their progress is valuable.

- Collaborating between Key Stakeholders: Engaging external key stakeholders to discuss and advise on logistics and other avenues of opportunity for the programme proved to have wider scope in its outcomes than just input into the project objectives. Key stakeholders also engaged in using the programme as a vehicle for culture change in their own practice e.g. PDST engaging in unconscious bias workshops and conversations with the programme team.

- Bringing Together Research and Practice : Findings have highlighted the importance of research-practice collaborations to address the three-strands of this programme. The inconsistencies exhibited in the survey responses from all teachers further corroborate the need for a whole school approach to raising awareness of unconscious bias and gender stereotyping in school policies and practices.

- Professional Learning Opportunities: Teacher reflections from both all staff and science teachers indicate a need for more opportunities for professional learning. The difference in impact of Phase I and Phase II suggests that sustained and ongoing professional learning opportunities are required to effect real change in classroom practice and school culture.

- Raising Awareness of Unconscious Bias: The audits of the school websites highlighted the lack of awareness around unconscious bias and gender/subject stereotyping. The imagery associated with physical science subjects was male dominated and Physics was generally listed at the bottom of the subject choices available at Senior Cycle.

- Deepening Confidence and Competence in the Teaching and Learning of Physics: Science teachers identified their key challenges in teaching physics, and these were addressed through the design and implementation of science teacher workshops. The feedback from science teachers indicates that increasing their understanding of basic physics concepts is as beneficial to them as focusing on pedagogical approaches.

- Building Resilience in Students: Creating experiences for students to reflect on unconscious bias and gender stereotyping issues is important to building resilience in students. Encouraging students to become their own advocates of building resilience proved to be an effective method of encompassing the student voice with one school employing a train the trainers model to students rolling out unconscious bias workshops.

- Active Learning in Physics: An inquiry-approach was used in workshop facilitation so that teachers could experience learning through inquiry and model the workshop approach in the physics classroom.

- Challenging Barriers to Inclusion: Evaluation of this programme has identified the key challenges for STEM education in Ireland as student's self-efficacy in STEM; students, parents and teachers lack awareness of STEM careers; impact of negative stereotypes and preconceptions; lack of resources for STEM subjects in school; and lack of awareness of STEM in society.

Programme Overview

Improving Gender Balance in Ireland aims to increase the engagement and understanding of students, particularly girls, studying physics at second level. This programme seeks to take a holistic approach to changing students' experience with physics and works collaboratively with schools, teachers and students to change perceptions of who can study science and tackle the inequities that prevent students from engaging in physics and STEM careers.

Programme Background

In Ireland, the 2019 statistics reported by the State Examinations Commissions show that 14% (7,942) of the total Irish Leaving Certificate student cohort (56,008) choose to complete the Leaving Certificate physics examinations. Only 4% (2116) of the total student cohort were girls completing Leaving Certificate Physics Examinations (State Examinations Commission, 2019). The STEM Education Review group reported that worryingly, 22% of the 723 Irish secondary level schools do not offer Physics as a separate subject at upper secondary level (STEM Education Review Group, 2016). In Ireland, the registrations of the Teaching Council of Ireland (2017) indicated that 3878 teachers were registered to teach Biology, 2376 registered to teach Chemistry and 1259 were registered to teach Physics (STEM Education Review Group 2016). All of these teachers are recognized to teach junior cycle science at lower second level (students aged 12-15 years) resulting in the majority of students never being taught physics by a qualified physics teacher. This data highlights the need to encourage more students, particularly girls, to continue in physics at upper secondary level and a further need to promote physics teaching as a future career for young people nationwide.

The situation in Ireland is not unique, with many countries seeking to address low numbers of teachers qualified to teach physics at second level. In England, physics teacher recruitment had hovered at about 400 each year from 1970 and reached an all-time low of 200 in 2001 (GOV.UK), while entries for physics A-level declined by 40 % in the 20 years to 2006 (Institute of Physics, 2006). However, following significant Government intervention, in partnership with the Institute of Physics, both trends have

reversed in England with physics teacher recruitment figures reaching an all-time high of 920 in 2012 and an average annual recruitment over the past five years of 750.

Strengthening the pipeline of STEM Education from early childhood to higher education leading to an increased uptake of STEM careers is of utmost importance to our national and global economy. However, several studies have identified barriers that effect students, particularly girls, studying physics and pursuing careers in physics/STEM. ASPIRES research reported that most young people and their parents had a very narrow view of where science careers can lead them (Archer et.al, 2013). Ito (2018) reports that student perceptions of pSTEM fields (physical science, technology, engineering and mathematics) can strongly influence students' interest in these subjects (Ito and McPherson 2018). Archer et.al (2010) associates science identity with student self-identification with science and their perception of its [science's] usefulness in the future, while Lewis (2017) emphasizes the importance of focusing women's sense of belonging in pSTEM in order to increase persistence in these subjects.

In order to support teachers to be confident and competent in teaching physics, they need to develop a deep understanding of physics concepts and utilize appropriate pedagogical approaches for teaching these concepts. Etkina (2010) describes five aspects of CKT (content knowledge for teaching) that bridges the gap between content and pedagogy in the teaching of physics; (i) orientation towards teaching, (ii) physics curriculum, (iii) student ideas, (iv) effective instructional strategies, (v) assessment methods (Etkina et al. 2018). Teachers need support to develop their understanding of these five aspects so they can plan and affect change in their own classroom practice.

"Your work provided the perfect stimulus for our team dialogue and the stats and insights you brought added a layer of depth and quality to our bank of information."

Acting Team Leader PDST Health and Wellbeing Team - Post Primary

Programme Objectives

The specific strands of the Improving Gender Balance Ireland programme were to:

I. Deepen science teachers' confidence and content knowledge for teaching physics
II. Adopt a whole school approach to addressing unconscious bias and gender stereotyping and build confidence and resilience for students, particularly girls, to continue with Physics
III. Increase awareness of STEM and careers in STEM

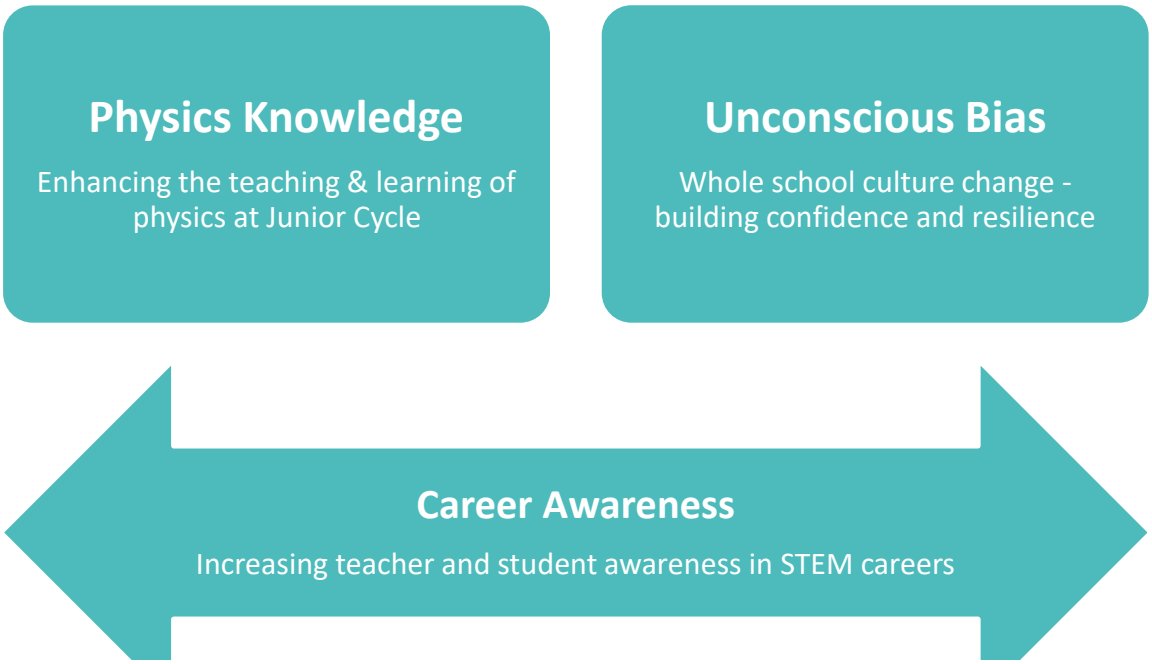


Figure 1: Improving Gender Balance Ireland Programme Objectives

The programme embeds the above three objectives in programme activities across all levels of the school environment: school management, teaching staff and students. The third objective, Career Awareness is integrated with the delivery of objectives one and two.

"I think it should be noted that, I think it was very, very useful that after every workshop that we were given a box of resources needed to conduct the activities from that talk"

Phase II Science teacher

Programme Partnerships

- **Programme Coordination and Management**

The programme team from CASTeL at Dublin City University consisted of a project coordinator to oversee all planning, implementation and evaluation of the programme and two programme officers that were recruited to implement the actions of the programme over two implementation phases: Phase I (January 2017-December 2019) and Phase II (August 2019 - December 2019). The project team held regular planning and review meetings to facilitate ongoing monitoring and effective implementation of all programme activities.

Programme partner meetings between CASTeL and IOP in Ireland personnel were held on a bimonthly basis in Phase I. In addition, several face-to-face and online meetings were held with IOP personnel working on parallel IGB projects in Scotland and England to share ideas and best practice. Personnel in IOP Ireland changed before the start of Phase II and the new personnel were given an update on the project activities and outcomes. Annual reports and meetings were held with Science Foundation Ireland staff to provide regular updates on project activities and outcomes.

- **Programme Advisory Committee**

A programme advisory committee was established and convened twice in the first implementation phase to advise and inform project activities and actions. Membership included key stakeholders of STEM education in Ireland, such as Institute of Physics in Ireland and UK, Department of Education Inspectorate, State Examinations Commission, NCCA, JCT Science, PDST Science, EpiSTEM at University of Limerick and a representative of Science Foundation Ireland was invited to attend as an observer at these meetings.

- **Collaborating Schools**

Phase I - Seven schools, from the greater Dublin area were recruited as a representative sample of Irish schools; and included 5 coeducational and 2 all-girls schools – also included 2 designated-disadvantaged schools. This was one more than the proposed six schools and showed how eager schools were to engage with the programme.

Phase II - Twenty-one additional schools from across 8 counties were recruited to collaborate in Phase II and consisted of 13 coeducational, 5 all-girls and 3 all-boys schools.

- **Independent Evaluation**

A tender for independent evaluation was awarded to Graphic Science to conduct a qualitative analysis of the impact of Phase I and Phase II on participating teachers and school leaders.

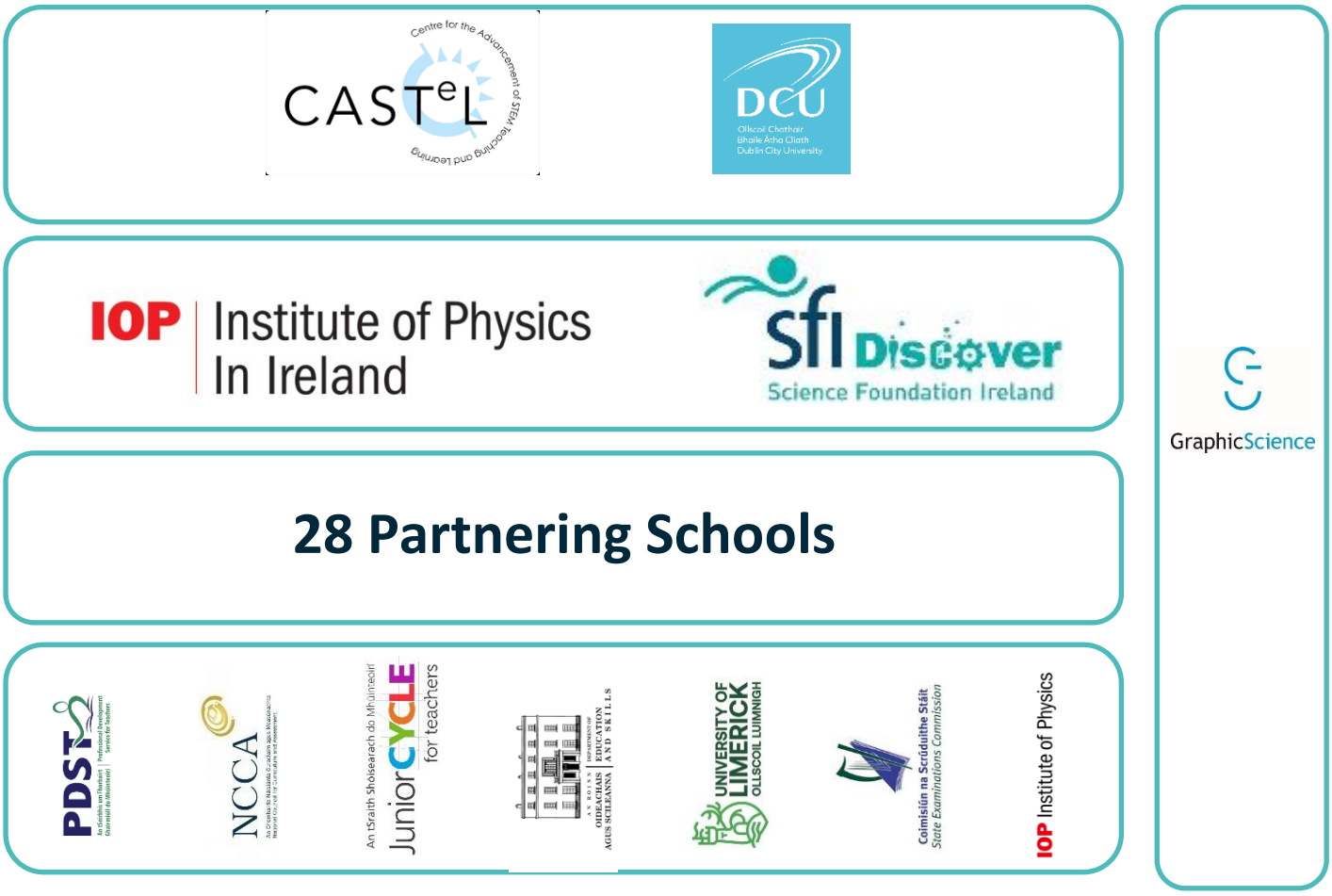


Figure 2: Improving Gender Balance Ireland Programme Partnerships

Programme Timeline

The key objectives of the Improving Gender Balance in Ireland programme were considered in the investment of time and resources when planning the programme implementation. Phase I of the programme was sustained and ongoing over 2.5 years with seven schools. Phase II examined an upscaling model of the Phase I approach with 21 schools over the last 5 months.

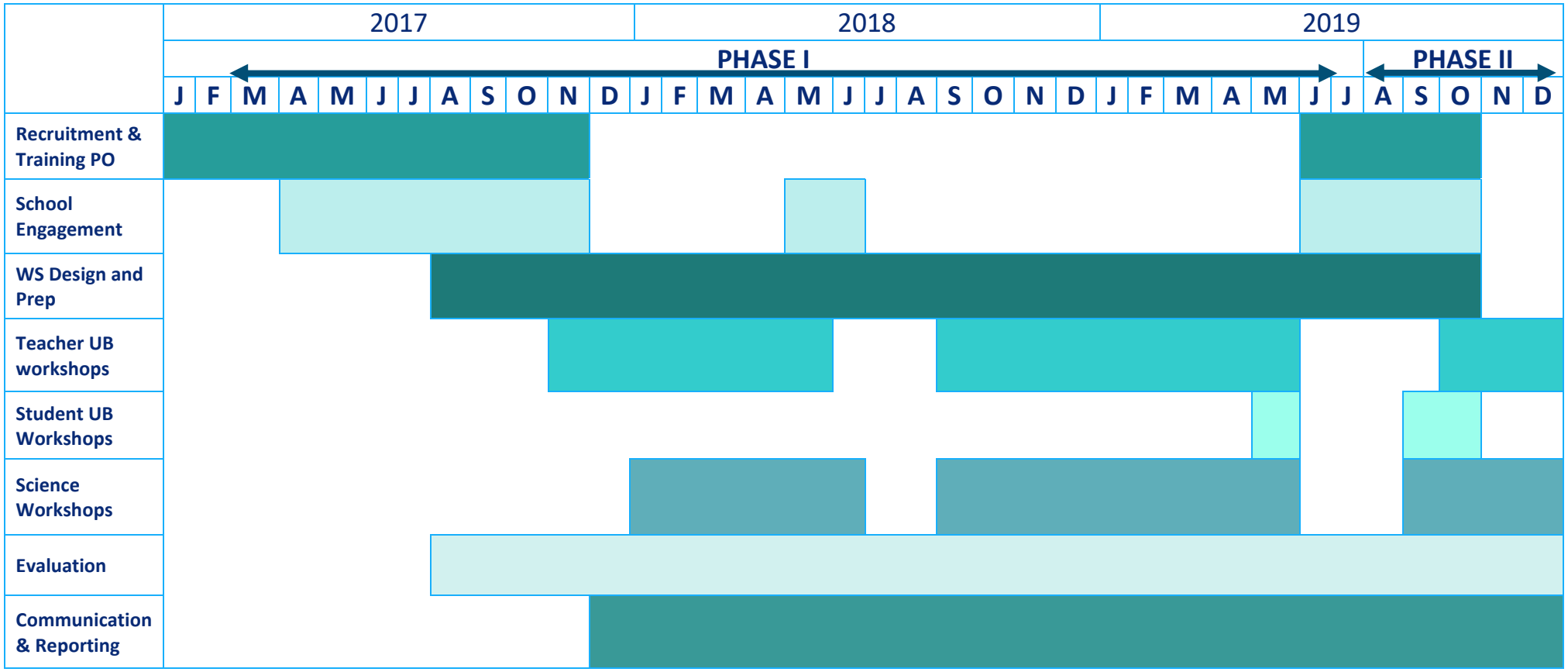


Figure 3: Improving Gender Balance Ireland Programme Timeline

- **Project Officer Recruitment & Training**

Two project officers were recruited and provided with ongoing training and induction into the various programme objectives and activities.

The first programme officer (PO) was recruited in August 2017 to champion Phase I of the programme. The main tasks of this role was to liaise with school leaders in the seven schools that were recruited for phase I implementation. Core duties included coordinating dates for science workshops and unconscious bias workshops, designing and implementing science and unconscious bias workshops, collecting and analysing evaluation data and disseminating findings. This PO also coordinated the science workshops for Phase II of the project.

A second programme officer was recruited to support for Phase II of the programme in August 2019. The role of this programme officer was to liaise with school leaders in the twenty-one different schools that were recruited for Phase II implementation, coordinate dates for unconscious bias workshops, deliver unconscious bias workshops, collect, analyse and present evaluation data.

- **School Engagement**

School Engagement commenced with outlining criteria to identify suitable schools to partner with on the programme. Schools were then approached with letters of invitations, application forms, follow up emails and phone calls and face-to-face meetings. Timing of school recruitment and time spent developing necessary relationships with key champions in each school was essential. School principal engagement was important for sustaining project activities and dependence on them to relay information to all staff and follow up on their progress was more valuable than any external agent trying to implement activities. Scheduling meetings with the school management (principal/deputy principal) during the month of June prior to implementing the project is effective in setting dates and identifying champion teachers to coordinate science workshops and unconscious bias workshops was a necessary part of the planning stages with schools. Establishing a science coordinating teacher of 3+ years' experience in the school was important. The coordinating teacher must have bought into the project and also must have negotiating and organizational skills to

manage other teachers in the department and liaise accordingly with the project officer and school principal.

- **Workshop Design & Preparation**

Substantial time was allocated to designing resources for workshops surrounding the three main objectives: deepening teachers content knowledge for teaching physics, increasing awareness of unconscious bias and gender stereotyping, increasing awareness of careers in STEM. The process followed for each workshop involved three main aspects:

i. Design & Development: 2 weeks preparation for every 90-minute workshops - workshop design, sourcing resources, timetabling, co-designing and refining.
ii. Reflection & Evaluation: Facilitator reflection, teacher reflection and feedback, data analysis and evaluation.
iii. Implementation: Gathering resources, facilitation, travel time.

Each workshop considered the i) design and development, ii) reflection and evaluation and iii) implementation as the key aspects in finalizing a workshop structure, approach and execution.

Science and unconscious bias workshops were developed at the start of the programme and continued to be reviewed and refined after feedback from teachers at the end of every workshop. Dates for workshops were scheduled with a coordinating teacher from each of the partnering schools in both Phase I and II.

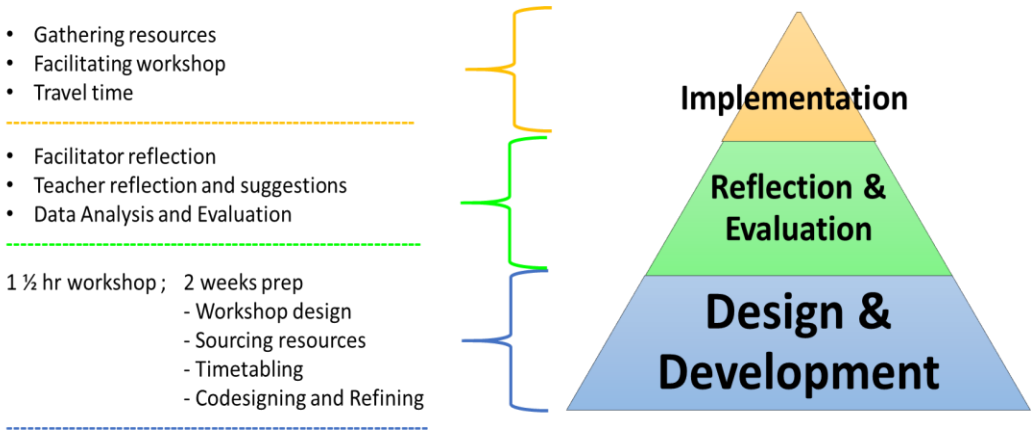


Figure 4: Workshop Development Plan

- **Teacher Unconscious Bias workshops**

Unconscious bias workshops were adapted from the IGB in England materials and resources to align with the Irish education system and in particular aligned with the SPHE curriculum (Strand 1). Overall, two (60 min) unconscious bias workshops and one (60 min) resilience building workshop was developed for teachers. One (50 min) unconscious bias workshop for students was also developed. Aligning whole school unconscious bias workshops with school Croke Park hours helped to incorporate the workshops into scheduled time rather than as extra hours outside of these commitments.

- **Student Unconscious Bias workshops**

Student unconscious bias workshops were less frequent in the programme as they were often requested from partnering schools to visit and engage students as part of a careers fair or science weeks. These workshops focused on creating an awareness of unconscious bias among students and investigating careers in STEM and role models to promote the inclusivity and diversity that Physics can bring as a career option.

- **Science workshops**

Science Teachers, although part of the same department, often worked independently when it comes to subject planning. Phase I & II focused on supporting teachers to actively collaborate as PLCs in their own school to plan/implement/reflect on physics lessons and embed inquiry-based approaches.

Aligning science workshops with department planning hours helped to incorporate the workshops into scheduled time rather than as extra hours outside of these commitments.

Providing teacher recognition with certificates of participation in workshops for teachers to add to their professional portfolio incentivized attendance at science workshops. Providing teachers with both pedagogical resources and classroom kits enabled teachers to be ready to plan their own classroom activities on these topics. Overall, nine (90 min) science workshops were developed: Light, Electricity, Energy, Speed, Density, Forces, Earth & Space, Planning 1, Planning 2.

Each science workshop followed three design principles: content knowledge for teaching, career & societal awareness and unconscious bias, in an effort to address each of the three objectives of the programme. Resources were adopted from previous STEM projects led by CASTeL, e.g. SAILS, ESTABLISH, Science on Stage or available from IOP that promoted inquiry-based approaches to teaching and learning in physics.

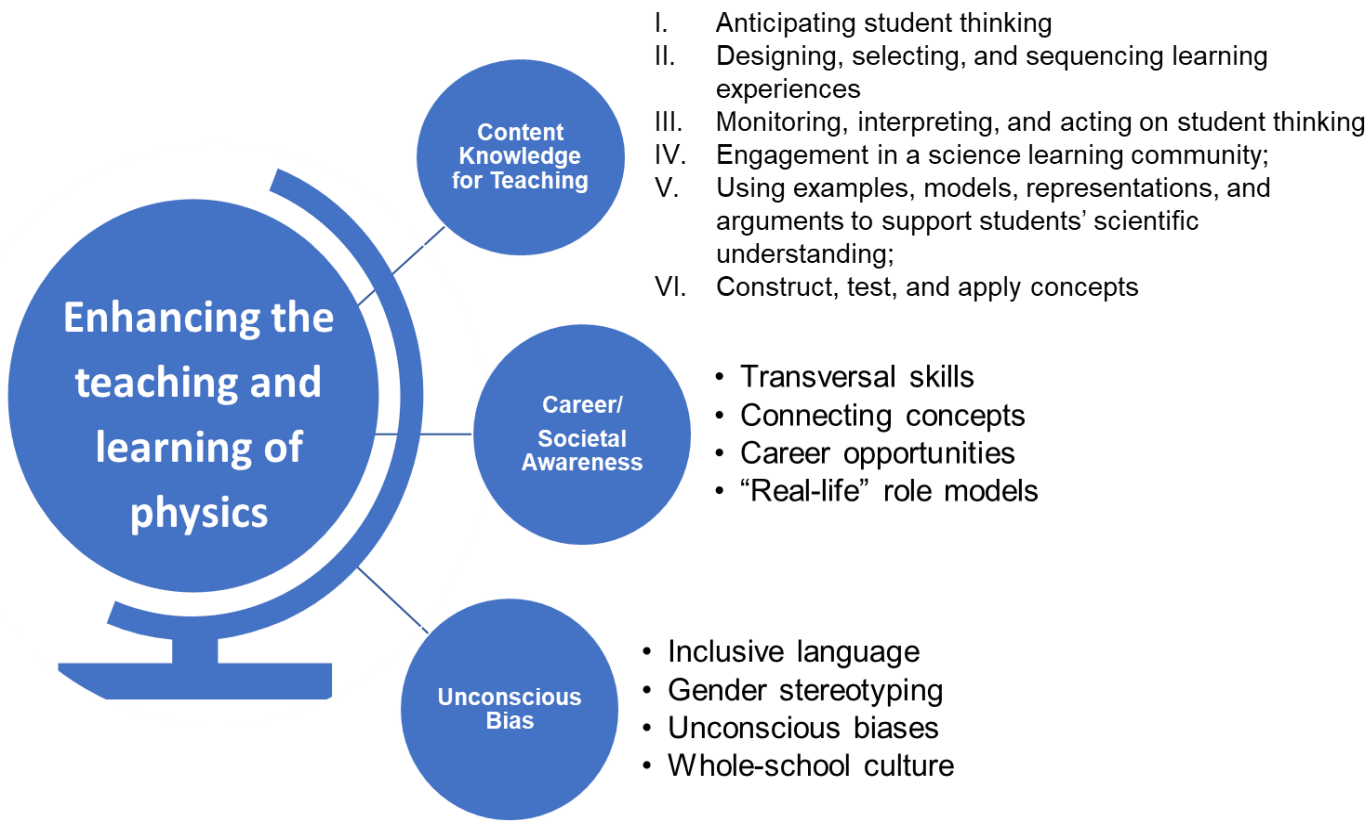


Figure 5: Science Workshop Design Principles

"I am learning so much and know that my students are benefitting too as a result. I can actually say that I am really enjoying teaching Physics now too due to a better understanding of some of the concepts." –
Phase I Science teacher

- **Programme Evaluation**

Internal Evaluation: Data (quantitative and qualitative) were collected from school leaders, teachers and students throughout Phase I and II to collect evidence of project impact on students, teachers and schools and in particular to inform the development of roll-out of Phase II and proposed framework for National roll-out. (See Appendix). Embedding the collection of data into application forms and as part of normal classroom practices was essential so as not be overly onerous on teachers. Embedding data collection within workshops meant that teachers were not disrupted in their thought process or felt that they had to do extra work for participating in the workshops.

External Evaluation: A tender for external evaluation was awarded to Graphic Science to conduct a qualitative analysis of the impact of Phase I and Phase II on participating teachers and school leaders

- **Communication & Reporting**

The programme approach, activities, outputs, outcomes and impact were shared and disseminated through presentations and workshops at national and European conferences. Findings from project evaluation have been shared with strategic partners and advisory group members. Programme activities have been promoted through the programme website and twitter.

"I have applied a good lot of the strategies that I've learnt, in the classroom with my own first year class and I actually think there's a better atmosphere in the class…just simple things the I have the room set up, the way I have them divided, the way I question myself in class…the way I assign roles"

-Phase I non-science teacher

Phase I Implementation

Organisational Structure

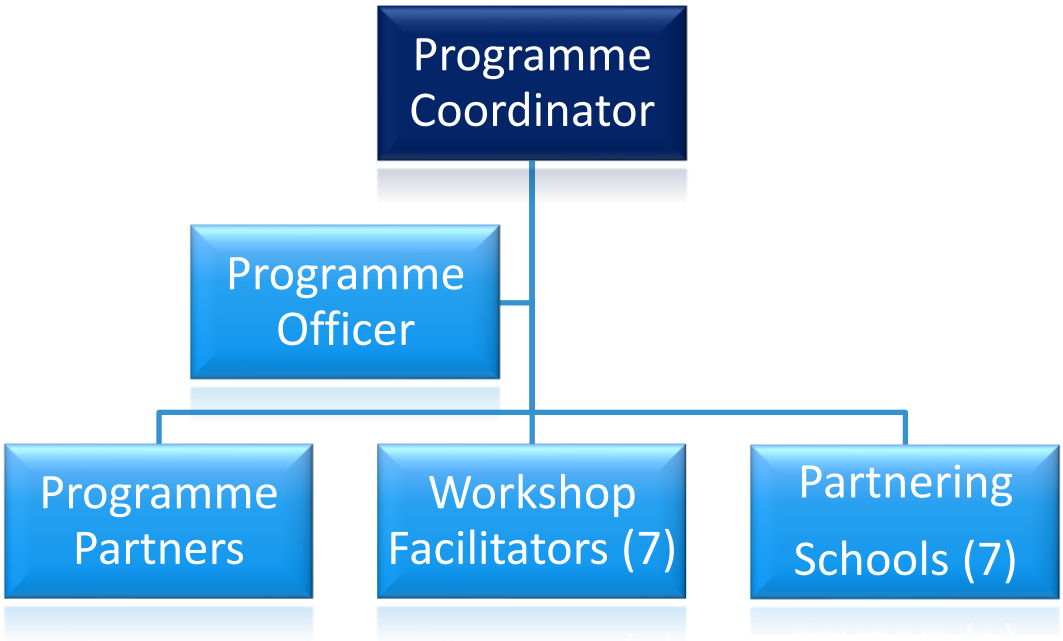


Figure 6: Phase I Organisational Structure

Programme Coordinator: The programme coordinator lead the team providing expertise on programme approach, financial management and relevant pedagogical support.

Programme Officer: The programme officer was a qualified second level science teacher with a good understanding of inquiry approaches and diverse school cultures.

Programme Partners: The Institute of Physics (IOP) was a strategic partner in this programme. IOP had previously developed pilot programmes in Improving Gender Balance in schools in England and Scotland and worked closely with the programme team in Ireland through the provision of advice on approaches to schools, access to materials and assistance in adapting materials for use in the Irish context. Regular meetings were held throughout 2017-2018 with IOP and DCU colleagues to support this programme as well as multiple phone calls and emails. Due to the departure of the IOPI policy officer and a change in personnel in IOP there was little exchange with IOP representatives during 2019.

Other stakeholders such as the Inspectorate, NCCA, JCT Science, State Examinations Commission, PDST, University of Limerick and school principals were involved in discussions and informed project activities and dissemination of the key findings of this project through the formation of a programme advisory committee.

Science Foundation Ireland were invaluable strategic partners in this programme. Regular review meetings were scheduled to share progress to date and offer advice on next steps. Embedding resources from SFI's Smart Futures demonstrated to schools the unity of our team with our partners in the dissemination of workshops.

Workshop Facilitators: Expert teachers were invited to facilitate physics content workshops to science teachers. A total of seven facilitators collaborated and facilitated workshops on the topics of: Energy, Light, Electricity, Forces, Continuous Based Assessments for Junior Cycle (EEI's) and Density. Introducing the science teachers to other advocates of engaging and inquiry-based teaching strategies added to the quality of the workshops.

Partnering schools: Seven schools, from the greater Dublin area were recruited as a representative sample of Irish schools; and included 2 all-girls schools, and 5 co-education schools and included 2 designated-disadvantaged schools. This was one more than the proposed six schools and showed how eager schools were to engage with the programme.

"It's really about creating an awareness more than anything else, and once people are aware of their biases, then they can do something about them."

- Phase II English teacher

Design Principles

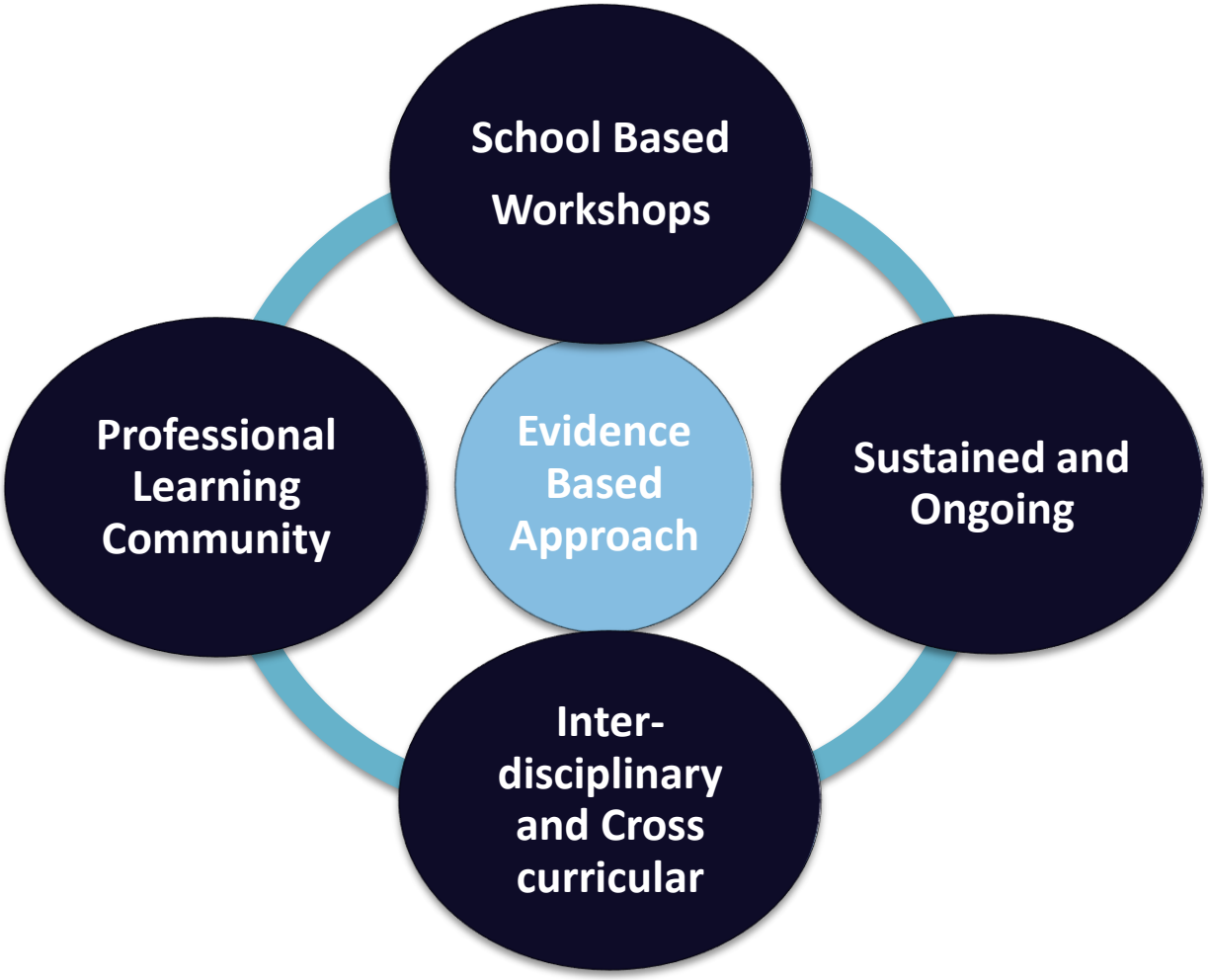


Figure 7: Phase I Design Principles

The Improving Gender Balance in Ireland programme adopted an evidence-based approach during Phase I. All workshops were school-based over a two-year period. This sustained and ongoing approach involved collaborating with teachers as part of professional learning communities within their own subject departments and across other subject departments also. Focussing on collaboration and professional learning, for the teachers and by the teachers, the teacher voice had an important role to play in the evaluation and refinement of the programme.

Phase I – Findings

This programme was internally evaluated at three different levels;

1. **Whole School** (including school management, all teaching staff, and in some cases SPHE and Career Guidance teachers),
2. **Science Teachers** (Biology, Chemistry, Physics),
3. **Students** (third year science students, 5th and 6th year physics students and transition year students).

School Baseline

- **School websites audits**

Each school's public website domain was audited to investigate how physics and gender were represented to the public. Website audits were categorised under the following headings: School Name, Imagery, Placement of Physics in Subject List, Science Related Extracurricular Activities, Involvement in Science Events/Competitions, Gender Balance/Equality Policy, Career Options for Physics listed.

- **Only 1 school mentioned gender equality in the form of discrimination against gender in their school policy**
- **All school websites had sparse imagery with little relevance to skills or action of partaking in school activities. Most imagery were of generic objects (clocks and chalk – stereotypical of school objects) All schools, however, had good balance of boys and girls in pictures.**

- **Pre-unconscious bias survey**

The pre-unconscious bias workshop surveys used were adopted from the Improving Gender Balance project in England. This survey interrogated; teacher profile, unconscious bias in the school and unconscious bias in the classroom (See Appendix).

Teacher profile identifies over 70% of participating teachers were female. Years of experience varied across the cohort, with 2-5yrs and 11-20yrs making up over 50% of teachers that took part in the survey. There was a 72% response rate to the survey in schools prior to participation in unconscious bias workshops.

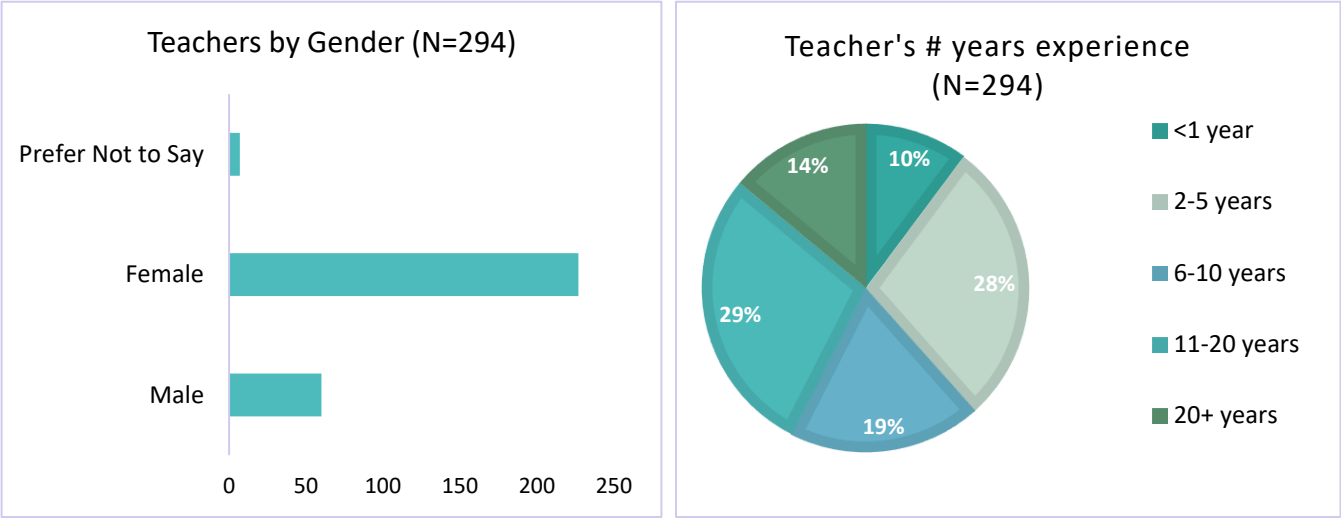
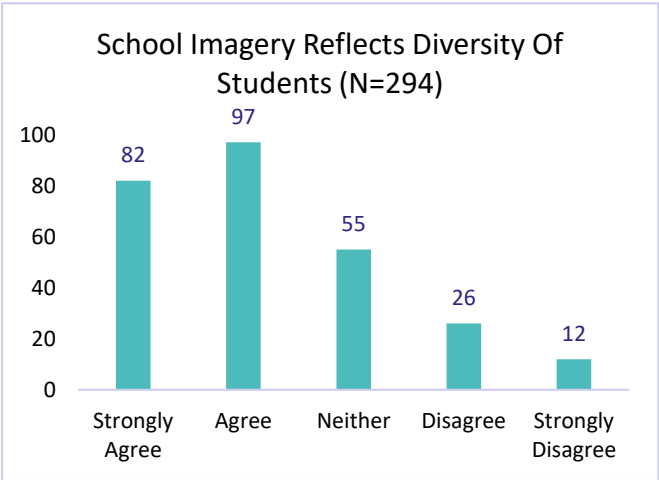


Figure 8: Phase I Teacher Profile

Teachers were confident that the Imagery used around the school and within the classroom reflected the diversity of the student population. With over 170 teachers Strongly Agreeing or Agreeing with the statement. Teachers also recognised that Unconscious Bias was not championed by any member of staff in the school.



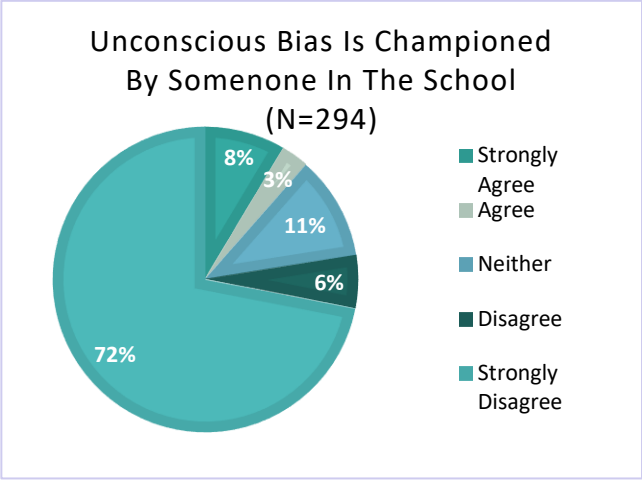


Figure 9: Teacher Responses to Pre-survey

Teachers were optimistic of the fact that it was not too late to alter any gender biases that may exist as part of the school culture.

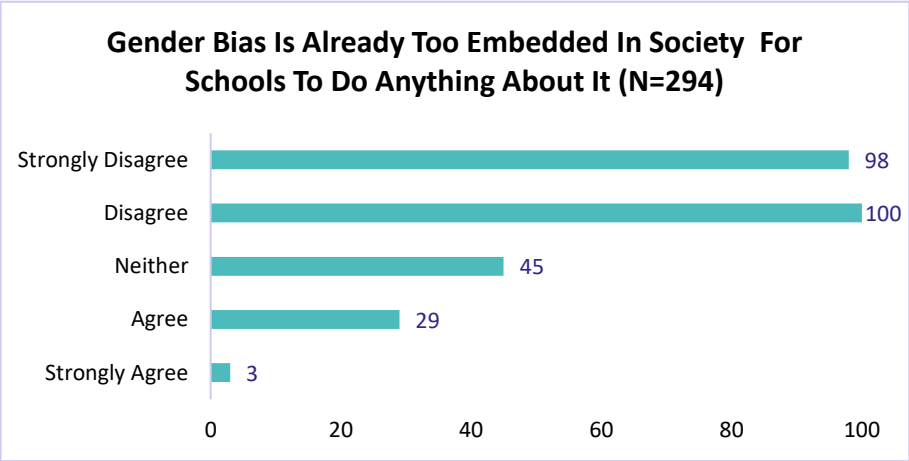


Figure 10: Teacher Responses to Pre-survey

Teachers responses to the following survey items highlighted a lack of knowledge on the topic with the majority of responses representing "neither" as a response to the questions around:

- **Gender bias policy in schools**
- **Promotion of subject career choice**
- **Unconscious bias in lesson Implementation**

Unconscious Bias Teacher Workshops

- **Workshop Feedback**

Teacher satisfaction was measure using a 5-point Likert scale tool (see Appendix) with space for teachers to add a comment if necessary. Feedback was very positive with teachers scoring higher than 75% satisfactory on all elements of the workshop.

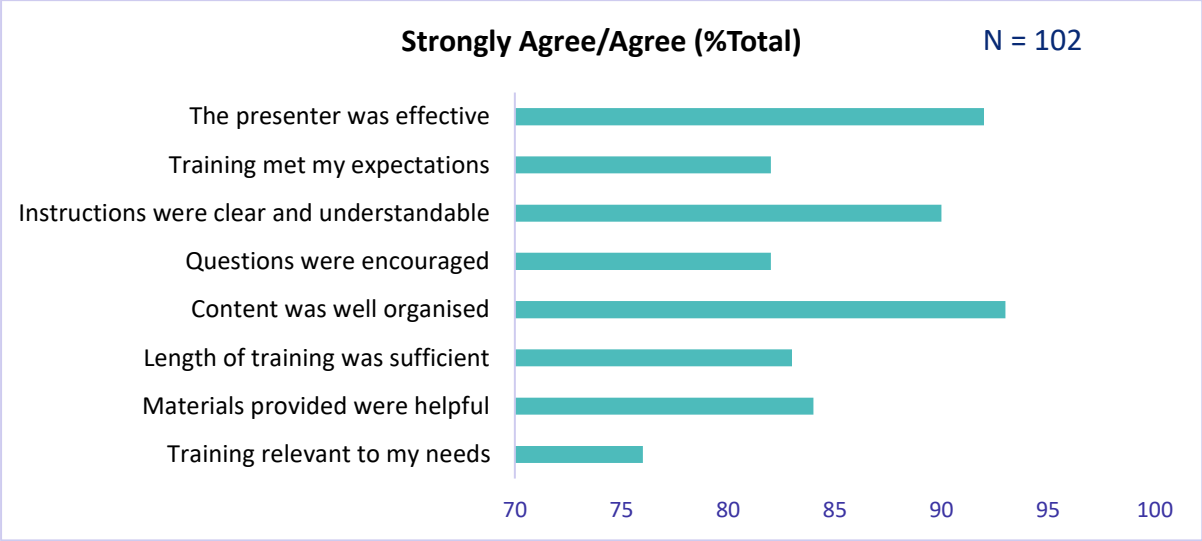


Figure 11: Teacher Satisfaction Survey Responses

Several teachers mentioned becoming aware of the need for unconscious bias workshops after the event, whereas previously they had not seen a need.

Teacher comments were also taken into account for refinement of future workshops, e.g.:

- **"Interesting topics and makes you think a little more"**
- **"More training would be good"**
- **"Really interesting and very relevant (career guidance)"**
- **"Excellent - would like to look at bias towards travellers/settled travellers. I know sometimes I make assumptions and maybe treat people differently"**

- **Impact on Classroom Practice**

Many teachers from Phase I reported impact from unconscious bias workshops on their classroom practice which included personal awareness and physical changes to classroom resources.

> *"…just simple things the I have the room set up, the way I have them divided, the way I question myself in class…the way I assign roles"* (Phase I participant)

All school in Phase I, proposed actions they would take in an effort to create awareness of unconscious bias, gender stereotypes and promote an environment of inclusivity and diversity among teachers and students.

> "We have identified [our unconscious bias] …and we have identified areas and maybe problem areas for teachers that we're going to work on through peer observations" (Phase I participant)

One school engaged in a whole school equality and inclusion showcase where twelve subject departments presented posters that evidenced changes made to classroom practice and resources to promote equality and inclusion across all subjects (Figure 12).

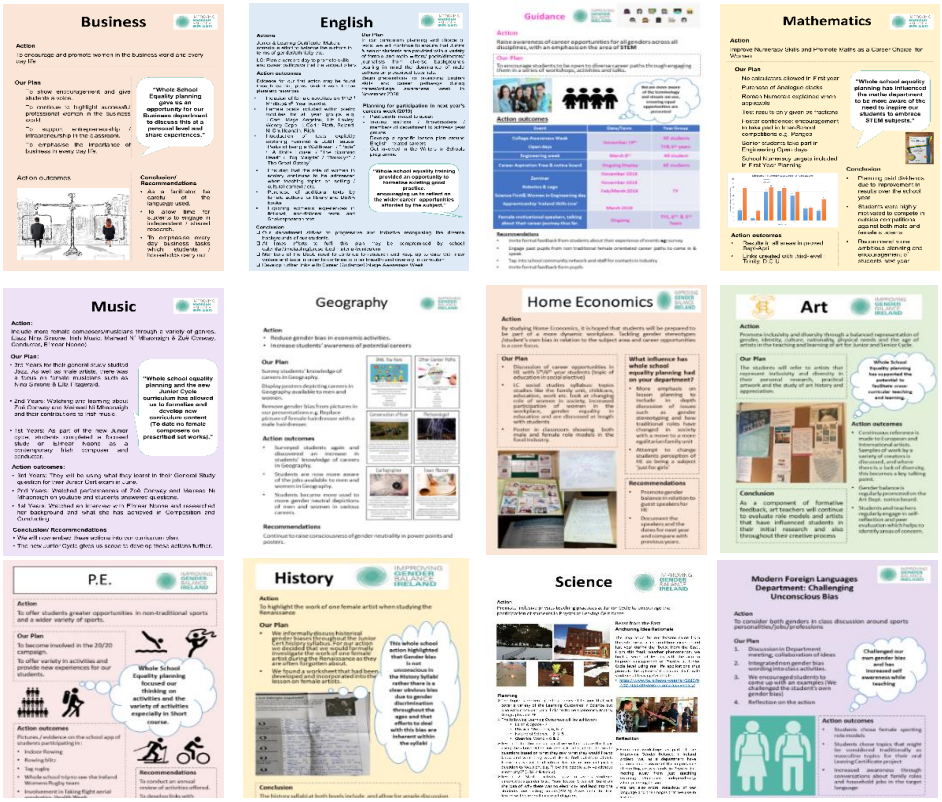


Figure 12: Subject Department Action Plans and Evidence of Impact

Science Teacher Workshops

- **Baseline data**

The school websites audits were also used to establish a baseline for the science department in schools. Placement of Physics on the school list of subjects and imagery around the science subjects and extra-curricular activities were analyzed for this purpose.

- **Two school websites had physics listed as the last subject on the list of subject options.**
- **Only one school had physics listed in the first quartile of their school website.**
- **All schools had mention of science-extracurricular activities, however few had included details on the activities that these involved.**

School application forms included information of the science teachers' demographics. Each school's distribution of science teachers to Physics, Chemistry and Biology were highlighted to inform workshop facilitators and pitch the workshop content to the correct level. Biology subject teachers had the largest presence in each school department, with a maximum of one Physics teacher and in one school there was no physics teacher in the department.

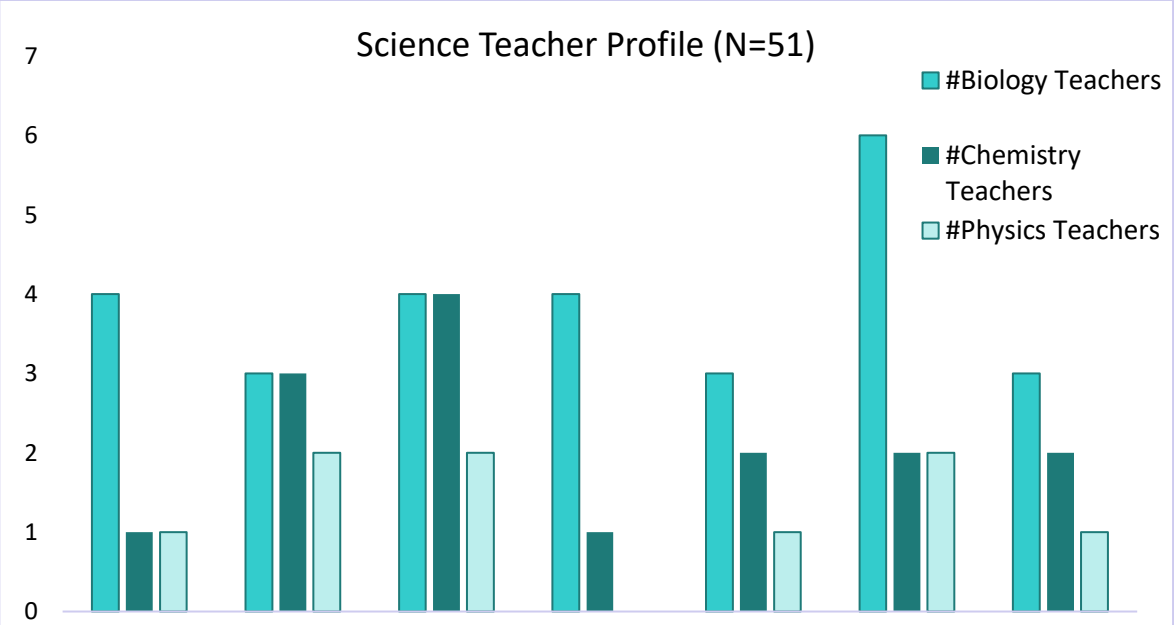


Figure 13: Phase I Science Teacher Profile

- **Science Workshop Engagement**

A total of seven topic specific workshops were carried out in all seven schools. Schools then completed one/two planning workshops depending on hours available to them. These workshops were carried out within school time for one school (where cover for science teachers were provided) and outside of school hours for the remaining seven schools.

Workshop ▼ School ▶	A	B	C	D	E	F	G
Light	✔	✔	✔	✔	✔	✔	✔
Energy	✔	✔	✔	✔	✔	✔	✔
Electricity	✔	✔	✔	✔	✔	✔	✔
Speed	✔	✔	✔	✔	✔	✔	✔
Junior Cycle CBA's	✔	✔	✔	✔	✔	✔	✔
Forces	✔	✔	✔	✔	✔	✔	✔
Density	✔	✔	✔	✔	✔	✔	✔
Planning 1	✔	✔	✔	✔	✔	✔	✔
Planning 2		✔		✔		✔	

Table 1: Phase I Science Workshop Engagement

- **A total of 88 ½ hours were committed to school-based physics workshops with 51 science teachers.**
- **Three of the seven schools participated in 100% of workshops, a total of 13 ½ hours of workshops.**
- **Four of the target schools participated in 12 hours of workshops.**

- **Impact on Classroom Practice**

Teacher class plans were evaluated to establish if inquiry-based and engaging physics approaches were embedded into classroom practice as a result of engagement with the Improving Gender Balance in Ireland science workshops. Each sequence of lessons were evaluated using the AST framework (Windschitl et al. 2012) to determine if the three key objectives of this research were achieved. The intellectual requirement for teachers in terms of planning questions and tasks in the classroom were classified as low-cognitive demand (focus on memorization, procedural tasks, recall understanding only) and high-cognitive demand (sense-making, no discrete answers, using evidence to support claims etc.) as defined by the cognitive demand in questions and tasks in Ambitious Science Teaching (Ambitious Science Teaching 2015). Teachers' sequence of lessons were evaluated according to these criteria to establish patterns in teacher planning for engaging physics.

Figure 14: Science Action Plans and Evidence of Impact

Dimensions of Planning	Specific Examples in Plans	Cognitive Demands Questions and Tasks
Causal Explanation	**Not Present in plan**	
Essential Question(s)	**Not present in plan**	
Scientific concepts	**Forces, Combustion, Light, Torques, Heat, Energy Transfer**	
Lesson activities	• E.g. Students design their own lever and explain in their own words how it works. • E.g. Light: Design an instrument that will allow you to see objects on the other side of the desk from a variety of different materials.	**Higher Cognitive Demand** • Processing Ideas: tasks required students to use ideas and information in ways that expanded understanding. • Connected activities with Ideas; Selected tasks that required some thought and the task solution was not self-evident from the solution.
Links to curriculum (cross strand)	• E.g. Investigate patterns of physical observables – but patterns are not outlined	• Specific cross strand curriculum links highlighted but not linked to success criteria of activities.
How is the learning assessed	• E.g. Questioning: How many mirrors will you use and why? What does this [experiment] tell you about the way light behaves?	**Higher Cognitive Demand** • Approach outlined with specific questions/connections to activity described
Career/Societal Awareness	• E.g.	• Specific careers linked with each individual activity. No links made with the content specifically.
Unconscious Bias Awareness	• E.g. Fireman/woman	• Bias in gender specific careers mentioned - misconceptions and differentiation included in bias (may be a misunderstanding)

Table 2: Evaluation of Science Teachers Class Plans

- **All eight aspects of the dimensions of planning, six from Ambitious Science Teaching and two from inclusive practices, were evident to some degree, however all aspects of the dimensions of planning were not evidenced in any single plan.**
- **Enhancing teachers' reflective and collaborative skills in order to support groups of teachers in planning for engaging science needs to be the goal of a professional learning community.**

Student Impact

The Improving Gender Balance in Ireland programme had an indirect impact on students. Science teachers who participated in the science workshops collected evidence on i) student interest in science subjects and career aspirations, ii) student belonging in science and iii) student-teacher classroom interactions.

- **Interest in Science Subjects**

Students were asked as part of a questionnaire to identify the science subject they were most interested in and least interested in. Student responses to the questionnaire relating to student interest in science and physics subjects, where students were asked to rank the three science subjects (Physics, Chemistry and Biology) on a 3-point Likert scale; 1 = Most Interested, 3 = Least Interested, are shown in the figure.

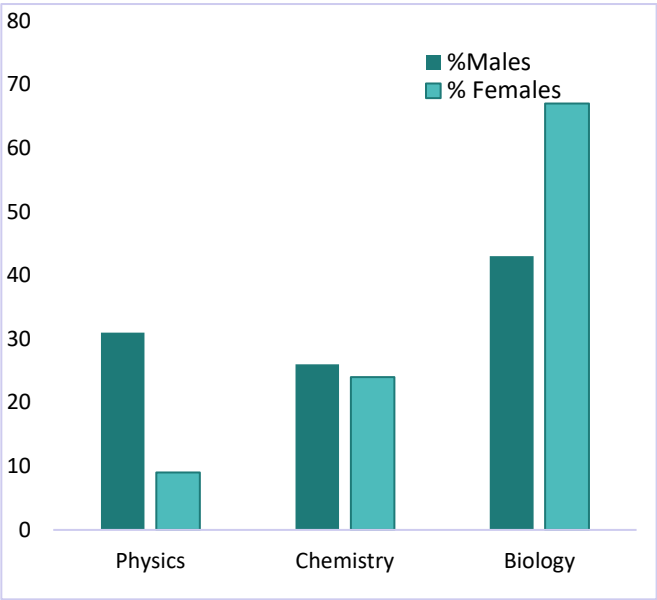


Figure 16a:Students' Interest in Science Subject by Gender (lower secondary level) N=509

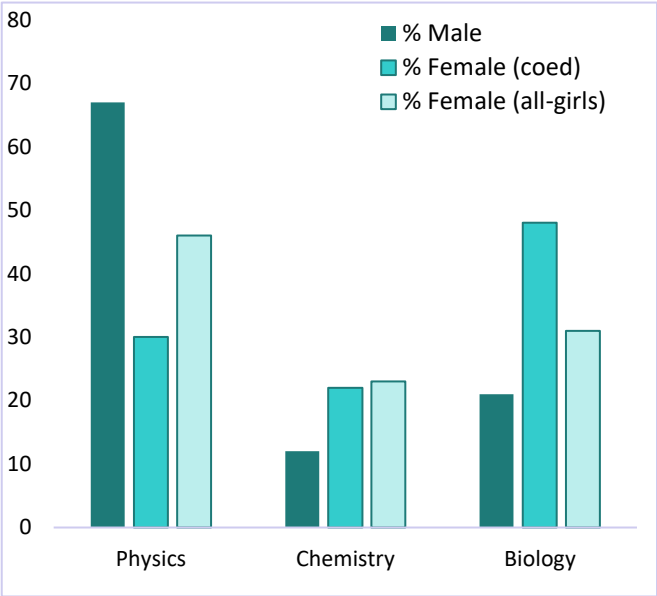


Figure 16:Students' Interest in Science Subject by School Type (lower secondary level) N=509

- **Biology was reported to be the overall most popular science subject for lower secondary students (males and females).**
- **Lower secondary female students from a single-sex school were found to have higher interest in the physical sciences (Physics and Chemistry) than females in a coeducational school.**
- **Females from a coeducational school have more of an interest in Biology as a science subject than females in an all-girls school**

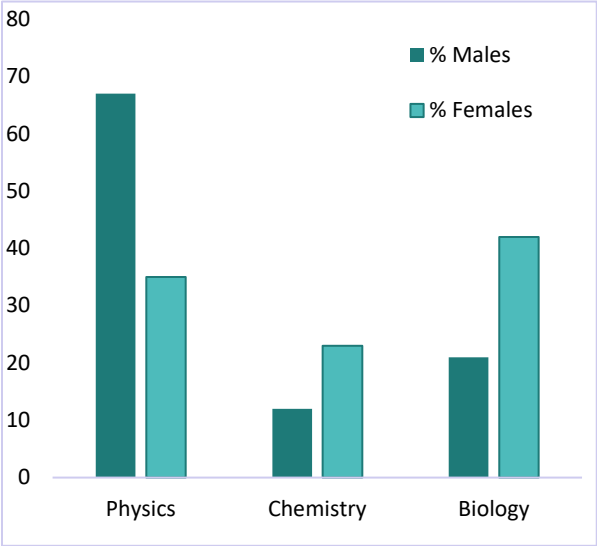


Figure 18:Students' Interest in Physics by Gender (upper secondary level) N=140

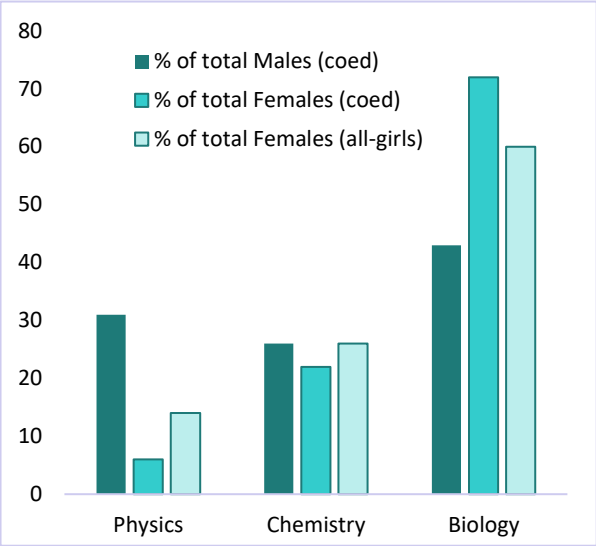


Figure 18: Students' Interest in Physics by School Type (upper secondary level) N=140

- **At upper secondary level, males' interest in Physics at upper secondary level, unsurprisingly, is higher than their interest in Biology.**
- **Female interest in Biology continues to be a competitor for Physics. Here, it is important to note that there is a high likelihood of these females also studying Biology as a Leaving Certificate subject.**
- **In particular, females from coeducational schools tend to exhibit a stronger interest in Biology than females in an all-girls school.**

When students were asked to write down their top three job preferences their career awareness was varied across the sample and exhibited a wide variety of professions across all sectors (Figure 19).

Figure 19: Student Career Interest (14-16 yrs)

- **Student – Teacher Classroom Interactions**

Two teachers completed classroom interactions self-evaluation tools (see Appendix) with their third-year science class to assess their own practice. Results from 40 students (25 boys, 15 girls) are shown in the Table. This evidence suggests that boys' interactions in science class tends to dominate in the classroom, answering more questions and getting more of the teacher's attention. One of the teachers who took part in completing this tool reflected after the lesson and said;

> *"Boys were more vocal. Girls asked when they needed more direction in their work or could add to the conversation."*

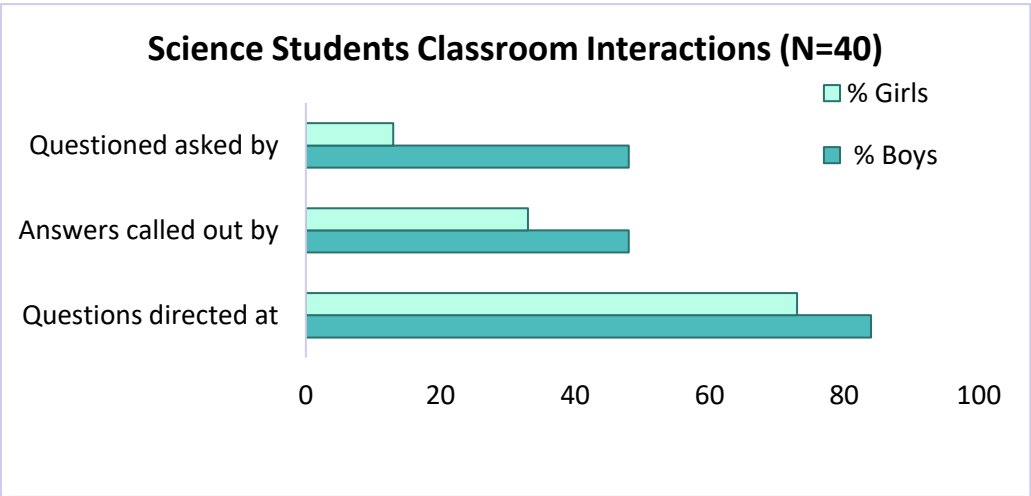


Figure 20: Teacher-Student Classroom Interactions

Student Belonging

An adaptation of Ito and McPherson's questionnaire was used to measure social belonging, ability belonging, self-efficacy and intentions to persist in science subjects (Ito and McPherson 2018). Students completed a 22-item questionnaire to investigate these factors. The first sample comprised of 509 (199 male, 310 female) lower second level science students (aged 15-16 years) in their third year of an integrated science course. 140 (100 male, 40 female) upper second level physics students (aged 16-18 years) who had already completed science at lower secondary and elected to study physics for two-year course at upper secondary level were included in the second sample. Findings from the surveys are summarized in the figure 21 below.

Lower Second Level

- Males have higher self-efficacy in science than females
- Females in a mixed school have higher Social Belonging, Ability Belonging and Self-efficacy than Females in an all-girls school
- Self-efficacy is a strong predictor of Intentions to Persist in science for both males and females
- Ability Belonging is a predictor of Intentions to Persist in science for males only

- Intentions to Persist in science not significant at lower secondary level
- Females in a single sex science class are more marginalized than males or females in a mixed science class
- High percentages of female students who rank Biology as most interested science subject are included in this cohort

Upper Second Level

- Males have greater Intentions to Persist in Physics than females
- Females in a mixed school have lower Intentions to Persist in Physics than Females in an all-girls school
- Social Belonging is a strong predictor of Intentions to Persist for both males and females

- Female social belonging is lower than males in Physics class
- Female in mixed physics class are more marginalized than those in an single sex physics class

Figure 21: Student Belonging in Science and Physics

Phase II Implementation

Organisational Structure

Phase II saw the expansion of the organizational structure in Phase I to include a second programme officer, four new workshop facilitators and 21 new schools.

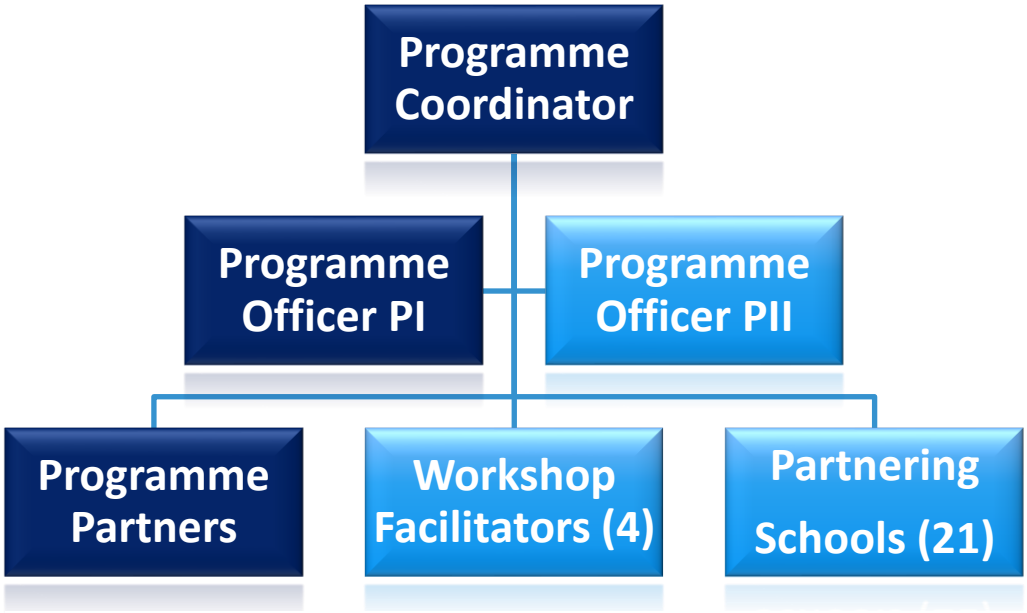


Figure 22: Phase II Organisational Structure

Programme Officer: The role of second programme officer (PII) was to communicate with representatives of twenty-one different schools, coordinate dates for unconscious bias workshops, deliver unconscious bias workshops, collect, report and disseminate findings.

Workshop Facilitators: Four expert science teachers were recruited to facilitate workshops, two of which were new to the programme. The inclusion of a Biology specialist teacher as one of the teachers advocating and facilitating engaging physics teaching and learning approaches was a result of Phase I teacher reflections. Providing ongoing training and support to these members of the team was crucial.

Partnering Schools: Twenty-one new schools were recruited in Phase II, from August 2019-December 2020, to trial an upscale model of Phase I. The schools recruited in this phase consisted of; 13 coeducational, 5 all-girls and 3 all-boys schools. These schools were represented in the wider Dublin area, Meath, Westmeath, Wexford, Roscommon and Galway.

Design Principles

In Phase II, the programme maintained its core elements of fostering professional learning communities, working within and across curricula and creating a sustained change with ongoing support. Unconscious bias workhops continued to be facilitated in-school and involve the entire teaching staff. Science workshops were faciliated regionally to accommodate a larger number of participating teachers (Figure 23).

Eighteen workshops were scheduled in the Dublin area at multiple times in four locations; Blackrock Education Center, Dublin West Education Centre, Dublin City University. This provided choice of times and dates for teachers from partnering schools to engage. Eight workshops were scheduled as cluster workshops in Drogheda and Athlone. Here teachers were offered one date/time for each of the three workshops to work with teachers in their school and some neighbourning schools. One full day workshop was held in Wexford for teachers that could not commute to the locations in Dublin.

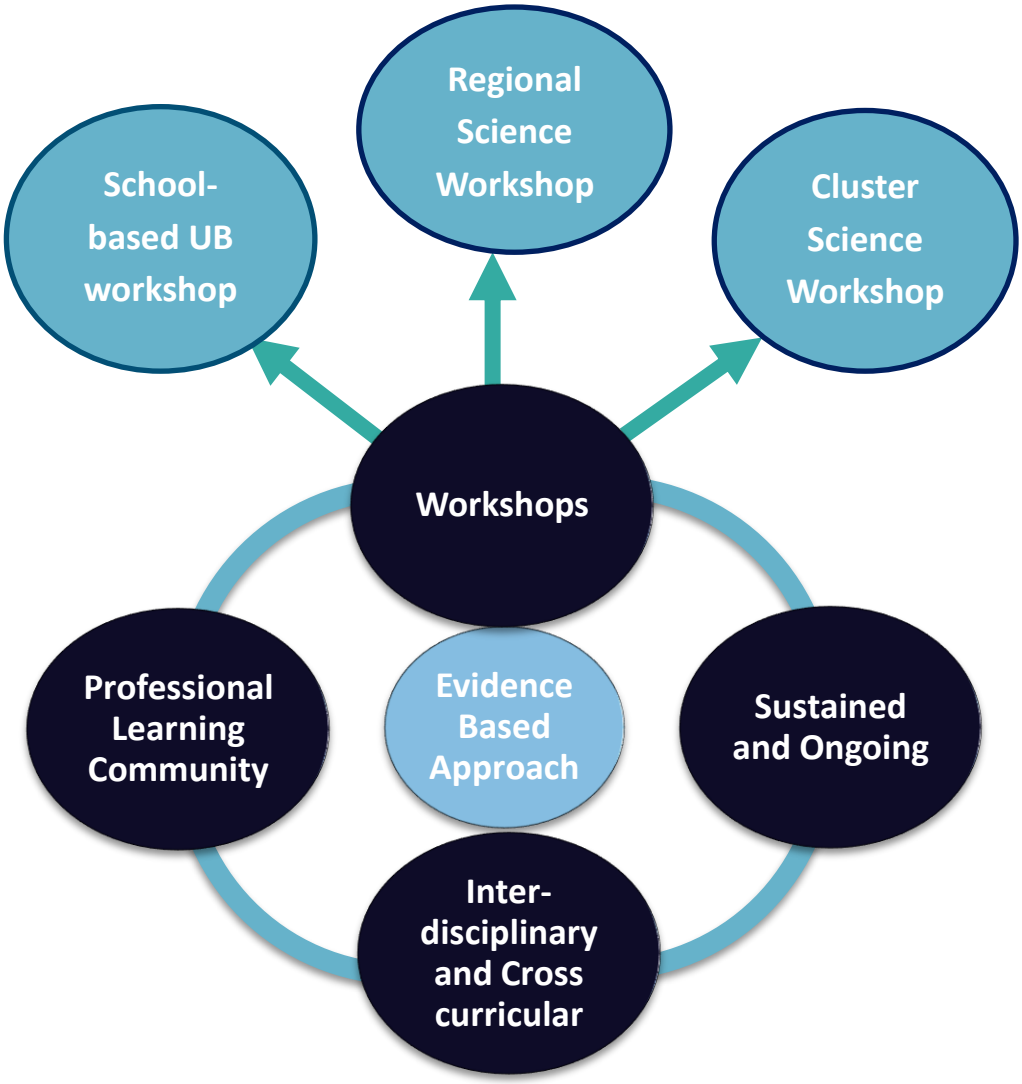


Figure 23: Phase II Design Principles

"..we did careers [in the workshop] and I said that was a great, very novel way that we would never have thought of before because we would teach science separately. I would have done it with science in general, but I thought it was a great idea when you're teaching a particular topic to show the careers that somebody who has an affinity for that topic might pursue."

-Phase II Science teacher

Phase II – Findings

School Engagement

Overall, 39 % (21) of the total cohort (54) of invited schools engaged with the programme. In the Midlands, the uptake was nearly doubled with 67% (6) of the total cohort (9) invited subsequently engaging.

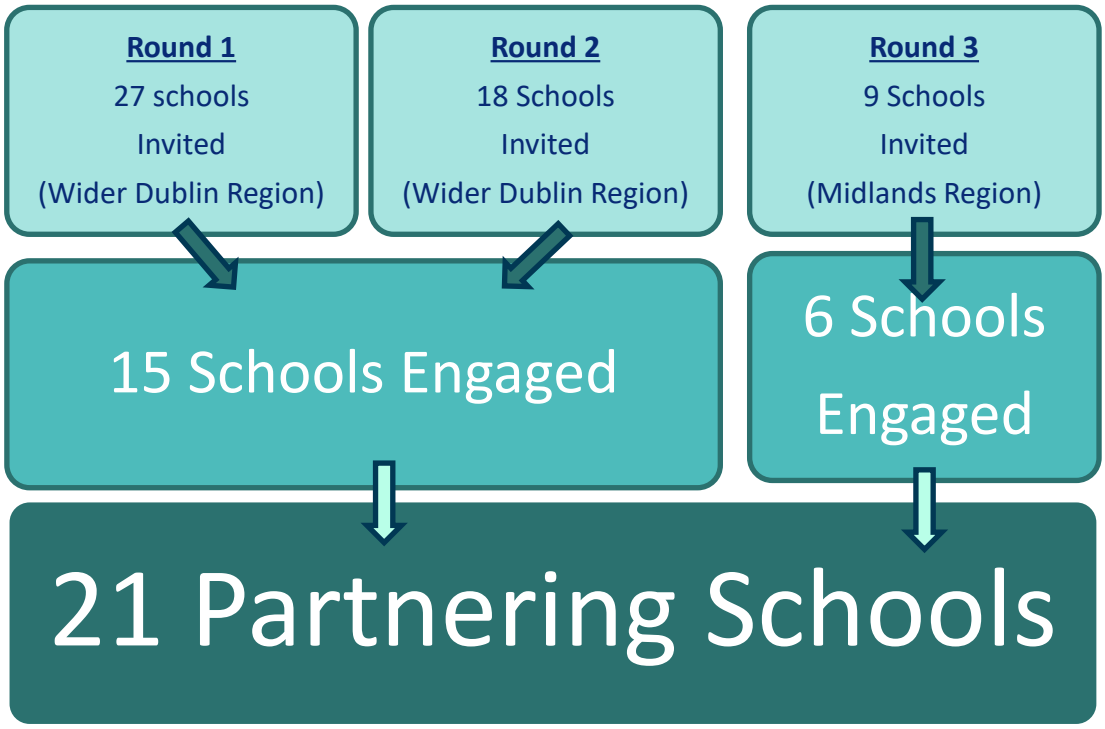


Figure 24: Phase II School Recruitment Process

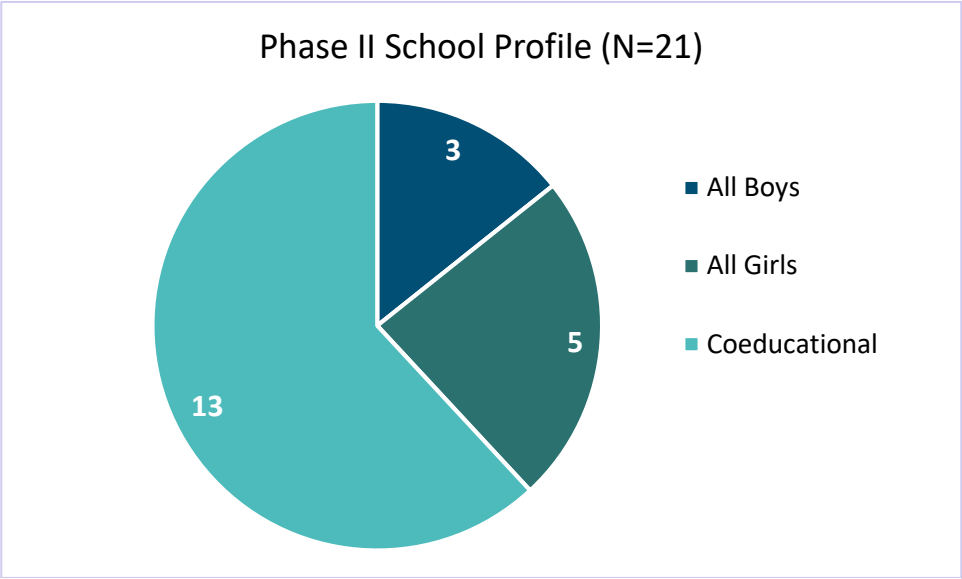


Figure 25: Phase II School Type Demographics

From the recruitment process it is evident that the onboarding of a key stakeholder at the outset of the recruitment process is imperative to the success of the project. Stakeholders primarily were science teachers (17/21) with some senior management involved.

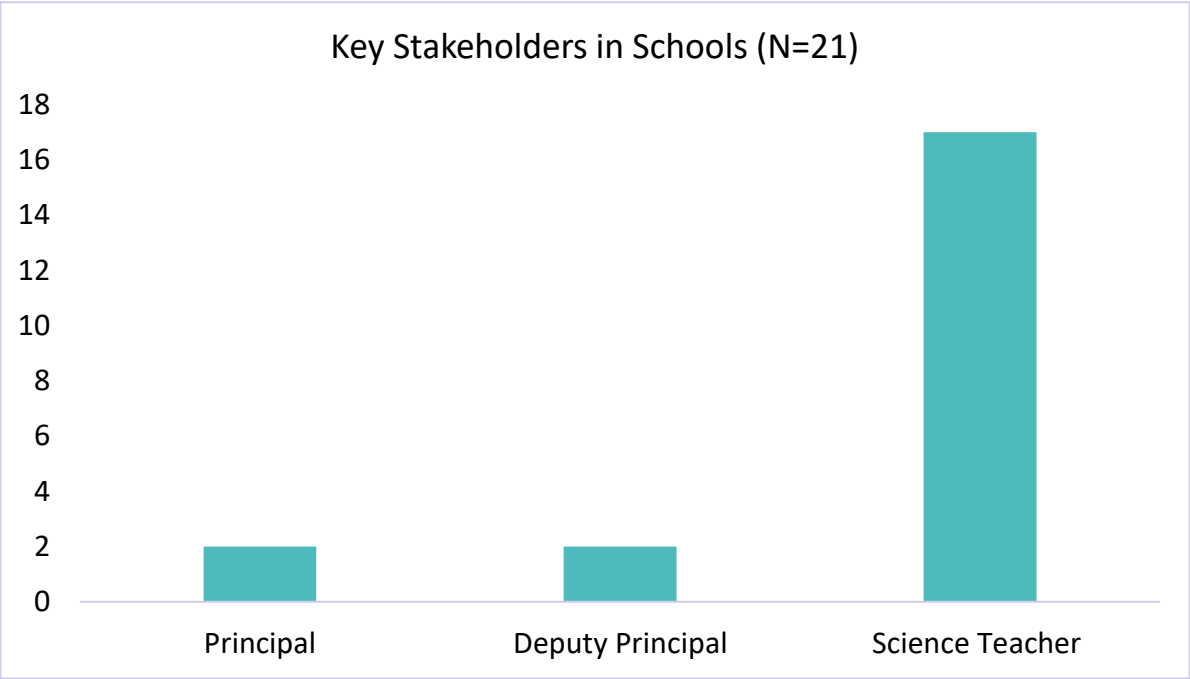


Figure 26: Key Stakeholders

Unconscious Bias Teacher Workshops

- **Snapshot of School Culture**

Adapting the framework for junior cycle principles (see School Priorities tool in Appendix), teachers from every subject department were asked to identify which of the priorities applied to their school. The level of interaction with each subject depended on the size of the department (some schools had two English departments) and teachers teaching several subjects at once but completing the tasks as a teacher of one of those subjects.

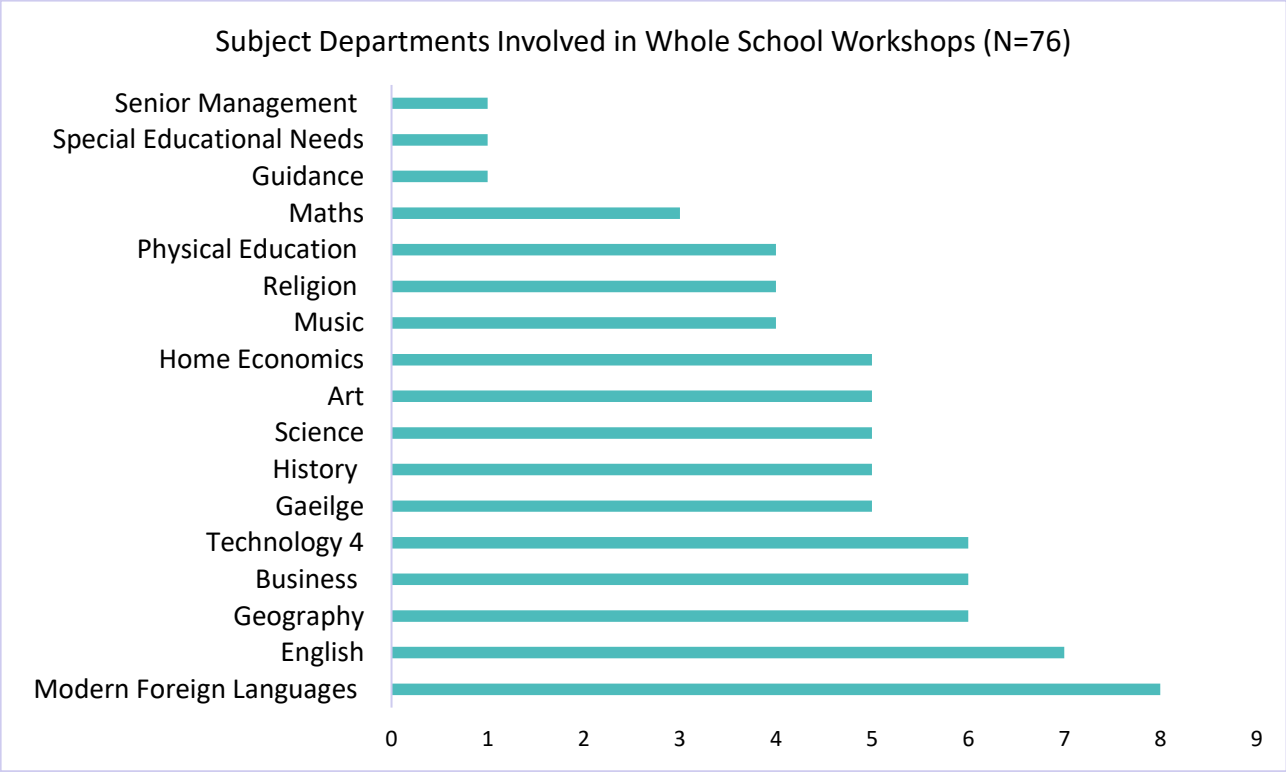


Figure 27: Engagement of Subject Departments

The results from the teachers in these departments were then collated and coded to give a snapshot of what the schools top priorities were.

Seven schools took part in this activity with a total of 217 participating teachers. From the below figure (Figure 28), it is evident that the seven schools placed greatest emphasis on the priorities of Wellbeing, Inclusive Education and Learning to Learn and least emphasis on Creativity and Innovation and Continuity and Development. This data was used to establish an overall view of the school culture across the sample. School management also received their own individual report of the findings as a tool to evaluate how the school culture is viewed from the perspective of its teaching staff.

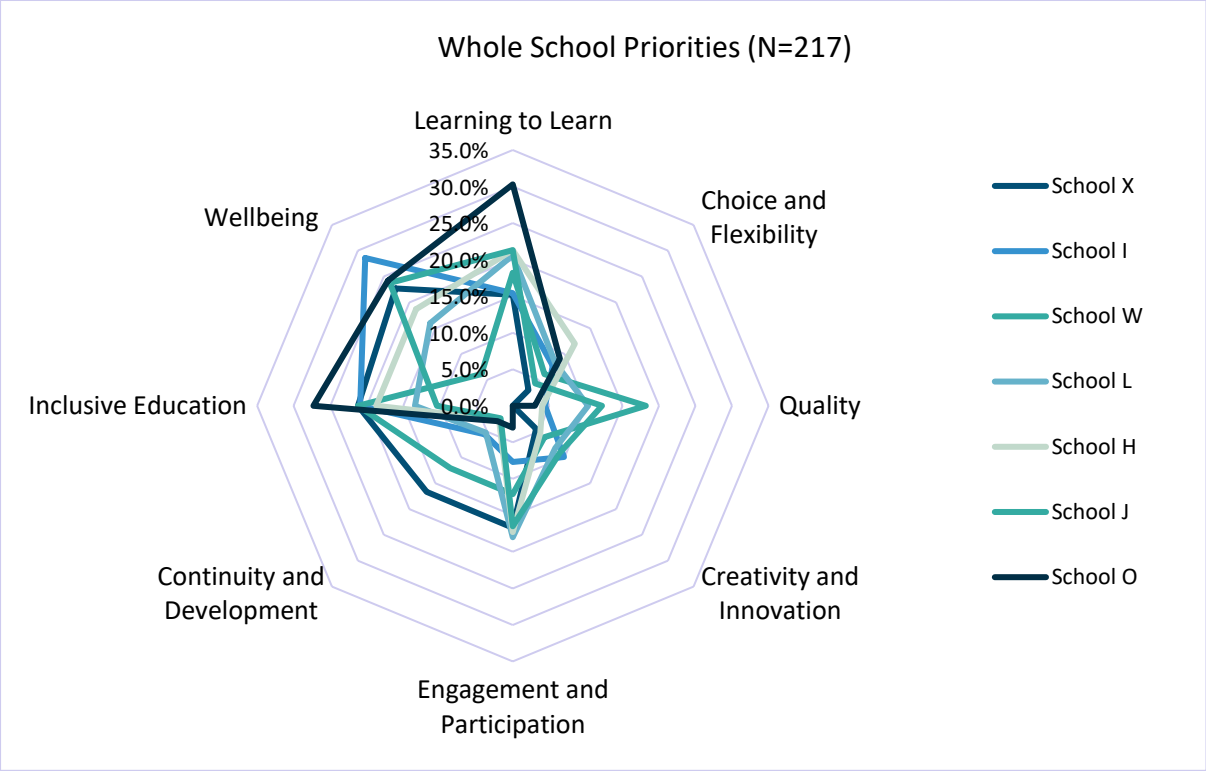


Figure 28: Snapshot of School Culture

- **Unconscious bias workshop engagement**

In Phase II, to account for schools limited number of Croke park hours to plan whole school unconscious bias workshops, alternative options were suggested for schools to engage in creating an awareness of unconscious bias on some level. Some schools opted to hold a voluntary workshop where interested teachers attended the workshop. Other schools engaged in a paper activities which saw representatives from each department evaluate the department under a variety of different areas; classroom resources, extra-curricular activities, online profile.

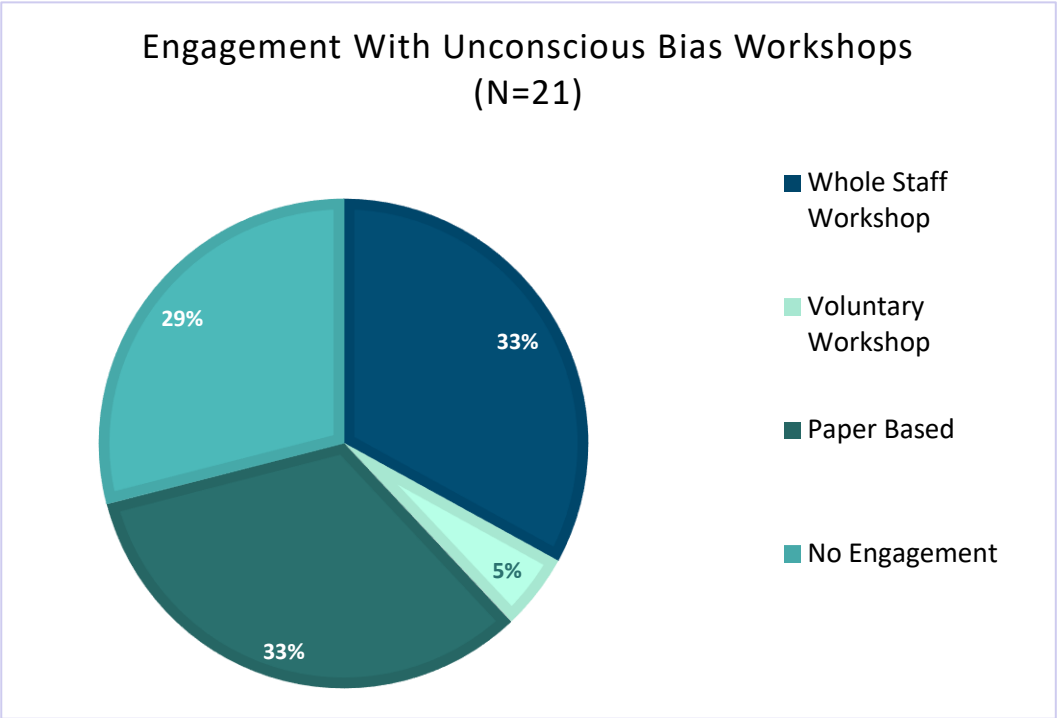


Figure 29: School Engagement in Strand 2

All schools participating in workshops or paper-based audits completed an action plan with proposed actions to take to romote equality and inclusion across the whole school. The key areas proposed in the plans included; online presence, subject profile, extracurricular experiences, resources, diversity & inclusion, careers and role models.

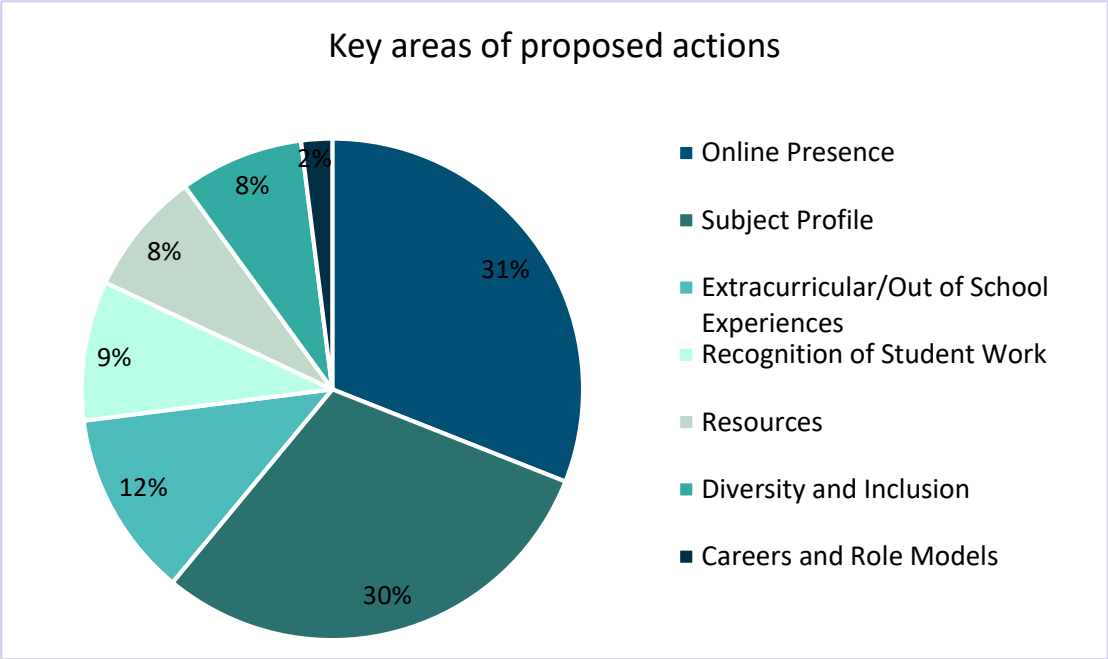


Figure 30: Areas Outline by Teachers in Action Plans

These action plans were followed up with after teachers had time to implement changes. However, due to a varied engagement with schools the level of impact on culture change is minimal. Further sustained and ongoing support is needed to embed change in classroom practice.

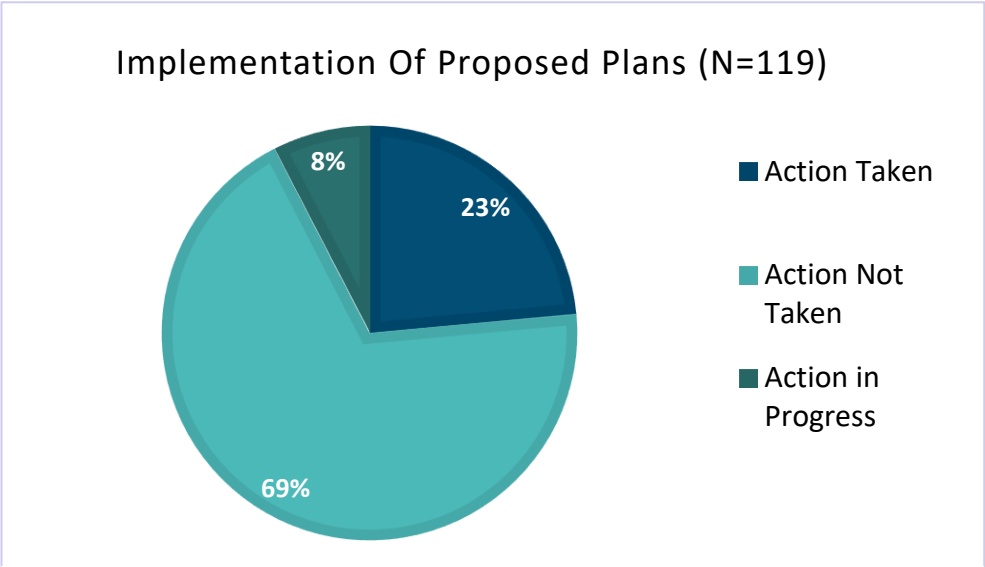


Figure 31: Follow up of Implementation of Proposed Actions

Science Teacher Workshops

- **Baseline**

Science Teacher backgrounds were again considered in the delivery of science workshops. The sample from Phase II followed a similar demographic to Phase I with the majority of teachers coming from a Biology specialism.

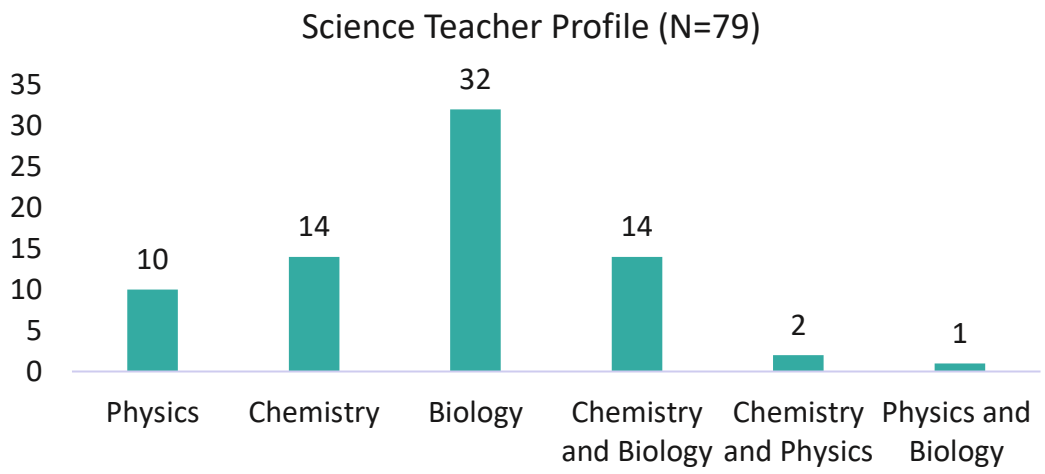


Figure 32: Phase II Science Teacher Profile

Science Departments that partook in the whole school unconscious bias workshops were also evaluated in terms of what they saw as the school's top priorities. In general, this followed the overall school snapshot of top school priorities with the exception of the stronger presence of engagement and participation.

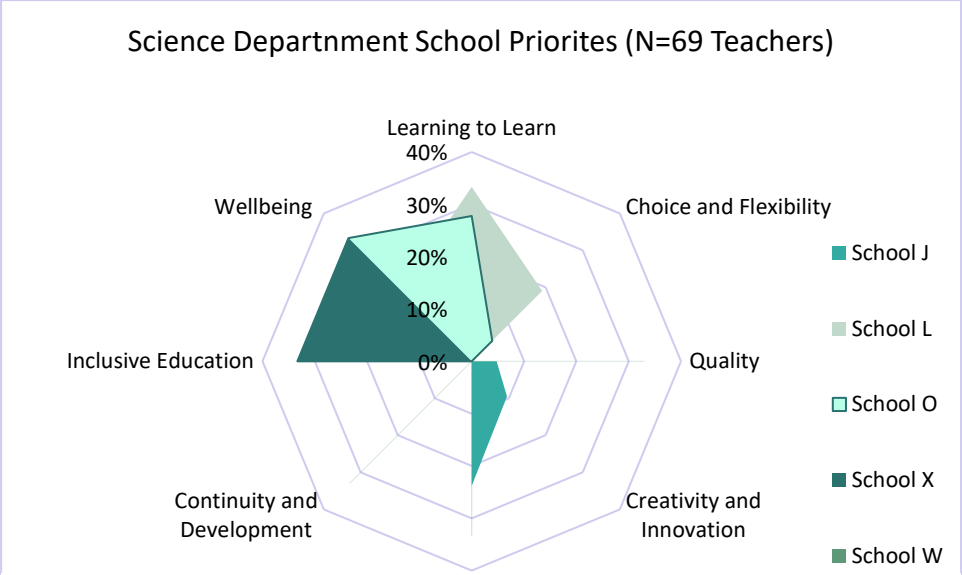


Figure 33: School Culture from Science Teacher Perspective

- **Science workshop engagement**

Science teachers attended a maximum of three science workshops across the topics of Density, Earth & Space and Electricity. Attendance was recorded and evaluated as a method of evaluating engagement in each of the topics.

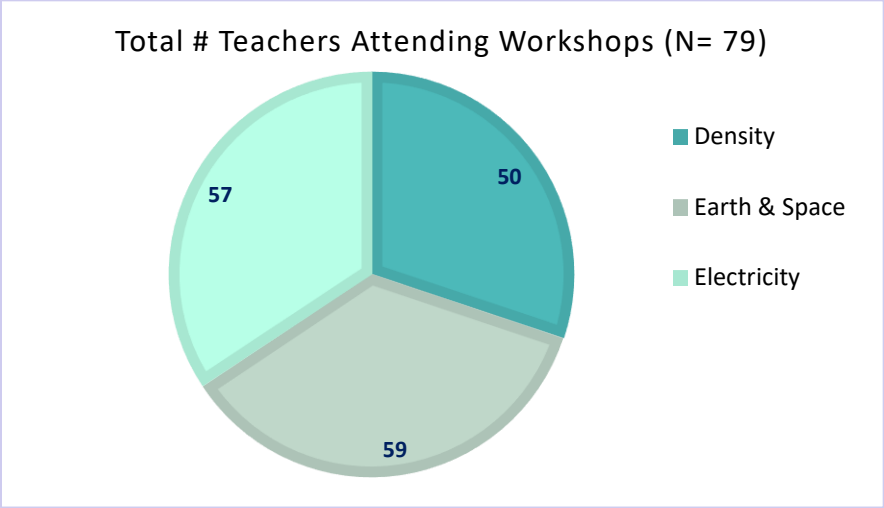


Figure 34: Phase II Science Teacher Engagement

The science workshops took place in regions around Dublin with three cluster groups in Drogheda, Wexford and Athlone. There were advantages and disadvantages to these different approaches. The regional model allowed teachers choice in dates and times to attend workshops. In this case, whole science department engagement varied. It was rare that an entire/majority department would attend the same workshop on the same date and in most cases three or four teacher would attend on behalf of the school. Much more between school collaboration and communication took place at the regional workshops.

The cluster workshops enabled teachers from neighbouring schools to attend workshops in their local areas. These workshops only allowed for two different time slots and no variation in dates, however the travel time for these school was much less as they were located in the local education centre or in some cases one of the participating schools. For the school clusters it was found that 70-100% of the science department in each school attended the workshops.

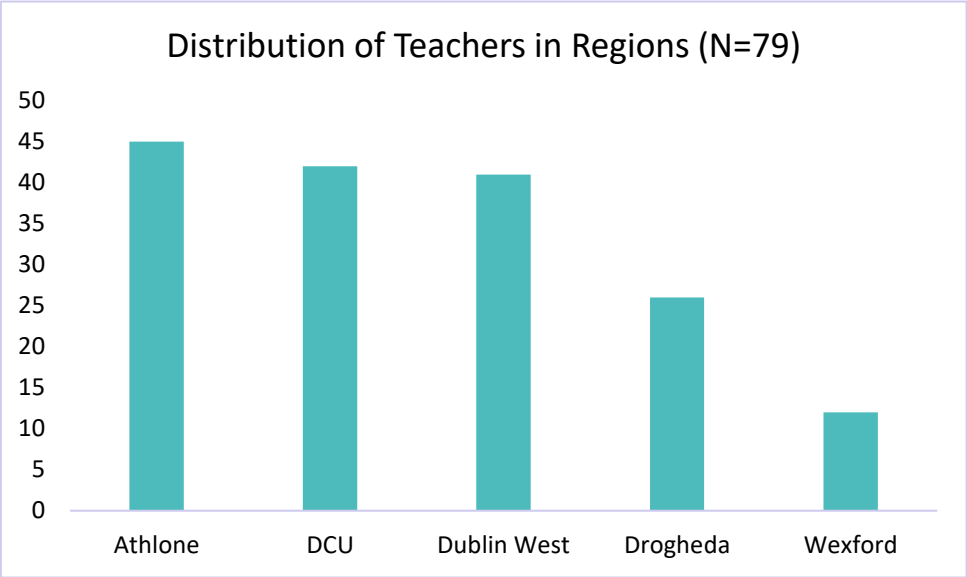


Figure 35: Teacher Distribution Across Regions

Science workshops met a 99% satisfaction rate from 144 feedback responses across all three workshops; Density, Earth & Space and Electricity, in all determinants except one related to the length of the workshop being sufficient (93% satisfaction). In this case is was often the case that teachers wanted more time and to engage with the facilitator and resources.

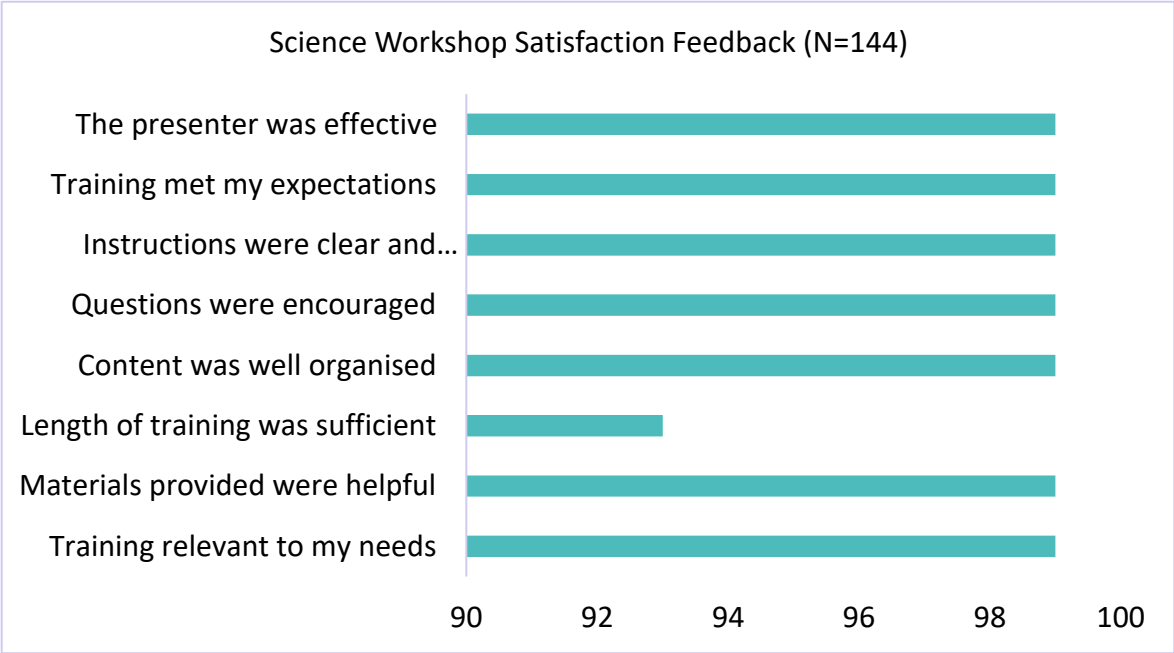


Figure 36: Science Teacher Satisfaction Survey Responses

Programme Impact

This programme impacted a range of stakeholders over the three years of the programme, namely:

- 1568 second level teachers (405 in Phase I and 1163 in Phase II) engaged in unconscious bias workshops.

- 132 science teachers (51 in Phase I and 79 in Phase II) participated in unconscious bias and multiple science workshops.

- 240 second level teachers participated in UB workshop at iWish Conferences: 3 workshop over 2 days for two years.

- 300 second level students from four schools participated in unconscious bias and career awareness workshops.

- 273 researchers and teachers at Science/teacher education conferences
  - SMEC 2019 unconscious bias workshops: 15 teachers
  - ISTA 2019 unconscious bias workshops: 8 teachers
  - SFI Discover partners meeting unconscious bias workshop: 80 partners
  - GIREP 2018 (oral): 30 researchers
  - Gender Equality in Higher Education 2018 – 10th European Conference (oral): 20 researchers
  - SMEC 2018 (oral): 20 researchers
  - GIREP 2019 (oral): 10 researchers
  - ESERA 2019 (oral) : 10 researchers

"[Unconscious bias] as long as it's just to the forefront of everybody's thinking when it comes to their planning…"

- **Phase II non-science teacher**

Key Highlights

The programme exceeded expectations in its scope and influence across 28 partnering schools and the main outcomes and impact of the programme are:

1. **Science teachers' confidence and competence was increased in the teaching and learning of physics at Junior Cycle.**

   Science (Biology, Chemistry and Physics) teachers were empowered to teach physics using inquiry approaches and embed unconscious bias and career awareness as part of their everyday classroom practice. Phase I teachers showed strong evidence of incorporating the resources from workshops into their lessons, through class plans, collecting evidence of impact, interviews with the external evaluators and post-workshop reflections. Phase II teachers reported an increase in confidence in teaching topics, e.g. Electricity at Junior Cycle Science.

2. **School leaders recognised and engaged in the issues addressed by the three-strand approach.**

   Senior management recognised the aims of the programme and supported scheduling suitable times for teachers to attend science and unconscious bias workshops. Their active engagement in promoting the project and involvement in discussions with all teachers during these workshops was very effective in publicly advocating and supporting change in whole-school culture.

3. **Student voice was recognised and promoted in changing school culture.**

   A key outcome that emerged from this project included the evolution of a student roll-out of unconscious bias workshops, in one of the Phase I schools, for students by students. A train-the-trainers approach was adopted to continue upskilling students in creating awareness of unconscious bias and careers.

4. **Appropriate workshop facilitation - critical for success**

   A total of seven experienced and relatable science teachers were invited to deliver physics workshops to science teachers. Introducing the science teachers to these advocates of engaging and inquiry-based teaching strategies added to the quality and impact of workshops. In particular, having one facilitator as a Biology

specialist, encouraged and motivated teachers of a similar background to take on new teaching materials with confidence.

5. **National professional development facilitators embedded strands of the project**

   National teacher support teams such as, the PDST STEM and the PDST Physical Education and SPHE teams requested workshops from project team on the unconscious bias and career awareness strands. Following these sessions the teams embedded our IGBI resources into their national professional development programmes with teachers in these disciplines.

6. **National awareness of gender equity and inclusion in STEM Education was increased**

   Dissemination of findings and shared learning from the project at national events were successful in raising the profile of IGBI. These included facilitating workshops at: iWISH conferences 2018 &2019, SFI Discover's partner meeting, PDST team meetings and Science and Maths Education Conference (SMEC) 2018 and International Science Teachers Association (ISTA) conferences, 2019 & 2020. Findings were disseminated at the Improving Gender Balance in Ireland's Equality and Inclusion 2019 Awards Ceremony with special guest Minister Mary Mitchell O'Connor. Invitations to project team members to join groups such as: National Gender Balance in STEM Advisory Group and 2020 Citizens Assembly on Gender Equality panel.

"Sometimes it can be difficult to actually be disciplined as a department to come together and to actually work on something specific that's related to the classroom, you know I think it's very useful…it certainly brings a good focus to the group and I think as well it puts out a template for maybe how departmental meetings could be held going forward even when DCU are not working with us, you know."

– Phase I Science teacher

National Implementation

Programme Design

The actions and findings of this programme have identified nine essential steps for achieving Equity and Inclusion in STEM Education (see Figure 37). These nine steps present a robust framework for Improving Gender Balance in Ireland which supports the adoption of flexible and scalable implementation models to support teachers and schools.

Figure 37: Nine essential Steps for Achieving Equity and Inclusion in STEM Education

Commitment of School Management and Leaders

School leader engagement in workshops was effective in advocating and supporting teachers to address unconscious in the school. School leaders are key drivers in sustaining this programme and dependence on them to relay information to all staff and follow up on their progress is valuable.

Collaborating between Key Stakeholders

Engaging external key stakeholders to discuss and advise on logistics and other avenues of opportunity for the programme proved to have wider scope in its outcomes than just input into the project objectives. Key stakeholders also engaged in using the programme as a vehicle for culture change in their own practice e.g. PDST engaging in unconscious bias workshops and conversations with the programme team.

Bringing Together Research and Practice

Findings have highlighted the importance of research-practice collaborations to address the three-strands of this programme. The inconsistencies exhibited in the survey responses from all teachers further corroborate the need for a whole school approach to raising awareness of unconscious bias and gender stereotyping in school policies and practices.

Professional Learning Opportunities

Teacher reflections from both all staff and science teachers indicate a need for more opportunities for professional learning. The difference in impact of Phase I and Phase II suggests that sustained and ongoing professional learning opportunities are required to effect real change in classroom practice and school culture.

Raising Awareness of Unconscious Bias

The audits of the school websites highlighted the lack of awareness around unconscious bias and gender/subject stereotyping. The imagery associated with physical science subjects was male dominated and Physics was generally listed at the bottom of the subject choices available at Senior Cycle.

Deepening Confidence and Competence in the Teaching and Learning of Physics

Science teachers identified their key challenges in teaching physics, and these were addressed through the design and implementation of science teacher workshops. The feedback from science teachers indicates that increasing their understanding of basic physics concepts is as beneficial to them as focusing on pedagogical approaches.

Building Resilience in Students

Creating experiences for students to reflect on unconscious bias and gender stereotyping issues is important to building resilience in students. Encouraging students to become their own advocates of building resilience proved to be an effective method of encompassing the student voice with one school employing a train the trainers model to students rolling out unconscious bias workshops.

Active Learning in Physics

An inquiry-approach was used in workshop facilitation so that teachers could experience learning through inquiry and model the workshop approach in the physics classroom.

Challenging Barriers to Inclusion

Evaluation of this programme has identified the key challenges for STEM education in Ireland as student's self-efficacy in STEM; students, parents and teachers lack awareness of STEM careers; impact of negative stereotypes and preconceptions; lack of resources for STEM subjects in school; and lack of awareness of STEM in society.

"So that was great to actually get to speak to other science teachers and there was a couple of leaving cert physics teachers where normally we wouldn't really get the opportunity to meet them very often."

- **Phase II Science Teacher**

Organisational Structure

For national implementation in Ireland, it is proposed that seven programme officers are required for 5 years in order to implement all three strands of the Improving Gender Balance Programme, operating in three regions with all 720 secondary schools in Ireland (Figure 38). Commitment to achieving these programme objectives has been received for national roll-out of IGB programmes in England and Scotland through 5 years of funding from the respective Departments of Education.

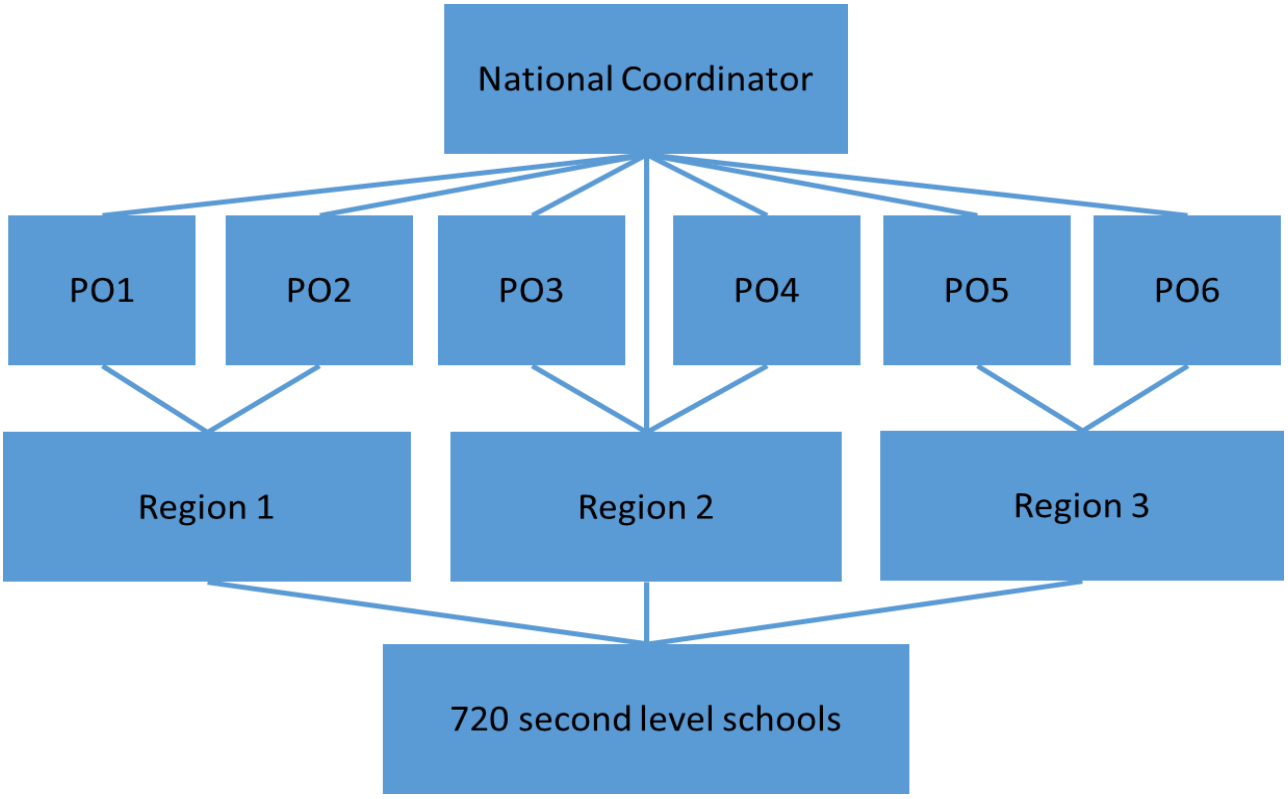


Figure 38: National Implementation Organisational Structure

National Coordinator: The role of the national coordinator is to provide leadership and coordination to the design, implementation and evaluation of the programme.

Programme Officers: The role of six programme officers (PO1-6) is to liaise with representatives of each school to coordinate dates for teacher workshops, design and facilitate unconscious bias and science workshops in each region.

Design Principles

The findings, from the Closing Doors report (Institute of Physics, 2013) in England, highlighted that that the best way to rectify gender imbalance in physics (and other subjects) is to address the problem through a combined approach of working across the school as well as in the subject areas, as schools showed that an imbalance in one subject tended to have imbalances across all subjects (Institute of Physics 2013). The findings from both the internal and external evaluation of this programme strongly concur with this conclusion.

The findings from phase I implementation, with seven schools, led to several proposed models for scaling and sustaining the project impact, namely:

(i) Host regional clusters of workshops with physics teachers, to empower them to deliver Physics workshops in their own schools.

(ii) School twinning – Support IGB schools to twin with another school in their locality.

(iii) Collaborate with University physics department across Ireland to roll out pilot programmes in their local schools

(iv) Liaise with established national science teacher education providers to facilitate physics workshops in schools and regions.

(v) Liaise with established teacher education providers to embed inclusive practices in other subjects and across whole schools.

Phase II implementation successfully adopted models (i) and (v) and recruited an additional 21 schools to participate in- school unconscious bias workshops and regionally-based science workshops. However, in order to address equity and inclusion issues in STEM Education, we must start with enabling equal opportunity for all students, female and males, as well as other underrepresented and disadvantaged students, to develop their understanding and interest in Physics. To date, only 28 (~4%) of Irish second level schools have had the opportunity to participate in this programme.

National Implementation will involve using an evidence-based approach to the design and implementation of professional learning opportunities for teachers (Figure 39).

The programme will maintain its core elements of fostering professional learning communities, working within and across curricula and providing ongoing and sustained support for teachers. Unconscious bias workhops will be facilitated in-school and involve the entire teaching staff. Science workshops wil be faciliated in regional locations and support clusters of science teachers from across and between schools forming their own professional learning communities.

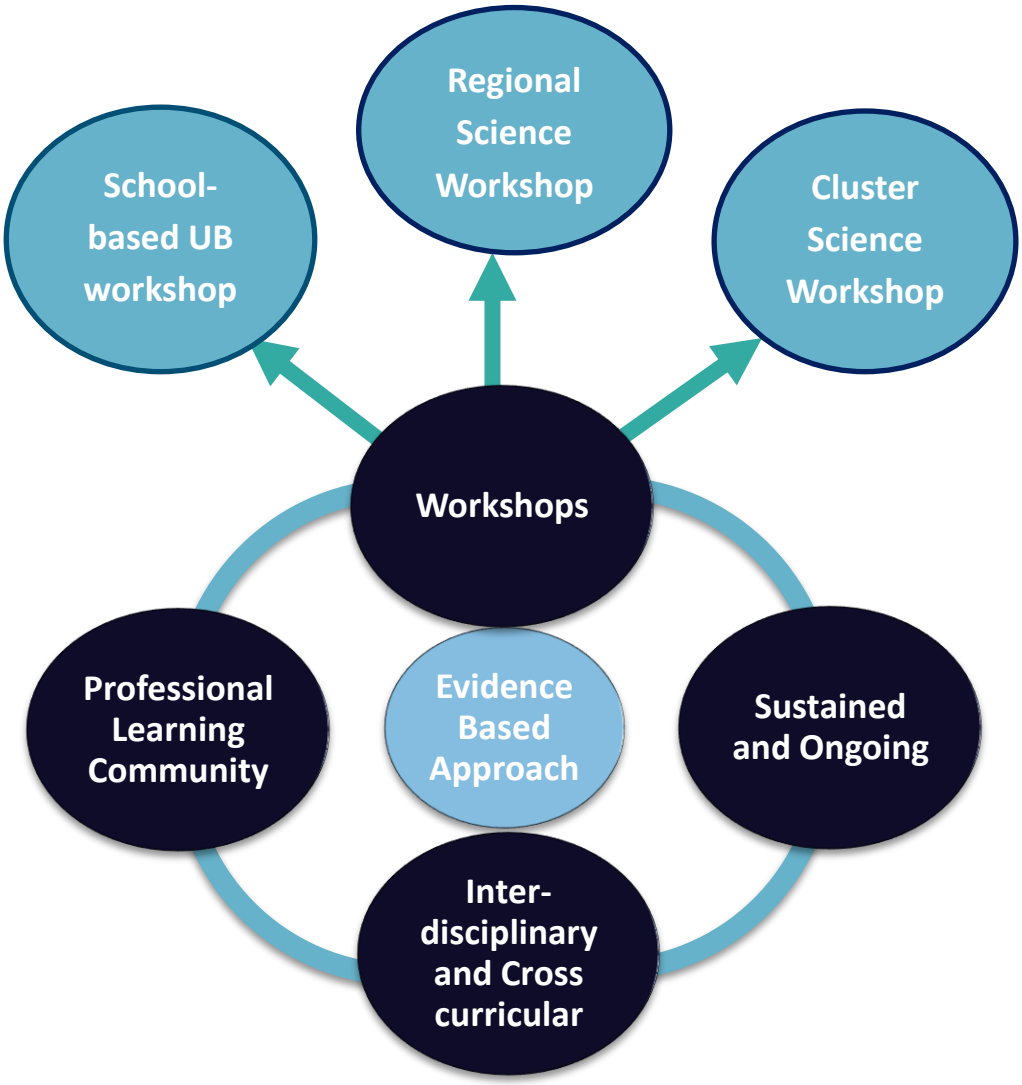


Figure39: National Implementation Design Principles

References

Ambitious Science Teaching. 2015. "A Discourse Primer for Science Teachers." *Ambitious Science Teaching*. Retrieved October 12, 2019 (http://ambitiousscienceteaching.org/wp-content/uploads/2014/09/Discourse-Primer.pdf).

Archer, L., Dewitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. Science Education, 94(4), 617–639.

Etkina, Eugenia, Drew Gitomer, Charles Iaconangelo, Geoffrey Phelps, Lane Seeley, and Stamatis Vokos. 2018. "Design of an Assessment to Probe Teachers' Content Knowledge for Teaching: An Example from Energy in High School Physics." *Physical Review Physics Education Research* 14(1):010127.

GOV.UK Statistics: Initial teacher training, Available at: https://www.gov.uk/government/collections/statistics-teacher-training [Accessed 8 May 2018].

Institute of Physics (2006) UK physics A-level entrants by gender and by nation, Available at: http://www.iop.org/policy/statistics/uk-a-levels/page_67953.html [Accessed 3 May 2018].

Ito, Tiffany, and Erin McPherson. 2018. "Factors Influencing High School Students' Interest in PSTEM." *Frontiers in Psychology* 9:1535.

Lewis, K. L., Stout, J. G., Finkelstein, N. D., Pollock, S. J., Miyake, A., Cohen, G. L., & Ito, T. A. (2017). Fitting in to move forward: Belonging, gender, and persistence in the physical sciences, technology, engineering, and mathematics (pSTEM). Psychology of Women Quarterly, 41(4), 420–436.
State Examinations Commission (2019). State Examination Statistics, Available at:https://www.examinations.ie/statistics/?l=en&mc=st&sc=r12 [Accessed 8 May 2019].

STEM Education Review Group. 2016. *A Report on Science, Technology, Engineering and Mathematics (STEM) Education Analysis and Recommendations*.

Windschitl, Mark, Jessica Thompson, Melissa Braaten, and David Stroupe. 2012. "Proposing a Core Set of Instructional Practices and Tools for Teachers of Science." *Science Education* 96(5):878–903.

List of Appendices

Appendix 1

Workshop Outline

IMPROVING GENDER BALANCE IRELAND

A partnership between CASTeL at Dublin City University, Institute of Physics in Ireland and Science Foundation Ireland

Workshop Information (Engaging Junior Cycle Physics)

Each of the following workshops are designed to promote engaging physics for Junior Cycle science students. Focussing on teacher confidence in the teaching and learning of physics, these workshops are a product of Junior Cycle science teacher's experiences, difficulties and successes in the teaching of physics at Junior Cycle as part of the Improving Gender Balance in Ireland programme. Considering unconscious bias and career awareness throughout, the workshops highlight the importance of physics in everyday life and it's connections to Chemistry, Biology and Earth & Space.

1. **Electricity 1**

   Making and Breaking a Circuit, Using the Multimeter to measure current and voltage, Lemon Battery, Batteries in Series and Parallel, Test Your Nerves, Running Bugs, Squishy Circuits, Careers in the field

2. **Earth & Space 1**

   Rocket Science, Photosynthesis on the Moon, Craters on the Earth/Moon (Meteor Science), Phases of the Moon, Information on Career Opportunities in Space Science

3. **Density 1**

   Defining Density, Density Applications, Measuring Instruments and Accuracy, Regular and Irregular Shapes, Linking Maths to Science, Identifying Materials Using Density, Calibration, Colourful Density

4. **Electricity 2**

   Building Prior Knowledge in Electricity, Understanding Circuits using PhET, Using Snap Circuits to Elicit Student Ideas, Ethical Implications of Electricity Generation, Designing and Building a Water Sensor

5. **Light 1**

   Students' Preconceived Ideas about Light, Connecting the History of Light to Today, Properties of Light, Optical Communication, Total Internal Reflection, Designing a Communication System, Careers in the Field of Light, Rainbow Nursery Challenge

6. **Energy & Sustainability 1**

   TBC

Workshop Information (Whole School/All-staff Unconscious Bias Workshop)

This unconscious bias workshop is designed to create an awareness, among members of school management and teachers of all subjects, about the barriers that can inhibit students from choosing particular subjects at secondary school. Investigating your own personal unconscious biases and the biases of your students can impact student interactions and student-teacher relations within the classroom. Focussing on strategies to minimize negative biases around the school and promote inclusivity and diversity in the classroom is one of the core outcomes of this workshop.

Appendix 2

Sample Website Audit

Gender Balance Website audit

Submission Date	2017-11-08 03:54:47
School Name	
Imagery	- Front banner: mixture of boys and girls in all images except digital learning (all boys) -Prefects: mixture of boys and girls - Very interactive and up to date website
Placement of Physics in Subject List	Not listed
Science Related Extra-curricular Activities	-In parents presentation- no mention of science extra-curricular activities -Cara Aire: supporting transition from primary to secondary No interaction with any subjects on the website
Involvement in Science Events/Competitions	No mention
Gender Balance/Equality Policy	First on the guidance policy list under diversity.
Career Options for Physics listed	None

Appendix 3

Unconscious Bias Pre-Survey Sample Items (Adapted from IGB Scotland)

5. Have you completed any training on unconscious bias as a teacher? * Mark only one oval.

- Yes
- No
- I don't know

6. The school has a policy and procedure to tackle any gender biased attitudes and behaviour they encounter in the school. * Mark only one oval.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

7. A member of staff leads and champions good practice for unconscious bias awareness across the whole school. * Mark only one oval.

- Strongly agree
- Agree
- Neither
- Disagree
- Strongly Disagree

8. The school has clear values and expectations regarding gender biased attitudes and behaviours and these are communicated to all parents and visitors involved in the life of the school. * Mark only one oval.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

9. The school's image (publicity, photographs, newsletters, job particulars and prospectus) reflects the diversity profiles of the staff. * Mark only one oval.

- Strongly agree
- Agree
- Neither
- Disagree
- Strongly Disagree

10. The school's image (publicity, photographs, newsletters, job particulars and prospectus) reflects the diversity profiles of the students. * Mark only one oval.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Appendix 4

Phase I Science Teacher pre-survey

Science Teacher Survey

The following section must only be completed by science teachers. Please complete it individually, not in a group/department. If you are not a science teacher you can go directly to the "submit form" tab. Thank you for your participation.

21. How many years (in total) have you been teaching Junior Cycle science?

22. Do you currently have hours teaching Leaving Certificate level physics? Tick all that apply.

- 6th yr physics
- 5th yr physics
- No

23. I am confident teaching [named subject] at Junior Cycle/Certificate level. Mark only one oval per row.

	Strongly	Agre	Neithe	Disagre	Strongly
Physical					
Chemical					
Biological					
Earth and					

24. I am confident teaching [named subject] at Leaving Certificate level. Mark only one oval per row.

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
Physic					
Chemistr					
Biolog					

25. What topic(s)/area(s) do your students experience most difficulty with, in physics, at Junior Cycle/Certificate level?

26. What topic(s)/area(s) do your students experience most difficulty with, in physics, at Leaving Certificate level?

27. What support would help you teaching Junior Cycle/Certificate physics?

28. What support would help you teaching Leaving Certificate physics?

Appendix 5

Workshop Satisfaction Survey

Feedback Sheet

Criteria	Strongly Agree 1	2	3	4	Strongly Disagree 5
Training was relevant to my needs					
Materials provided were helpful					
Length of training was sufficient					
Content was well organised					
Questions were encouraged					
Instructions were clear and understandable					
Training met my expectations					
The presenter and/or presentation was effective					

Other Comments (what you found useful/would like to see more of/what you would change):

Appendix 6

School Letter of Invitation

IMPROVING GENDER BALANCE IRELAND

Centre of Advancement of STEM Teaching and Learning (CASTeL)
Dublin City University
Glasnevin
Dublin 9

Dear Principal/Teacher,

It is my pleasure to invite your school's participation in the pilot roll out of the **Improving Gender Balance in Ireland**, which is coordinated by the Centre for the Advancement of STEM Teaching and Learning (CASTeL) at Dublin City University in strategic partnership with the Institute of Physics (IOP) Ireland and Science Foundation Ireland and has received endorsement from the National Council of Curriculum and Assessment (NCCA).

We are currently recruiting schools to partner with CASTeL and IOP Ireland in the second phase of the Improving Gender Balance in Ireland project. Upon application a shortlist of accepted schools will be contacted with further details of the project. We ask that you kindly submit your application at your earliest convenience as spaces are limited.

The key objective of the Improving Gender Balance in Ireland Programme is to address the engagement and retention of students studying physics to Leaving Certificate level. The key actions of this programme are to:

1. Support all science teachers in their teaching of physics at Junior Cycle.
2. Address students' attitudes towards physics. Engage students in workshops to explore stereotyping, build self-confidence and academic resilience. Develop awareness of STEM industries, careers and role models.
3. Adopt a whole school approach to stereotyping. Benchmark the attainment and progression in STEM by gender. Enhance the school culture/commitment to equality throughout the school.

Throughout the four-month cooperation, **all** staff will receive **a one-hour Unconscious Bias** workshop, which can be used as a Croke Park hour (if you wish). In addition to this, all science teachers will receive **three workshops** on Junior Cycle Physics topics (which can be put towards their CPD). Upon completion of these workshops' science teachers will be in receipt of a class set of resources per school.

We invite your school to register your interest in participating in this project by completing the attached i) application form, ii) science workshop form and iii) letter of agreement and returning it by September 27th.

Should you have any queries, please do not hesitate to contact our Project Officer, Georgina Fagan; CASTeL Project Officer, School of Physical Sciences, Dublin City University, Glasnevin, Dublin 9. E: info@igbireland.ie T: 01-7005845

Alternatively, you can complete the application online via this link.
https://forms.gle/GkexJBMAL81ucqJg8

The application for the Science Workshops can also be completed online via this link.
https://forms.gle/dZcH2afGtRoE9HQB7

Kind Regards,

Eilish McLoughlin,
Associate Professor, School of Physical Sciences,
Director CASTeL, Dublin City University,
National Coordinator, Improving Gender Balance Project in Ireland

E: eilish.mcloughlin@dcu.ie
T: 01-7005862

Appendix 7

School Application Form

IMPROVING GENDER BALANCE IRELAND

A partnership between CASTeL at Dublin City University, Institute of Physics in Ireland and Science Foundation Ireland

APPLICATION FORM

The information that is collected will be kept private and stored securely and safely. As the surveys are anonymous, your name will not appear on any information. The information that is gathered in the study will be kept for five years. After this time, it will be destroyed.

CONTACT DETAILS

School Name:

School Roll Number:

School Address:

School Phone Number:

Principal's Name:

Principal's Email:

SCHOOL INFORMATION

Teaching Staff Population:	Males:	Females:	Other:
Student Population:	Males:	Females:	Other:
Numbers of students taking JC science:	Males:	Females:	Other:
Numbers of students taking LC physics:	Males:	Females:	Other:
Numbers of students taking LC chemistry:	Males:	Females:	Other:
Numbers of students taking LC biology:	Males:	Females:	Other:

SCHOOL WORKSHOP DATES

UNCONSCIOUS BIAS

Each partnering school will take part in a **whole school unconscious bias** workshop that can be allocated one Croke Park hour (should the school wish). This workshop focuses on identifying teachers' and students' unconscious biases and identifying how this may impact inclusion and diversity in the classroom. This workshop will be facilitated with all teaching staff. We would like to schedule schools for one of these (hour-long) workshops and request that your school suggest two suitable dates. We will select one of the dates and reply with confirmation.

A point of contact (principal, deputy principal, teacher) is suggested for our project officer to coordinate any changes in dates/times etc.

Unconscious Bias Workshop Date 1: _____

Unconscious Bias Workshop Date 2: _____
(If the first cannot be facilitated)

Point of contact

Name: _____ Role/Position: _____

Email: _____ Phone: _____

Appendix 8

Science Teacher Application Form

IMPROVING GENDER BALANCE IRELAND

A partnership between CASTeL at Dublin City University, Institute of Physics in Ireland and Science Foundation Ireland

SCIENCE WORKSHOPS

Improving Gender Balance in Ireland is offering three inquiry-based physics workshops to enhance the teaching and learning of physics at Junior Cycle, to all partnering schools. The topics covered will be; Density, Electricity and Earth & Space. These workshops will be schedule regionally in locations around Dublin. Once **all science teachers** in your school have completed **the three workshops,** your school will be gifted with a class set of resources for each topic. We will be offering aprox. 4 dates for each workshop to facilitate all science teachers from all partnering schools. We ask that your science teachers fill out the form below to register for these workshops. A point of contact (coordinating science teacher) is suggested for our project officer to coordinate any changes in dates/times etc.

Point of contact

Name: _____ Role/Position: _____

Email: _____ Phone: _____

Provisional Timetable for Science Workshops

Density

Location	Date	Times	Option
Drogheda	Thursday Oct. 24th	14.30 – 16.00 17.00 – 18.30	1 2
DCU	Wednesday Nov. 20th	14.30 – 16.00 17.00 – 18.30	3 4
Dublin West	Thursday Oct. 3rd	16.30 – 18.00 18.00 – 19.30	5 6
Blackrock	Wednesday Dec. 11th	14.00 – 15.30 17.00 – 18.30	7 8

Earth and Space

Location	Date	Times	Option
Drogheda	Thursday Dec. 12th	14.30 – 16.00 17.00 – 18.30	1 2
DCU	Wednesday Oct. 9th	14.30 – 16.00 17.00 – 18.30	3 4
Dublin West	Monday Nov. 25th	16.30 – 18.00 18.00 – 19.30	5 6
Blackrock	Thursday Sep. 26th	 17.00 – 18.30	7 8

Electricity

Location	Date	Times	Option
Drogheda	Thursday Oct. 10th	14.30 – 16.00 17.00 – 18.30	1 2
DCU	Wednesday Nov. 6th	14.30 – 16.00 17.00 – 18.30	3 4
Dublin West	Monday Dec.9th	16.30 – 18.00 18.00 – 19.30	5 6
Blackrock	Monday Dec. 2nd	14.00 – 15.30 17.00 – 18.30	7 8

Science Teacher Application Form

IMPROVING GENDER BALANCE IRELAND

A partnership between CASTeL at Dublin City University, Institute of Physics in Ireland and Science Foundation Ireland

SCIENCE TEACHER INFORMATION

Teacher Name	Email Address	Number of years teaching	Specialist L.C. Subjects (as registered by Teaching Council)	Current subjects Timetabled	Preferred option for Workshops (see timetable)
EXAMPLE: Deirdre O'Neill	EXAMPLE: 123@gmail.com	4	Maths, Physics	Maths JC, Maths LC, Physics LC	**Density:** Option 1 **Earth & Space:** Option 6 **Electricity:** Option 4
					Density: Earth & Space: Electricity:
					Density: Earth & Space: Electricity:
					Density: Earth & Space: Electricity:
					Density: Earth & Space: Electricity:
					Density: Earth & Space: Electricity:
					Density: Earth & Space: Electricity:

Appendix 9

Adapted Survey of Ito (2018) - Factors Influencing High Schools Students' Interest in PSTEM

Class: **Teacher:** **Gender:**

Please response to each of the following statements on a scale of 1-5.

1= Strongly Agree, 2= Agree, 3=I don't know, 4=Disagree, 5=Strongly Disagree

1. I feel a connection with the community associated with my science class	1	2	3	4	5
2. I feel like an outsider in my science class	1	2	3	4	5
3. I feel like I belong in my science class	1	2	3	4	5
4. People in my science class accept me	1	2	3	4	5
5. People in my science class are a lot like me.	1	2	3	4	5

6. I feel similar to the kinds of people who have what it takes to succeed in my science class	1	2	3	4	5
7. I'm not certain I "fit in" intellectually in my science class	1	2	3	4	5
8. When I'm doing work in my science class, I feel a sense of competence;	1	2	3	4	5
9. I sometimes feel like other students in my science class have skills that I don't	1	2	3	4	5
10. I worry that no matter how hard I try, I won't be able to perform successfully in my science class	1	2	3	4	5

11. I'm interested in knowing more about the science being taught	1	2	3	4	5
12. I could see myself going into a career related to science	1	2	3	4	5
13. In college, I plan to major in a field or subject related to science	1	2	3	4	5
14. After fulfilling my Leaving Certificate, I will not take another course like science	1	2	3	4	5
15. I will look into joining/have joined extracurricular activities related to science after school	1	2	3	4	5

16. I am confident that I can demonstrate what I know on exams in my science class	1	2	3	4	5
17. I am confident that I can complete class homework by myself in my science class	1	2	3	4	5
18. I am unable to demonstrate what I learn in my science class on exams	1	2	3	4	5
19. I am confident that I can perform well on exams in my science class	1	2	3	4	5
20. I am not confident that I can learn and understand the concepts taught in my science class	1	2	3	4	5
21. I am confident that I can complete the science class with a B or better in the Junior Cycle	1	2	3	4	5
22. I am confident that I can learn the basic concepts associated with the science class	1	2	3	4	5

23. What science subject are you most interested in? Rank in order 1-3 where 1=Most Interested.

Physics	
Chemistry	
Biology	

24. What are the top three courses you would like to do after you finish school?

1.	
2.	
3.	

25. What are the top three jobs/careers you would like to do after you finish your education?

1.	
2.	

Appendix 10

Action Plan Template

Subject Department Audit

IMPROVING GENDER BALANCE IRELAND

A partnership between CASTeL at Dublin City University, Institute of Physics in Ireland and Science Foundation Ireland

School: _____

Subject Department: _____

Teacher Names: _____

_____

(1) **Identify** positive and negative aspects of how your subject is portrayed:

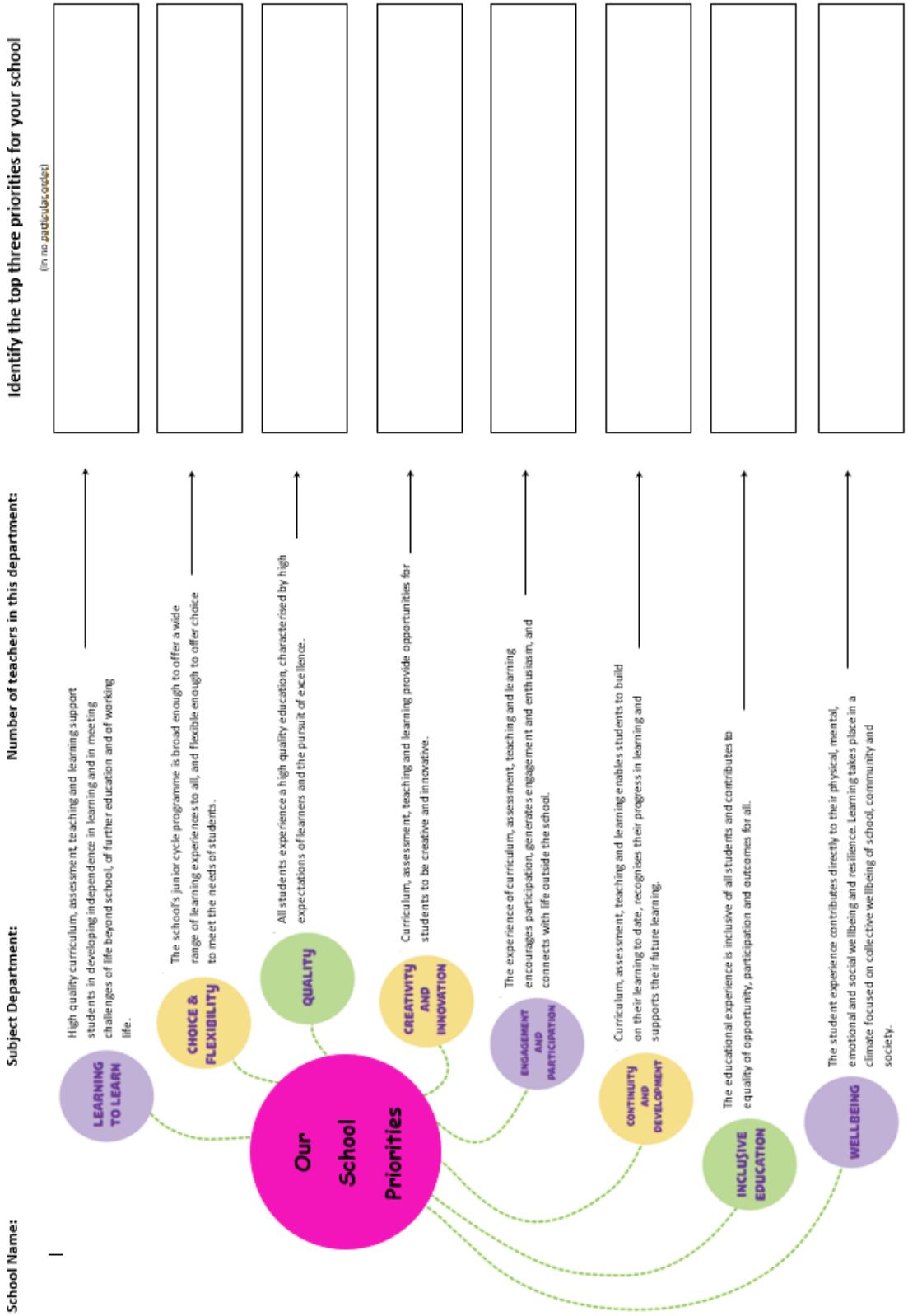
How is your subject portrayed	Positive Aspects	Negative Aspects
a. On the school's public website		
b. In the classroom *(e.g. posters/displays/resources)*		
c. Across the school *(e.g. notice boards/extra-curricular)* =		
d. Other		

(2) What **action** will your department now take (Oct. 2019 – Dec. 2019) to address one aspect identified above (positive or negative).

(3) Follow up to be completed in December 2019.

Appendix 11

School Priorities Tool



Appendix 12

Inclusive Teaching Top Tips

10 Inclusive Teaching Tips for Teachers

These tips were developed from our research into gender and behaviour patterns. We recognise that there are variants and these behaviours are not the experience of all individuals. Inclusive teaching is therefore intended to support all students.

1 Use everyday language

Low confidence learners can be intimidated by technical jargon. Avoid it and make sure that you only introduce technical language or equations once the context is understood.

2 Avoid asking for volunteers

Some groups may be more likely to raise their hands, call out answers and volunteer to take part in activities. Other techniques, such as individual whiteboards or selecting students at random, can broaden the range of students participating.

3 Assign roles for practical work

Certain students are more likely to dominate the active roles while others may take on more passive roles, like writing. To avoid this, you can assign roles or use single-sex groups for practical and group activities.

4 Use examples that show how your subject links to their experience

This is useful for all students, but research shows that girls in particular tend to appreciate context and seeing the bigger picture.

5 Use gender-neutral contexts whenever possible

Try to avoid using examples that focus on stereotypically male or female hobbies or interests.

6 Allow time for pair or group discussions

Give time for students to discuss answers to challenging questions before asking them to share ideas with the class.

7 Challenge discriminatory language

School should be welcoming to everyone. Always treat sexist language as unacceptable, and tackle the attitudes behind it.

8 Monitor your interactions with different genders

You might be surprised at the ratio of different genders asking or answering questions in your class. Keep a note yourself or ask a colleague or student to observe one of your lessons and keep count.

9 Regularly refer to a range of careers that use skills from your subject

Girls are more likely to consider their future career when choosing their options. Emphasise the transferable skills that studying your subject helps to develop.

10 Ensure that your students are exposed to a diverse range of role models in your subject

Be wary of giving your students the impression that only some people can do your subject. Emphasise that everyone can do it, irrespective of their background.

Find out more at **iop.org/genderbalance**

IOP Institute of Physics

Appendix 13

Classroom Interactions self-audit tool

Classroom interactions self-evaluation template

Research by the Institute of Physics suggests that boys tend to dominate in the classroom, answering more questions and getting more of the teacher's attention, usually without the teacher being aware of any imbalance. This template will help you to assess your own practice.

If you are comfortable doing so, you may find it useful to invite a colleague or student to complete the template for you during a lesson.

Date: _____

Class: _____

	Boys	Girls
Number in class		
Hands up		
Questions directed at		
Answers called out by		
Questions asked by		

Notes

NOTE: Some students may not identify as boys or girls. Please edit this template as appropriate for the needs of your class.