



# Final Report

## Enhancing Summative Assessment of Practical Science: A Systemic Approach

A collaboration between University of Oxford and AQA Research

Principal Investigator

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Department of Education

Project Funded by Wellcome Trust, Gatsby Foundation and Royal Society  
Grant number: 209659/Z/17/Z

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## **PROJECT INFORMATION**

### **Principal Investigator**

Professor Sibel Erduran, University of Oxford

### **Project team**

Science education: Professor Sibel Erduran, Associate Professor Ann Childs, Associate Professor Judith Hillier, Dr Alison Cullinane, Dr Olga Ioannidou, from University of Oxford.

Assessment: Professor Jo-Anne Baird, Dr Yasmine El Masri from University of Oxford; Dr Lena Gray, Dr Ruth Johnson, Dr Steve Wooding and Ms Katy Finch, from AQA.

### **Funding**

Project Calibrate is jointly funded by the Wellcome Trust, the Gatsby Foundation and the Royal Society (Grant number: 209659/Z/17/Z)

### **Duration**

January 2018-December 2020

Extension to March 2021 due to Covid-19

### **Project website**

<https://projectcalibrate.web.ox.ac.uk/>

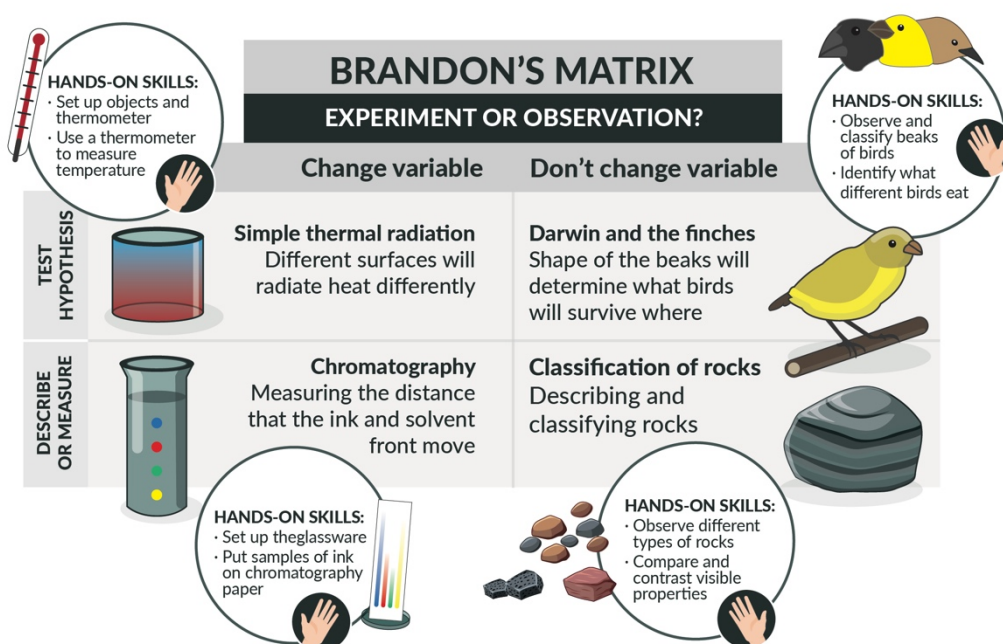
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## EXECUTIVE SUMMARY

Project Calibrate is a collaboration between the Department of Education at University of Oxford and AQA Research. The project which took place from 2018-2021 aimed to design, implement and test summative assessments of practical science.

- The project addressed **a central problem in teaching practical science** about how pupils are often exposed to only a fairly simplistic account of the scientific method. The mythical 'scientific method' is frequently taught as singular and linear, starting with a hypothesis which is then tested through a recipe-like experiment. The conclusions from scientific investigations are thus drawn in a fairly straightforward fashion. Project Calibrate not only challenged this simplistic account of scientific methods because it is not reflective of how scientists actually *do* science, but also the project has developed and tested concrete strategies for teaching and assessing a diversity of scientific methods. If future generations of scientists and citizens are to engage in authentic experiences of science, then practical science in schools needs to be taught and assessed in ways that are consistent with how scientists *do* science.
- At the core of Project Calibrate is a framework called **Brandon's Matrix**<sup>\*</sup>. The matrix illustrates that not all experiments rely on hypothesis testing. Instead, scientists use a range of approaches when they engage in scientific investigations. Brandon represents the connections between experiments and observations in terms of a



<sup>\*</sup> Brandon, R. (1994). Theory and experiment in evolutionary biology. *Synthese*, 99, 59–73.

matrix (i.e. two-by-two table) in which an investigation (experiment/observation) is related to whether or not it involves the manipulation of one or more variables, and whether it involves an explicit hypothesis test or is instead concerned with parameter measurement and/or recording observations (see Figure above).

- A **contemporary example** mapped to Brandon's Matrix involves the Covid-19 pandemic. Scientists have been collecting data on how the virus might be influencing a patient's breathing over a period of time. Such observation is simply based on the recording of parameters such as the concentration of oxygen in the blood, where there is no manipulation of variables in the sense of an experimental design. Sometimes the data might be subjected to hypothesis testing about correlation between incubation period and extent of lung disease, but without actually conducting an experiment. Such investigations result in non-manipulative hypothesis testing. Scientists are also conducting randomised control trials in which drugs and vaccines are treated as variables in interventions that also include control groups to test the placebo effect. All of these different approaches including hypothesis testing and parameter measurement are used in science, and there is no one single method but rather a diversity of scientific methods.
- Brandon's Matrix inherently stresses the **interplay of thinking and doing in practical science**. In other words, each category of the matrix stresses what is done in terms of hands-on skills (e.g. experiments, observations) as well as minds-on approaches (e.g. questioning the type of investigation). By highlighting the thinking behind the doing in practical work, Project Calibrate approach has been consistent with contemporary cognitive learning theories that emphasise meaning making and conceptual understanding in science. The design of assessments, especially high-stakes summative assessments, is not always defined in terms of what best promotes pupils' learning. The now outdated behaviourist learning theories which focus on promoting desired behaviours and discouraging undesired ones with less interest in thought processes have been linked to controlled assessments and multiple-choice tests where only performance mattered. In contrast, cognitive and socio-cultural learning theories give precedence to the thinking processes involved in learning. The assessments emphasise meaning making and conceptual understanding with partial credit being allocated to elements of the response such as the use of a correct approach for answering a question (El Masri, Erduran & Ioannidou, 2021).
- Project Calibrate capitalised on the **expertise of science education researchers, teacher trainers and assessment researchers** based in a leading university and the research division of a nationally influential examination board in order to design, test and evaluate the affordance of Brandon's Matrix to support the teaching, learning and assessment of practical science. The Project's Advisory Board consisted of internationally renowned experts in science education and

educational assessment as well as leading practising scientists who have provided feedback on the various project components. A particularly well received aspect of the project was the use of Brandon's Matrix as a rigorous and well-justified framework that was applied consistently across the design of examination questions, continuous professional development resources as well as video-based teaching and learning materials. All resources have been compiled on the project website and they are accessible free of charge on the project website (<https://projectcalibrate.web.ox.ac.uk/home>).

- The project began with a **baseline literature review** of the international and national research literature on summative assessment of practical science. Assessment documents from a set of selected English speaking countries that performed higher than the OECD average in the 2015 PISA science test were analysed qualitatively guided by questions such as “*what is the construct of practical science*” and “*what is the format of assessment?*” (Erduran, El Masri, Cullinane & Ng, 2020). The examined jurisdictions used different approaches from traditional external pen-and-paper tests to internal teacher assessments that included different formats (e.g. laboratory report). Innovative approaches to the assessment of practical skills (e.g. PISA computer-based tasks) do not seem to be represented in these high-stakes assessments. The literature has illustrated that there are significant challenges with innovation in high-stakes summative assessment of practical science due to limitations regarding infrastructure as well as reliability and cost involved in large scale adaptations of technology-based innovations in summative assessments. The review of research literature focusing on the national landscape of high-stakes assessment of practical science has illustrated that the teaching and learning of investigative practical work for the GCSE became formulaic, narrow and dominated by hoop jumping exercises that bore little resemblance to the spirit of scientific inquiry (Childs & Baird, 2020). The implications is that there will be teaching to the test, narrowing of the curriculum and gaming of the system. Hence, the design of summative assessments need a much more nuanced view of what *tests worth teaching to* would look like.
- The **relevance of Brandon's Matrix for current GCSE examination papers** was investigated through a sample of chemistry questions from two papers of three major examination boards. The findings of this investigation (Cullinane, Erduran & Wooding, 2019) pointed to how manipulative parameter measurement dominated the examination papers and how manipulative hypothesis testing type questions were present in a limited capacity. This was contrary to initial belief that manipulative hypothesis testing would be dominant, as this is often presented as ‘the scientific method’ in many science classrooms. This inconsistency illustrates the disconnect between what is taught and what is assessed. Furthermore, more marks were allocated to manipulative type questions, even though the relative frequency for these items were lower. In other words, there was relatively more

items dedicated to non-manipulative parameter measurement as compared to manipulative parameter measurement. The relative distribution of marks was not consistent suggesting that more marks were dedicated to manipulative parameter measurement as compared to the number of items covered in the examination.

- A group of ***GCSE examiners working for different examination boards*** in England were recruited and trained in using Brandon's Matrix for designing summative assessments. The examiners subsequently produced assessments on two topics each for biology, physics and chemistry. Each set of summative assessments consisted of questions corresponding to each cell of the Brandon's Matrix as well as a fifth category where different scientific methods were evaluated collectively. The summative assessments were mapped onto existing assessment objectives for GCSE. The sets of summative assessments are available to download on the project website.
- Studies were conducted with ***local teachers and pupils*** to investigate their attitudes towards practical science in general, and Brandon's Matrix in particular. Interviews with a sample of teachers illustrated that science teachers are generally positive about Brandon's Matrix (Cullinane, Hillier, Childs & Erduran, in press; Ioannidou, Finch & Erduran, in review) although their understanding of the components of scientific methods can be naïve (Ioannidou & Erduran, 2021). Studies with a sample of pupils' responses towards the designed physics assessments illustrated that pupils held a very narrow understanding of what a scientific method is. Pupils considered the scientific method to be about hypothesis testing, variable manipulation and measurement of several variables. Furthermore, they reported not to enjoy drawing conclusions from data (El Masri, Erduran & Ioannidou, 2021). The pupils' reports of not enjoying taking measurements were inconsistent with their reporting of enjoying setting up equipment and recording observations.
- Science ***teachers recruited from Oxford and Liverpool*** participated in continuous professional development (CPD) activities using the Project Calibrate approach. The timing of the local teachers' implementation of lesson activities corresponded to the onset of the Covid-19 pandemic and the school closures. Hence, the investigations into their teaching experiences have been limited. Existing data on teachers who have participated in the CPD activities have been analysed indicating a positive reception overall (Ioannidou, Finch & Erduran, in review). Further CPD sessions were conducted on ***webinars*** involving teachers from across England. The experiences with the teachers' and examiners' workshops have been refined to produce continuous professional development resources with the choice of a full day, 4-hour and 2-hour versions of training to engage in teaching and learning of practical science using Brandon's Matrix (Wooding, Erduran & Cullinane, 2020).

- The lockdown and school closures meant that data collection in project schools could not take place for the majority of the teachers. In order to ensure that the project approaches can be disseminated to teachers, the Project Calibrate team members who are experienced science teachers and teacher educators themselves have produced **online teaching videos** focusing on a topic in GCSE biology, chemistry and physics. The teaching videos are available on the project website. These videos were distributed nationally to teachers who have used them in their teaching. Data were collected from teachers who taught using the videos and the pupils who completed the designed summative assessments.
  
- **A national survey** was conducted with 152 teachers and 969 pupils who used the project video learning resources and summative assessments as part of their regular lessons. The pupils' understanding of scientific methods was investigated before and after the use of resources. This study, currently in review in an international research journal (Erduran, Ioannidou & Baird, in review) has been summarised in the *Key Findings* document.
  
- The **key findings** of national survey are as follows:
  - Finding 1:* The resources helped pupils understand scientific methods better. Pupils showed better understanding of scientific methods after watching the online lessons and completing the assessment questions. This suggests that the designed resources can be used as an effective tool for teaching about the diversity of scientific methods.
  - Finding 2:* Pupils indicated that the Project Calibrate approach helped them understand scientific methods better. On average 75% of the pupils agreed or strongly agreed that the resources helped them understand scientific methods better. This suggests that pupils understood the learning objectives of the resources and engaged with them in a meaningful way.
  - Finding 3:* Most pupils associated the resources with practical science. 82% of the pupils reported that the resources were targeting practical science, while on average 55% answered that the questions were similar to the questions that pupils complete in their classrooms. This suggests that pupils perceived the resources as adequate for teaching and assessing practical science at GCSE level.
  - Finding 4:* Teachers had a positive attitude towards the online teaching and learning resources. On average most teachers (73%) found the online teaching resources useful for teaching scientific methods, although only 37% found the online resources targeting scientific methods easy. This finding suggests that teachers found the resources valuable, although they also recognized that the resources can be challenging for some pupils.
  - Finding 5:* Teachers found the summative assessments useful and indicated that they would use them. On average 86% of the teachers found the designed assessments useful for assessing practical science and 73% found them useful for

assessing pupils' understanding of scientific methods. 85% of the teachers would use the summative assessments in their classrooms. This observation highlights teachers' general positive attitude towards the designed assessments.

- In summary, Project Calibrate produced a range of **research publications** (e.g. Childs & Baird, 2020; Cullinane et al., 2019; Erduran et al., 2020; El Masri et al., 2021; Ioannidou & Erduran, 2021) in peer-reviewed international journals as well as **practitioner-oriented resources** engaging examiners and teachers (Erduran & Wooding, 2021; Erduran, 2020; Wooding, Cullinane & Erduran, 2020). Examiners designed summative assessments on two sets of topics in physics, biology and chemistry. Video-based teaching and learning resources based on Brandon's Matrix were produced by the project team who have extensive teaching experiences in secondary schools in England. The experiences with the teachers' and examiners' workshops have been refined to produce continuous professional development resources with the choice of a full day, 4-hour and 2-hour versions of training to engage in teaching and learning of practical science using Brandon's Matrix. The resources have been compiled on the project website (<https://projectcalibrate.web.ox.ac.uk/>) and are freely available to be downloaded.
- Project Calibrate team has conducted a range of **engagement activities** including presentations at key international (e.g. European Science Education Research Association) and national (e.g. Association for Science Education) conferences. A keynote lecture was delivered on the project at the ASE conference in 2021 as well as at the OxfordAQA conference with engagement from international schools. The research findings and CPD resources have been integrated into teaching programmes at University of Oxford, including the PGCE Science (with trainee teachers) and the Master's in Learning and Teaching (with in-service teachers) programmes. Local dissemination activities has included doctoral student poster conference and public seminars.
- Overall, there has been **positive reception** by both teachers and pupils about the Project Calibrate Approach. One Head of Science remarked:

*"Our science department will be weaving in the understanding of Brandon's Matrix into their teaching."*

One Head of Biology whose school participated in the national survey said:

*"I would like to express our gratitude for putting this together as we have been looking at resources that will help students' with their practical understanding of science."*

Pupils were equally enthusiastic about the Project Calibrate approach. One pupil said:

*"Before I watched the videos, I thought all scientific investigations require a hypothesis of some sort, which these videos disproved in an easy-to-understand way. Thank you for opening my eyes."*

Another pupil remarked about the assessments as follows:

*"I liked the questions because they helped me really think about the experiments I have done previously."*

## SUMMARY OF OUTPUTS

The outputs of the project are as follows:

- **10 peer-reviewed publications**

- 5 Research publications published in peer reviewed journals
- 1 Published book chapter
- 3 Research publications in review
- 1 Book chapter in review

- **30 engagement events**

- 9 International conferences
- 4 National conferences
- 3 Examiners' workshops
- 3 Teachers' workshops
- 7 Local events including department (Oxford and AQA)
- 2 Teaching sessions (PGCE and MLT courses)
- 1 End of project national dissemination event
- 1 PISA 2024 Expert Group event

- **12 practitioner-oriented outputs**

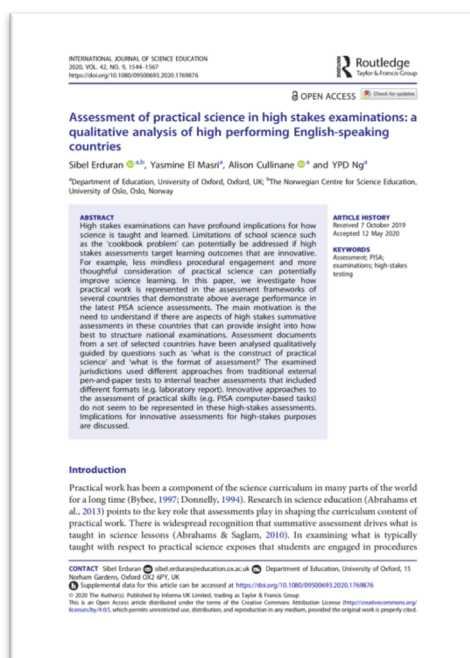
- 4 Articles (1 in press, 1 in review)
- 6 Sets of assessments
- 1 Set of continuous professional development resources
- 1 Set of technical output as teaching and learning videos

- **Other**

- 2 Blog posts
- 1 Document of key findings

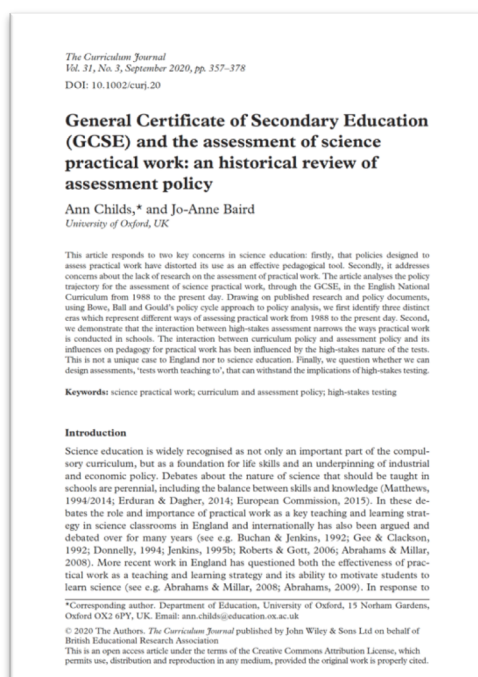
# PUBLICATIONS AND OTHER OUTPUTS

## Research journals



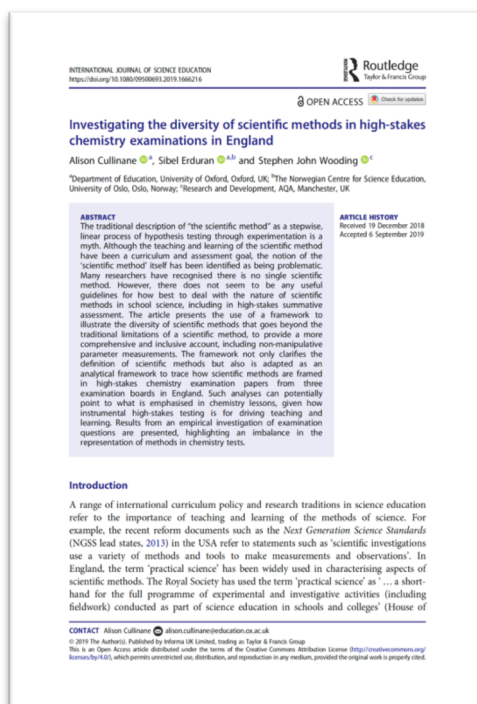
- Survey of international assessments in high stakes contexts in a sample of English-speaking countries with above average performance on PISA assessments

Erduran, S., El Masri Y., Cullinane, A., & Ng Y. (2020). Assessment of practical science in high stakes examinations: a qualitative analysis of high performing English-speaking countries. *International Journal of Science Education*, (9), doi: [10.1080/09500693.2020.1769876](https://doi.org/10.1080/09500693.2020.1769876)



- Historical review of high stakes assessment of practical science at GCSE level in England

Childs, A., & Baird, J. A. (2020). General Certificate of Secondary Education (GCSE) and the assessment of science practical work: an historical review of assessment policy. *The curriculum journal*, 31(3), pp. 357-378. doi: [10.1002/curj.20](https://doi.org/10.1002/curj.20)



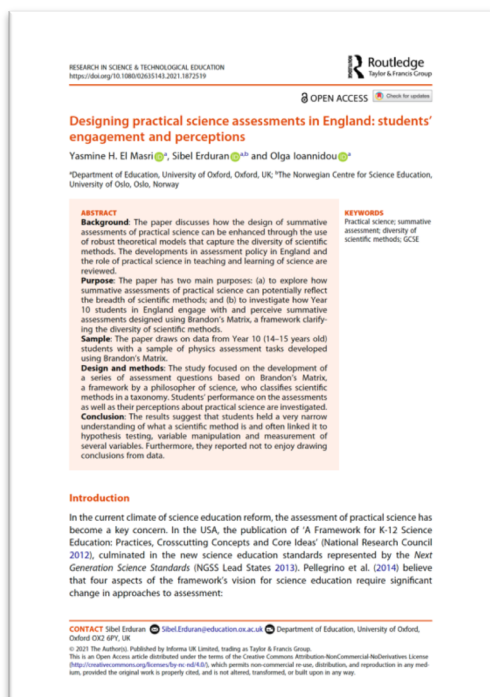
- Investigation about examination questions from different examination boards in England for their coverage of scientific methods

Cullinane, A., Erduran, S., & Wooding, S. J. (2019). Investigating the diversity of scientific methods in high-stakes chemistry examinations in England. *International journal of science education*, 41(16), pp. 2201-2217. doi: [10.1080/09500693.2019.1666216](https://doi.org/10.1080/09500693.2019.1666216)



- Quantitative analysis of teachers' understanding and perceptions of scientific methods

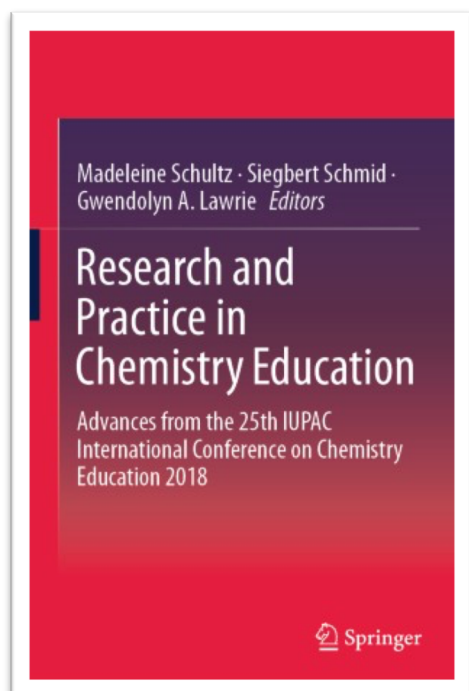
Ioannidou, O., & Erduran, S. (2021). Beyond Hypothesis testing: investigating the diversity of scientific methods in science teachers' understanding. *Science & Education*, 40(2). <https://doi.org/10.1007/s11191-020-00185-9>



- Investigation about pupils' perceptions of scientific methods and designed summative assessments

El Masri, Y., Erduran, S., & Ioannidou, O. (2021). Designing practical science assessments in England: students' engagement and perceptions, <https://doi.org/10.1080/02635143.2021.1872519>. *Research in Science & Technological Education*.  
<https://doi.org/10.1080/02635143.2021.1872519>

## Book chapters



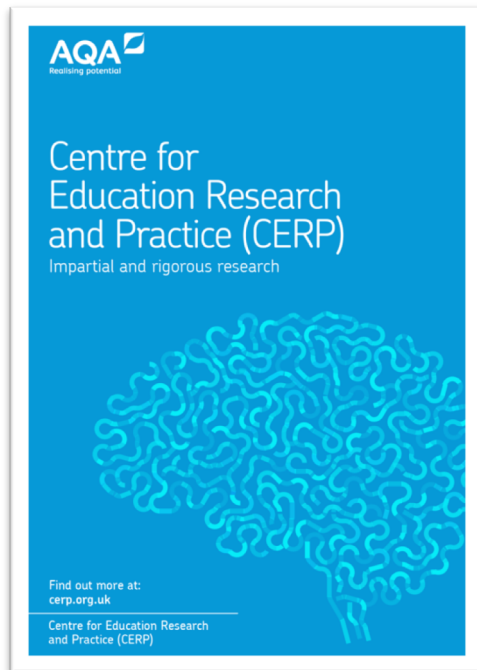
- Investigating high stakes chemistry assessments at GCSE level in England

Erduran S., Cullinane A., & Wooding S. J. (2019). Assessment of Practical Chemistry in England: An Analysis of Scientific Methods Assessed in High-Stakes Examinations. In, M. Schultz, S. Schmid, and G. Lawrie (Eds.), *Research and Practice in Chemistry Education - Advances from the 25th IUPAC International Conference on Chemistry Education 2018* (pp. 135-147). Springer Singapore.

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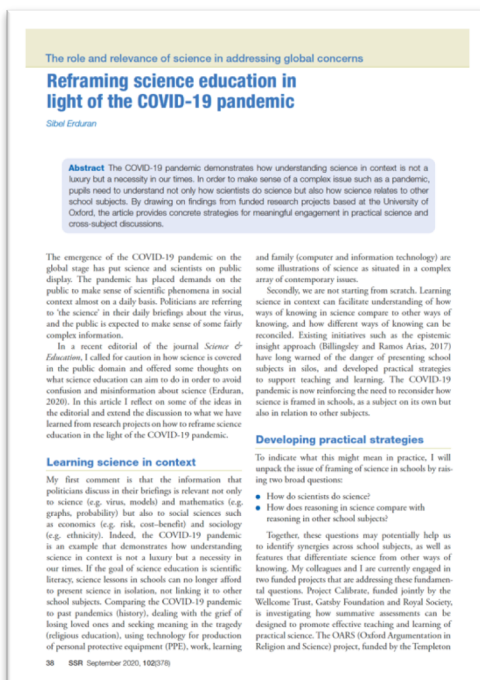
## Practitioner-oriented publications

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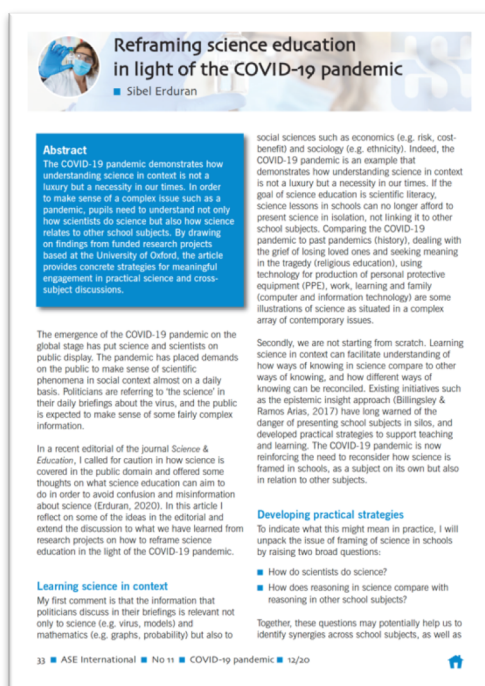
- Provides a description of the project illustrating innovation in assessment in GCSE practical science
- Key AQA document distributed to research stakeholders in educational assessment

El Masri, Y., Erduran, S., & Cullinane, A. (2018). Building bridges between assessment and subject matter: an innovative approach to assessing GCSE practical science. *Centre for Education Research and Practice: Impartial and rigorous research*, p.4. Manchester: AQA.



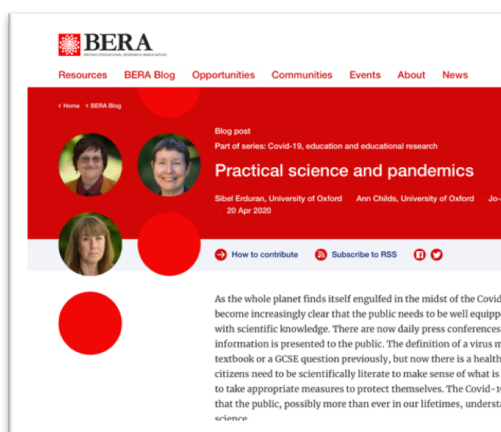
- Relevance of Project Calibrate approach to the pandemic context

Erduran, S. (2020). Reframing science education in light of the Covid-19 pandemic. *School Science Review*, 102(378), 38-43.



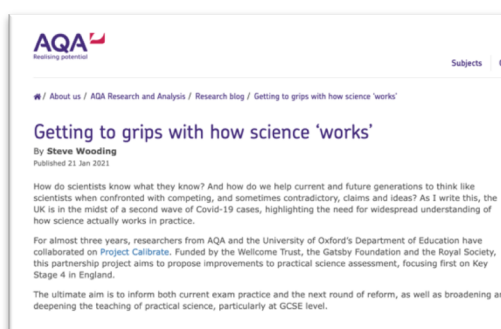
- SSR (2020) article chosen to be included in ASE International

Erduran, S. (2020). Reframing science education in light of the COVID-19 pandemic. *ASE International*, 11, pp.33-39.



- Blog entry for British Educational Research Association
- Project Calibrate approach and its relevance to the pandemic

Erduran, S., Childs, A. & Baird, J. A. (2020, April 20). Practical science and pandemics. *BERA*. <https://www.bera.ac.uk/blog/practical-science-and-pandemics>



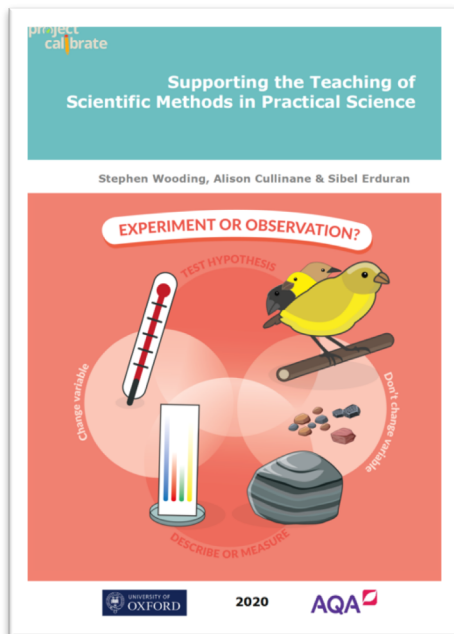
- Blog entry for AQA
- Project Calibrate approach and its relevance to how science works

Wooding, S. J. (2021, January 20). Getting to grips with how science 'works'. *AQA*. <https://www.aqa.org.uk/about-us/our-research/blog/post?post=defence-brevity>

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## CPD and teaching/learning resources

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- Resources for continuous professional development of science teachers
- Choice of full day, 4-hour and 2-hour workshops

Wooding, S., Cullinane, A., & Erduran, S. (2020). *Supporting the Teaching of Scientific Methods in Practical Science*. Oxford: University of Oxford. <https://doi.org/10.5287/bodleian:xqvKxnmnX>

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### Teaching & Learning Resources

The videos that are presented in this page were produced as part of Project Calibrate to show possible ways of teaching. The introductory video discusses different methods that are applied by scientists in order to answer their questions. The present practical investigations performed by the Calibrate team, while they discuss the scientific methods that are applied in investigations.

| Watch the video >                                                                                                                                                                                                                                                    | Watch the video >                                                                                                                                                                                                                                                                 | Watch the video >                                                                                                                                                                                                                                                  | Watch the video >                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                    |
| <b>Introduction to scientific methods</b><br>In this video, Steve discusses how scientists follow different scientific methods to answer their questions. He also uses examples to introduce Brandon's Matrix as a way to present and categorise scientific methods. | <b>Chromatography</b><br>In this video, Ann presents a practical investigation of Chromatography. She uses this investigation as an example of non-manipulative parameter measurement. She also presents examples of other methods that could be followed for this investigation. | <b>Osmosis</b><br>In this video, Alison presents a practical investigation of Osmosis. She uses this investigation as an example of manipulative parameter measurement. She also presents examples of other methods that could be followed for this investigation. | <b>Electrophoresis</b><br>In this video, Alison presents a practical investigation of Electrophoresis. She uses this investigation as an example of manipulative parameter measurement. She also presents examples of other methods that could be followed for this investigation. |

- Teaching and learning resources based on videos associated with the assessments

The project's website (<https://projectcalibrate.web.ox.ac.uk/home>) makes all the outputs that have been produced by Project Calibrate publicly available. This includes free and accessible teaching and learning resources for pupils and teachers, as well as teacher educators.



- Summative assessments designed by examiners from different examination boards
- 6 topics with 5 different categories of practical science linked to assessment objectives and assigned marks

Cited: Project Calibrate (2020). *Summative Assessment Resources for Practical Science: Electromagnetic spectrum*. Oxford: University of Oxford.

Similar citation is used for different topics.



- Key findings of the national survey with 959 pupils and 152 teachers
- Currently in review in an international research journal

This report presents some of the key research findings regarding the pupils' and teachers' views and the impact of the designed resources on pupils' learning. The summary can be found here:

<https://ora.ox.ac.uk/objects/uuid:629348b9-3159-4d57-b6da-163d4767c3c9>

## In press

Erduran, S., & Wooding, S. (2021). Bringing together Hands-on and Minds-on Skills: A Project Calibrate Approach to Summative Assessment of Practical Science, *School Science Review*. March issue.

## In review

Cullinane, A., Hillier, J., Childs, A., & Erduran, S. (in review). Teachers' views of practical science in high stakes summative assessments: the case of science teachers from England. *Research in Science Education*.

Erduran, S., Ioannidou, O., & Baird, J. (in review). The impact of epistemic framing of teaching videos and summative assessments on students' learning of scientific methods. *International Journal of Science Education*.

Ioannidou, O., Finch, K., & Erduran, S. (in review). Secondary teachers' views about teaching and assessing the diversity of scientific methods in practical science. *Journal of Education for Teaching*.

Hillier, J., Cullinane, A., Harris, R., Jakoby, S., Childs, A., & Erduran, S. (in review). Practical theorising in a changing context: enabling beginning science teachers to negotiate different expectations in the reality of schools. In, K. Burn & T. Mutton (Eds.), *Practical Theorising in Teacher education*. London: Routledge.

Hillier, J., & Ioannidou, O. (in review). Using practical work: strategies to avoid closing down practice. *Science Teacher Education*.

## ENGAGEMENT ACTIVITIES

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|                           |                                                                                                                                                            |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Activity Title</b>     | Project Calibrate Final Dissemination Event                                                                                                                |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                 |
| <b>How many people?</b>   | 11-50                                                                                                                                                      |
| <b>Geographical Reach</b> | National                                                                                                                                                   |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                 |
| <b>Other Audience</b>     | Schools, Policymakers/politicians, Professional Practitioners, Third sector organisations                                                                  |
| <b>Activity Years</b>     | 2021                                                                                                                                                       |
| <b>Result Description</b> | The final dissemination event brings together the entire team and the research findings to the broad education and assessment audience on March 5th, 2021. |

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|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Activity Title</b>     | Use of project resources in a Master's programme for in-service teachers, University of Oxford                                                           |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                               |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                  |
| <b>Geographical Reach</b> | National                                                                                                                                                 |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                               |
| <b>Other Audience</b>     | Schools                                                                                                                                                  |
| <b>Activity Years</b>     | 2021                                                                                                                                                     |
| <b>Result Description</b> | The project resources and research findings were incorporated into a 3-hour session in the Master's in Teaching and Learning Programme by Sibel Erduran. |

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|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Activity Title</b>     | National Institute for Studies in Education (NISE) 2021                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>How many people?</b>   | 1-10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Activity Years</b>     | 2021                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Result Description</b> | Title: A systematic approach to teaching and assessing science: contributions from Project Calibrate<br>Presenter: Alison Cullinane<br>Date and location: January 25th 2021, online event<br>A group of academics from the University of Limerick attended the talk. Dr Alison Cullinane presented results from Project Calibrate and the attendees expressed interest in a potential collaboration about out of field teaching and the teachers' confidence to teach practical work. |

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|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Activity Title</b>     | ISHPSSB 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Other Audience</b>     | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Activity Years</b>     | 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Result Description</b> | <p>Title: Brandon's Matrix: a view on scientific methods in the Biology classroom</p> <p>Presenters: Alison Cullinane, Olga Ioannidou &amp; Sibel Erduran</p> <p>Date &amp; location: December 11th 2020, online event</p> <p>In this presentation, the project's methodology and the impact on student's learning of scientific methods, with a special focus on Biology, were discussed. The audience was approximately 25 researchers from overseas, who engaged with the designed teaching and learning material. The research team shared the project's website where participants were able to find more information. The presentation was very well-received, as researchers praised the systematic methodological approach as well as the conceptual framing of the project.</p> <p><a href="https://sites.google.com/dcu.ie/ishpssb2020/home">https://sites.google.com/dcu.ie/ishpssb2020/home</a></p> |

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| <b>Activity Title</b>     | OxfordAQA Partner Schools Conference 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Other Audience</b>     | Schools, Third sector organisations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Activity Years</b>     | 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Result Description</b> | <p>Title: Project Calibrate: A New Approach to Teaching and Assessing Practical Science</p> <p>Presenters: Sibel Erduran, Steve Wooding, Alison Cullinane &amp; Olga Ioannidou</p> <p>Date &amp; location: 24th November 2020, online event</p> <p>This online event was organised by OxfordAQA and the primary audience was approximately 100 teachers from overseas. The presentation aimed to present the project's aims and engage the audience through an interactive activity. During the webinar, the participants reported positive views on the presented material and they expressed interest in the designed teaching resources.</p> |

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| <b>Activity Title</b>     | AQA Internal Events 2020                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Geographical Reach</b> | Local                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Primary Audience</b>   | Industry/Business                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Other Audience</b>     | Third sector organisations                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Activity Years</b>     | 2020                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Result Description</b> | <p>Title: Project Calibrate: Getting to grips with how science works</p> <p>Presenters: Katy Finch &amp; Steve Wooding</p> <p>Date &amp; location: November 3rd, AQA Zoom webinar</p> <p>This presentation took place in an internal event organised by AQA. Approximately 50 AQA employees across the organisation attended the webinar, in which they engaged with the main concepts and findings of the project.</p> |

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| <b>Activity Title</b>     | Presentation at the Royal Society of Chemistry, London, UK                                                                                                                                                                                                                                                                                   |
| <b>Activity Type</b>      | A formal working group, expert panel or dialogue                                                                                                                                                                                                                                                                                             |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                      |
| <b>Geographical Reach</b> | National                                                                                                                                                                                                                                                                                                                                     |
| <b>Primary Audience</b>   | Policymakers/politicians                                                                                                                                                                                                                                                                                                                     |
| <b>Other Audience</b>     | Schools, Policymakers/politicians, Professional Practitioners, Other audiences                                                                                                                                                                                                                                                               |
| <b>Activity Years</b>     | 2020                                                                                                                                                                                                                                                                                                                                         |
| <b>Result Description</b> | <p>Presentation about Project Calibrate as part of the PISA 2024 Expert Visioning Group meeting held at the Royal Society of Chemistry, London.</p> <p>Erduran, S. (2020, February). Beyond the cookbook approach to practical science: Designing “tests worth teaching to”. Presentation at the Royal Society of Chemistry, London, UK.</p> |

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| <b>Activity Title</b>     | Oxford Research Away Day 2020                                             |
| <b>Activity Type</b>      | Participation in an open day or visit at my research institution/facility |
| <b>How many people?</b>   | 51 - 100                                                                  |
| <b>Geographical Reach</b> | Local                                                                     |
| <b>Primary Audience</b>   | Academics and postgraduate students                                       |
| <b>Activity Years</b>     | 2020                                                                      |

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| <b>Result Description</b> | <p>Title: Project Calibrate: Designing resources for assessing practical science</p> <p>Presenter: Olga Ioannidou Date &amp; location: 7<sup>th</sup> October 2020, University of Oxford</p> <p>This presentation was a part of the departmental Research Away Day. Approximately 56 researchers attended this online event, where project Calibrate was presented as an example of successful contingency planning during COVID-19.</p> |
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| <b>Activity Title</b><br><b>Activity Type</b><br><br><b>How many people?</b><br><b>Geographical Reach</b><br><b>Primary Audience</b><br><br><b>Activity Years</b><br><b>Result Description</b> | <p>Oxford Department of Education Poster Event 2020</p> <p>Participation in an open day or visit at my research institution/facility</p> <p>11 - 50</p> <p>Local</p> <p>Professional Practitioners, Undergraduate students, Postgraduate students</p> <p>2020</p> <p>Title: Project Calibrate: From Cookbook Approaches to Mindful Exploration Presenter: Olga Ioannidou</p> <p>Date and location: 21<sup>st</sup> October 2020, University of Oxford, Department of Education, UK</p> <p>Dr Olga Ioannidou presented a poster at an online event organised by the Department of Education. Participants were able to ask questions and discuss the preliminary findings of the project.</p> |
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| <b>Activity Title</b><br><br><b>Activity Type</b><br><b>How many people?</b><br><b>Geographical Reach</b><br><b>Primary Audience</b><br><br><b>Activity Years</b><br><b>Result Description</b> | <p>Australasian Science Education Research Association (ASERA) Conference 2020</p> <p>A talk or presentation or debate</p> <p>51 - 100</p> <p>International</p> <p>Professional Practitioners, Undergraduate students, Postgraduate students, Other audiences</p> <p>2020</p> <p>Title: What counts as scientific? Teachers' understanding and views of scientific methods</p> <p>Presenters: Olga Ioannidou &amp; Sibel Erduran</p> <p>Date &amp; location: 24-26<sup>th</sup> June, online conference</p> <p>The research team discussed findings from a Project Calibrate study targeting teachers' views on scientific methods.</p> <p><a href="https://www.asera.org.au/conferences/2020-conference/asera2020-online-conference-members-only">https://www.asera.org.au/conferences/2020-conference/asera2020-online-conference-members-only</a></p> |
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| <b>Activity Title</b>     | Association for Science Education (ASE) Annual Conference 2020                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Geographical Reach</b> | Regional                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Other Audience</b>     | Professional Practitioners, Postgraduate students                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Activity Years</b>     | 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Result Description</b> | <p>Title: Project Calibrate – Research Meet Big Bites</p> <p>Presenters: Sibel Erduran, Olga Ioannidou, Alison Cullinane</p> <p>Date &amp; location: 8-10<sup>th</sup> January, Reading, UK</p> <p>The research team presented the designed assessments to 15 science teachers. The teachers expressed their opinions regarding the teaching material designed by Project Calibrate.</p> <p><a href="https://www.ase.org.uk/annual-conference2020">https://www.ase.org.uk/annual-conference2020</a></p> |

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| <b>Activity Title</b>     | Post Graduate Certificate in Education (PGCE) 2019                                                                                                                                                                                                                              |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                      |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                         |
| <b>Geographical Reach</b> | Local                                                                                                                                                                                                                                                                           |
| <b>Primary Audience</b>   | Postgraduate students                                                                                                                                                                                                                                                           |
| <b>Other Audience</b>     | Professional Practitioners                                                                                                                                                                                                                                                      |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                                                            |
| <b>Result Description</b> | <p>Presenter: Dr Alison Cullinane</p> <p>Date and location: 9<sup>th</sup> December 2019, Department of Education University of Oxford, UK</p> <p>Dr Alison Cullinane delivered a session showcasing project work on the PGCE science course consisting of 44 PGCE interns.</p> |

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| <b>Activity Title</b>     | Teacher Webinar 2019                                                                                                                                                                                                                               |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                         |
| <b>How many people?</b>   | 1 - 10                                                                                                                                                                                                                                             |
| <b>Geographical Reach</b> | National                                                                                                                                                                                                                                           |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                         |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                               |
| <b>Result Description</b> | <p>Title: Summative Assessment For Practical Science: From Cookbook Approaches To Mindful Exploration</p> <p>Presenters: Alison Cullinane &amp; Stephen Wooding</p> <p>Date &amp; location: 6<sup>th</sup> November 2019, University of Oxford</p> |

This online workshop was designed for science teachers. Approximately 10 teachers attended the workshop where they actively engaged with the teaching materials designed by Project Calibrate. Some engaged teachers provided positive feedback and reported that they changed their views as a result of their participation.

<http://www.education.ox.ac.uk/events/summative-assessment-for-practical-science-from-cookbook-approaches-to-mindful-exploration/>

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| <b>Activity Title</b>     | Oxford Department of Education Poster Event 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Activity Type</b>      | Participation in an open day or visit at my research institution/facility                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Geographical Reach</b> | Local                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Primary Audience</b>   | Professional Practitioners, Undergraduate students, Postgraduate students, Other audiences, Study participants or study members                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Result Description</b> | <p>Title: Designing resources for assessing practical science: The Project Calibrate approach</p> <p>Presenters: Olga Ioannidou, Alison Cullinane, Sibel Erduran</p> <p>Date and location: 14<sup>th</sup> October 2019, Department of Education, University of Oxford</p> <p>Dr Olga Ioannidou presented a poster at the departmental poster conference, where undergraduate and postgraduate students, researchers, as well as in-service teachers discussed the research design of the project.</p> <p><a href="http://www.education.ox.ac.uk/events/annual-poster-conference-2019/">http://www.education.ox.ac.uk/events/annual-poster-conference-2019/</a></p> |

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| <b>Activity Title</b>     | Teacher Workshop 2019 (St. Edmund's) |
| <b>Activity Type</b>      | Event, workshop or similar           |
| <b>How many people?</b>   | 1 - 10                               |
| <b>Geographical Reach</b> | Local                                |
| <b>Primary Audience</b>   | Professional Practitioners           |
| <b>Other Audience</b>     | Schools                              |
| <b>Activity Years</b>     | 2019                                 |

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| <b>Result Description</b>                                                                                                                                                                                       | <p>Title: Project Calibrate Teacher Workshop</p> <p>Presenters: Stephen Wooding &amp; Katy Finch</p> <p>Date &amp; location: 16<sup>th</sup> October 2019, St. Edmund Arrowsmith Catholic High School, Ashton-in-Makerfield</p> <p>Seven secondary science teachers participated in this workshop that aimed to introduce Project Calibrate to in-service science teachers. The workshop included interactive group activities, as well as lesson planning and discussions.</p>                                                                                                                                                                                                                                                                                                                     |
| <b>Activity Title</b><br><b>Activity Type</b><br><b>How many people?</b><br><b>Geographical Reach</b><br><b>Primary Audience</b><br><b>Activity Years</b><br><b>Result Description</b>                          | <p>Oxford Alumni Reunion 2019</p> <p>A talk or presentation or debate</p> <p>11 - 50</p> <p>National</p> <p>Alumni</p> <p>2019</p> <p>Title: Beyond Bunsen burners and Test Tubes -Project Calibrate, the future of practical science.</p> <p>Presenter: Alison Cullinane</p> <p>Date and location: 21<sup>st</sup> September 2019, University of Oxford, UK Dr Alison Cullinane presented ideas from the project at the University of Oxford alumni reunion weekend luncheon attended by over 50 alumni.</p>                                                                                                                                                                                                                                                                                       |
| <b>Activity Title</b><br><b>Activity Type</b><br><b>How many people?</b><br><b>Geographical Reach</b><br><b>Primary Audience</b><br><b>Other Audience</b><br><b>Activity Years</b><br><b>Result Description</b> | <p>Teacher Workshop 2019 (St. Julie's)</p> <p>Event, workshop or similar</p> <p>11 - 50</p> <p>Local</p> <p>Professional Practitioners</p> <p>Schools</p> <p>2019</p> <p>Title: Project Calibrate Teacher Workshop 2019</p> <p>Presenters: Alison Cullinane, Stephen Wooding, Olga Ioannidou &amp; Katy Finch</p> <p>Date &amp; location: 26<sup>th</sup> September 2019, St Julie's Catholic School, Liverpool.</p> <p>Twelve secondary science teachers attended this teacher training session. The aim of the session was to introduce Brandon's Matrix as a teaching tool to in-service science teachers. During the session, the teachers also completed a questionnaire regarding their understanding of scientific methods, while they participated in group discussions and activities.</p> |

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| <b>Activity Title</b>     | European Science Education Research Association (ESERA) 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Primary Audience</b>   | Academic researchers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Other Audience</b>     | Professional Practitioners, Undergraduate students, Postgraduate students, Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Result Description</b> | <p>Title: Scientific methods in high stakes chemistry examinations: diversity or disparity?</p> <p>Presenters: Alison Cullinane, Stephen Wooding, Sibel Erduran</p> <p>Date &amp; location: 26-30<sup>th</sup> August 2019, Bologna, Italy</p> <p>The team presented a paper on the scientific methods as presented in high stakes chemistry examinations. The audience was researchers, postgraduate and undergraduate students as well as teachers.</p> <p><a href="https://www.esera.org/news/esera-announcements/653-esera-conference-2019">https://www.esera.org/news/esera-announcements/653-esera-conference-2019</a></p> |

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| <b>Activity Title</b>     | Association for Science Education (ASE) Annual Conference 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Geographical Reach</b> | National                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Other Audience</b>     | Professional Practitioners, Postgraduate students, Other audiences, Third sector organisations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Result Description</b> | <p>Title: A systemic approach to summative assessment of practical science</p> <p>Presenters: Sibel Erduran, Alison Cullinane, Stephen Wooding</p> <p>Date &amp; location: 9-12<sup>th</sup> January 2019, Birmingham, UK</p> <p>In this presentation, the approaches to summative assessment including work with examiners as well as professional development strategies were discussed with teachers, researchers, and school representatives.</p> <p><a href="https://www.ase.org.uk/news/annual-conference-2019-call-proposals">https://www.ase.org.uk/news/annual-conference-2019-call-proposals</a></p> |

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| <b>Activity Title</b>     | Oxford Department of Education 2019 |
| <b>Activity Type</b>      | Event, workshop or similar          |
| <b>How many people?</b>   | 11 - 50                             |
| <b>Geographical Reach</b> | Local                               |

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| <b>Primary Audience</b>   | Academic researchers, Professional Practitioners, Postgraduate students, Other audiences, Study participants or study members                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Activity Years</b>     | 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Result Description</b> | <p>Title: Project Calibrate: Teachers' development on Summative Assessment of Practical Science</p> <p>Presenters: Sibel Erduran, Ann Childs &amp; Alison Cullinane</p> <p>Date and location: 21<sup>st</sup> January 2019, Department of Education, University of Oxford, UK</p> <p>A number of teachers, researchers, and postgraduate students attended the workshop in which the aims of the project were presented.</p> <p><a href="http://www.education.ox.ac.uk/events/teachers-professional-development-on-summative-assessment-of-practical-science-perspectives-from-project-calibrate/">http://www.education.ox.ac.uk/events/teachers-professional-development-on-summative-assessment-of-practical-science-perspectives-from-project-calibrate/</a></p> |
| <b>Activity Title</b>     | Association for Educational Assessment (AEA) 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Primary Audience</b>   | Postgraduate students, Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Result Description</b> | <p>Title: Building Bridges between Assessment and Subject Matter: An Innovative Approach to Assessing GCSE Practical Science</p> <p>Presenters: Yasmine El Masri, Sibel Erduran, Alison Cullinane, Ruth Johnson</p> <p>Date &amp; location: 7-10<sup>th</sup> November 2018, Arnhem, The Netherlands</p> <p>In this presentation task exemplars that align with Brandon's matrix were presented.</p> <p><a href="http://easyconferences.eu/aea2018">http://easyconferences.eu/aea2018</a></p>                                                                                                                                                                                                                                                                       |
| <b>Activity Title</b>     | Examiners' workshop (1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>How many people?</b>   | 1 - 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Geographical Reach</b> | Regional                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Other Audience</b>     | Study participants or study members                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Result Description</b> | <p>Date &amp; location: 14<sup>th</sup>-15<sup>th</sup> May 2018, Manchester, UK</p> <p>In attendance were members from the University of Oxford (3 staff), AQA (5 staff), and 8 examiners, which were in-service teachers. The objectives of the workshop were to discuss and agree on the construct of practical</p>                                                                                                                                                                                                                                                                                                                                                                                                                                              |

science to be used in the project and to produce an assessment specification for the project.

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| <b>Activity Title</b>     | Examiners' workshop (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>How many people?</b>   | 1 - 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Geographical Reach</b> | Regional                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Other Audience</b>     | Study participants or study members                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Result Description</b> | Date & location: 24 <sup>th</sup> September 2018, Manchester, UK<br>In attendance were members from the University of Oxford (2 staff), AQA (3 staff) and 8 examiners, which were in-service teachers. In this workshop, the examiners began to develop the assessment tasks based on the ideas that they outlined in the brainstorming session . The examiners were provided with specific deadlines for the development of the assessments at the end of the workshop. |

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| <b>Activity Title</b>     | Examiners' workshop (3)                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>How many people?</b>   | 1 - 10                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Geographical Reach</b> | Regional                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Primary Audience</b>   | Professional Practitioners                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Other Audience</b>     | Study participants or study members                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Result Description</b> | Date & location: 16 <sup>th</sup> November 2018, Manchester, UK<br>Two Oxford and 2 AQA staff coordinated this workshop, while 6 examiners attended the event. The aim of this workshop was to capture how activities in this series of workshops were similar and different from other QPEC workshops they had attended. Instructions were provided to the examiners for refining the assessments that they developed in the previous sessions. |

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| <b>Activity Title</b>     | International Association for Educational Assessment (IAEA) Conference 2018                           |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                      |
| <b>How many people?</b>   | 51 - 100                                                                                              |
| <b>Geographical Reach</b> | International                                                                                         |
| <b>Primary Audience</b>   | Other audiences                                                                                       |
| <b>Other Audience</b>     | Postgraduate students, Other audiences                                                                |
| <b>Activity Years</b>     | 2018                                                                                                  |
| <b>Result Description</b> | Title: Mapping Practical Science in Guideline Documents and its Conceptualisation in GCSE Assessments |

Presenters: Alison Cullinane, Yasmine El Masri, Sibel Erduran, Steven Wooding

Date & location: 9 -14<sup>th</sup> September 2018, Oxford

This presentation discussed a review of how the assessment of these required practical activities manifests in science assessments.

<https://iaea.info/conference-proceedings>

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| <b>Activity Title</b>     | IUPAC International Conference of Chemical Education 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Activity Type</b>      | A talk or presentation or debate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Other Audience</b>     | Postgraduate students, Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Result Description</b> | Title: Assessment of Practical Chemistry: Towards a Systemic Approach<br>Presenter: Sibel Erduran<br>This presentation was an introduction to the aims of Project Calibrate. Researchers, graduate students, and practitioners engaged with the designed assessments, while the broader implications for chemistry education were discussed.<br><a href="https://iupac.org/event/25th-international-conference-chemistry-education-icce-2018/">https://iupac.org/event/25th-international-conference-chemistry-education-icce-2018/</a> |

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| <b>Activity Title</b>     | Oxford Department of Education Poster Event 2018                                                                                                                                                                                                                                                                                                           |
| <b>Activity Type</b>      | Participation in an open day or visit at my research institution/facility                                                                                                                                                                                                                                                                                  |
| <b>How many people?</b>   | 11 - 50                                                                                                                                                                                                                                                                                                                                                    |
| <b>Geographical Reach</b> | Local                                                                                                                                                                                                                                                                                                                                                      |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                            |
| <b>Other Audience</b>     | Policymakers/politicians, Professional Practitioners, Postgraduate students, Other audiences                                                                                                                                                                                                                                                               |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                       |
| <b>Result Description</b> | Title: Project Calibrate: A Systemic Approach to Summative Assessment of Practical Science<br>Presenters: Alison Cullinane, Sibel Erduran<br>Date and location: 8 <sup>th</sup> October 2018, Department of Education, University of Oxford<br>The presentation introduced Project Calibrate to researchers, students, and examination board participants. |

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| <b>Activity Title</b>     | International Association for Educational Assessment (IAEA) Conference 2018                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Activity Type</b>      | Event, workshop or similar                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>How many people?</b>   | 51 - 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Geographical Reach</b> | International                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Primary Audience</b>   | Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Other Audience</b>     | Postgraduate students, Other audiences                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Activity Years</b>     | 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Result Description</b> | Title: Assessment of Practical Science: A Policy History in England<br>Presenters: Ann Childs, Judith Hillier, Lena Gray, Ruth Johnson & Jo-Anne Baird<br>Date & Location: Oxford, 9 -14 <sup>th</sup> September 2018<br>The presenters discussed with IAEA participants how common issues of high practical science have been tackled in other countries around the world.<br><a href="https://iaea.info/conference-proceedings/">https://iaea.info/conference-proceedings/</a> |

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## COLLABORATIONS AND PARTNERSHIPS

- AQA Research

Year: 2018- 2021

**Description:** Project Calibrate is a research and development collaboration between the University of Oxford and AQA Research, and aims to foster effective teaching, learning, and assessment of practical science. The resource pack contains five summative assessments developed as part of the project to assess learners' understanding of and skills in GCSE practical science. From AQA Research, Stephen Wooding and Katy Finch have contributed to the CPD workshops as well as development of resources and publications. Ruth Johnson and Lena Gray have helped coordinate the administrative aspects of the project at AQA.

**Partner Contributions:** Development of the summative assessments, professional development of teachers, data analysis, writing of papers

### Resultant Outcomes:

- Ioannidou, Finch & Erduran (in review) - Research paper in *Journal of Education for Teaching*
- Erduran & Wooding (2021) - Practitioner article in *School Science Review*
- Wooding, Cullinane & Erduran (2020) - CPD resources
- Project Calibrate (2020) – 6 sets of summative assessments
- Cullinane, Erduran & Wooding (2019) - Research paper in *International Journal of Science Education*
- Erduran, Cullinane & Wooding (2018) - Book chapter

## SOFTWARE AND TECHNICAL PRODUCTS

- Teaching and Learning Resources on Practical Science

Year: 2020

**Description:** The videos that are presented in this page were produced as part of Project Calibrate to illustrate strategies for teaching about scientific methods. The introductory video discusses different methods that are applied by scientists in order to answer their questions. The rest of the videos present practical investigations performed by the Project Calibrate team, while they discuss the scientific methods that are applied in each of the investigations. URL: <https://projectcalibrate.web.ox.ac.uk/teaching-learning-resources>

