

Deanery Digests are short, plain language summaries of the Department of Education's research outputs. This Deanery Digest is based on research conducted by members of the Department of Education at the University of Oxford. Full references for this suite of research are provided at the foot of this Digest.

Secondary Science Teaching and Learning for Understanding How Science Works

What is this research about and why is it important?

This digest is about four projects related to science teaching, learning and continuous professional development. These were called *Project Calibrate*, *Oxford Argumentation in Religion and Science (OARS) Project*, *Project FutuRISE*, and *SciKids*. The overarching theme across all projects is the promotion of understanding about how science works and engagement of secondary pupils in authentic scientific reasoning and practices. In secondary schools, pupils are often exposed to simplistic accounts of how science works in terms of scientific methods, practices and reasoning. For example, the 'scientific method' is frequently taught as singular and linear, starting with a hypothesis which is then tested through a recipe-like experiment, when science uses a diversity of methods that often do not have a linear structure. The projects not only challenged simplistic accounts about science from different perspectives (e.g., scientific methods in the case of *Project Calibrate*, scientific argumentation in the case of *OARS Project*) but also developed and tested concrete strategies for teaching, learning and professional development to support teachers as well as students in engaging in more authentic scientific practices.

What did we do?

Project Calibrate was a collaboration between the Department of Education at University of Oxford and AQA Research. The project took place from 2018-2021 and aimed to design, implement and test summative assessments of practical science. It involved teachers in Oxford, Manchester and Liverpool. *Oxford Argumentation in Religion and Science (OARS) Project* took place from 2018-2021, involved secondary science and religious education (RE) teachers and their students in Oxfordshire. FEDORA was a 3-year EU-funded project that ran from 2020-2023. Project FutuRISE was a subset of the FEDORA project funded by the ESRC IAA. FEDORA gathered 6 partner institutions from five European countries. It conducted research and practice towards the regeneration of the ecosystem of science learning, by developing a future-oriented model to enable creative thinking, foresight and active hope, as skills needed in formal and informal science education. FutuRISE engaged secondary pupils in climate change education in a museum in Oxford to apply the FEDORA principles. SciKids Project ran from 2021-2023 and engaged early years education teachers from the United Arab Emirates on a professional development programme to teach about nature of science.

What did we find?

Project Calibrate illustrated that pupils showed better understanding of scientific methods after watching 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. Both

teachers and pupils had a positive attitude towards the online teaching, learning and assessment resources. Teachers found the summative assessments useful and indicated that they would use them.

OARS Project researched science and RE teachers' views of argumentation which illustrated variations in how argumentation is perceived in each subject as well as in pedagogy. There were significant differences in favour of RE teachers' self-reported use of pedagogical strategies such as group discussions and debates. Teachers collaborated in different ways. For example, in some cases they planned their lessons together, using common frameworks to guide their use of argumentation as a pedagogical strategy. In other cases, teachers engaged in professional conversations about their lessons and exchanged mutually beneficial ideas that helped them reflect on their practice. Video-based evidence of science and RE teachers' cross-subject collaboration in teaching argumentation illustrates that when using similar pedagogical strategies, science and RE teachers demonstrated variation in how they articulated the purpose of argumentation in learning and how they enacted it in their teaching. Evidence has been generated about how students engage in argumentation in science, RE and combined contexts as well as perspective taking.

Project FutuRISE was a subset of the FEDORA Project. Research was carried out about developing a future-oriented model to enable creative thinking, foresight and active hope, as skills needed in formal and informal science education. The topic was on learning about climate change in the context of the informal learning context of a natural science museum. Instructional strategies such as infusing scenarios and arts into scientific discussions were adopted to induce imagination, future-oriented thinking and emotional responses. Statistical results showed that the intervention significantly boosted participants' futures literacy, environmental agency and positive emotions. However, it did not increase their interests in learning science in out-of-school context.

SciKids Project engaged early years' science teachers in learning about nature of science. Among the teachers, there was varied perceptions on some key concepts such as the role of bias and prejudices on scientific facts, the employment of some scientific practices across different branches of science, and the influence of politics in science.

What does it all mean anyway?

Collectively the projects promote pupils' engagement in authentic scientific practices and reasoning so that they develop good understanding of how science works. Ultimately understanding how science works benefits not only professional scientists but also everyday citizens who have to respond to a variety of science-related societal issues such as climate change and pandemics.

Teaching and training resources:

Resources from *Project Calibrate* [here](#).

Resources from *SciKids* [here](#).

Resources from *OARS* [here](#).

Resources from *FutuRISE* [here](#).

The research on which this Digest is based is available open access

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