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Key Findings and Recommendations

Evaluation of the Energy Foresight Resources by the
Centre for Research in Education and
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The Open University

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ENERGY FORESIGHT

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Physical science education is in crisis with a decline in uptake at A-level reflected in the closure of a significant number of physics departments in Higher Education. Research shows that:

- Students' interest in physics and chemistry declines as they go through secondary school. It starts off lower and declines more rapidly than for other subjects. This is a national and international phenomenon.
- The decline in A-level entry has been most severe for physics for both boys and girls. The number of girls studying physics A-level is now very low.
- The decline in students' interest and particularly girls' alienation from physics has been linked to the lack of relevance of the subject to students' lives and concerns.

Energy Foresight resources

Energy Foresight is part of a national initiative, *Twenty First Century Science*, addressing this crisis and providing a science curriculum for 14 - 16 year olds that covers key scientific ideas in the context of current scientific debates about social issues and dilemmas. The resources were designed to support the teaching of 'Radioactive materials' and include: three 20-minute Programmes - *Radioactivity and Health*; *Power Production*; and *Radioactive Waste*; Teacher guidance and lesson plans and Student activities including discussion, debates and role plays and an *Energy Foresight* website.

Energy Foresight evaluation

The evaluation first considered the impact of the professional development days which involved 130 teachers across England. These included 23 teachers piloting *Twenty First Century Science* and 107 teachers using the current science curriculum for 14 - 16 year olds. The evaluation next considered the effectiveness of the implementation of the resources in schools. 280 students who studied *Energy Foresight* provided feedback. The data collection methods included: teacher and student questionnaires, observation of training events and interviews with teachers and students.

Key Findings

- The overwhelming majority of teachers rated the professional development days as very good or good.

  'As Head of department, days like this looking at a whole topic in some detail are very useful.'
  'This was an excellent day.'

- Between 85% and 100% of the teachers at the different events rated the *Energy Foresight* resources as excellent or good.

- A mark of the success of the professional development was that the pilot teachers commented that training of this calibre should have been available for each of the *Twenty First Century Science* modules.

  'There should have been one of these courses for every core and applied module – since a lot of the information is new.'

Teacher feedback after using Energy Foresight resources in schools

- After implementing the *Energy Foresight* resources teachers continued to rate them overall as excellent or good. They praised the relevance of the resources, their excellent coverage and accessibility and attraction for students.

  'Up to date, and female friendly.'
  'Good visualisations of concepts.'
  'Excellent Programmes overall.'

- Teachers were very positive about the new teaching approach in the resources:

  'Different teaching and learning methods in each lesson = variety = more student interest = better results!'

- Teachers teaching the traditional science curriculum thought the *Energy Foresight* resources allowed better depth of coverage of the existing curriculum.

- Teachers found the resources good at:

  - meeting curriculum requirements for students;
  - motivating students' learning across all objectives covered;
  - providing adequate evidence to allow informed decision-making;
  - developing students' scientific knowledge.

- After using the resources with students the teachers reported the resources were good or excellent in developing awareness of roles and jobs in all the relevant areas and considered they fairly represented alternative positions in the power debate.

Impact on students

- Only a quarter to a fifth of students ***before*** studying the *Energy Foresight* resources reported liking physics and the vast majority considered it was a subject which did not involve discussion.

- ***Before*** the implementation very few girls compared to boys reported liking physics. They did not find it interesting, relevant to their lives or helpful to them in understanding themselves and the world.

- ***After*** the implementation the non-pilot students, both boys and girls, and the pilot girls reported a significant positive shift in their liking for physics. The level of their interest rose and it was now seen as a subject where they discussed ideas and which helped them to understand themselves. There were no significant shifts for the pilot boys.
- ***After*** the implementation there was a very significant shift for girls in moving from seeing physics as irrelevant to their lives to appreciating its relevance. There was no change for boys.

> *'… it wasn't just like a textbook, it showed that these things actually happened and it made it seem more real, you were able to like comprehend it better and understand it more because of that. …it was more about the world around you, and I think that's more interesting, you know, better in terms of the future really.'*

> *'It was actually quite different, because we didn't used to look at, like something related to the world, whereas now we're actually looking at things that might involve us.'*

Changing students' opinions is not easily achieved the *Energy Foresight* resources however, had a significant and measurable impact on students promoting reflection on the issues

- The pilot girls reported significant positive shifts in their opinions about the benefits of using radioactivity to fight disease; identify medical problems and of the acceptability of people working with radioactive materials. There were negligible shifts found for the non-pilot students except for the increase in the boys' positive response to using radioactive materials to treat diseases.

> *Girl: 'I always thought it* [radioactivity] *was bad, but from watching the Programmes and talking about it I know that it can help. I found how radioactivity can help the medical profession. I found that really interesting.'*

Changes in understanding of science ideas and concepts

- The *Energy Foresight* resources were effective in supporting students' learning. **After** the implementation across the samples there was a significant increase in students' understanding demonstrated on the knowledge questions.

> *'We just had our mock in science and it was based around that topic, that section that we've just done, and a lot of it was like oh yeah, I remember when we watched the Programme, and the section of that Programme we watched rather than sometimes what the teacher's told us. So I think the fact that it's a picture as well, you get to see it, and that's what brought it back to my mind a lot.'*

- ***Before*** the implementation boys as a group demonstrated a significantly higher overall level of understanding of the topic concepts and ideas than did the girls.

- This performance gap **disappeared** between the pilot girls and boys after their study of the *Energy Foresight* resources as the girls made very significant increases in their understanding. This is a very important finding given that national tests and examinations continue to show boys outperforming girls on physics questions.
- The approach used in the *Energy Foresight* resources was successful in increasing students' awareness of jobs and knowledge of working practices and contexts. The results show far more of this type of resource is needed if there is to be significant impact on students.
- Both teachers and students reported that they wanted more of this type of resource.

Key Recommendations

Teachers were impressed with the extent to which the *Energy Foresight* Programmes engrossed their students and motivated them. Students were eloquent in their descriptions of how Programmes like these support their learning.

1. **The curriculum includes power transmission as well as production. This is an area of the curriculum that students report difficulty with particularly girls. It would be very beneficial if an additional Programme which exploited real world contexts and 3D animations was developed to support the teaching of this topic.**
2. **The student and teacher support materials should be rewritten taking into account boys' beliefs about what they know and providing specific support to challenge them to develop a broader understanding of how science applies to real life situations and dilemmas.**
3. **In subjects like science where practical activity is being reduced the use of Programmes that bring the real world into the classroom are needed. *Energy Foresight* Programmes as stimulus materials should be used as exemplars for the development of further resources that enhance students' understanding of the relevance of science to their lives.**

The contexts selected for students' learning are crucial. The *Energy Foresight* resources appealed to both boys and girls. Girls rated *Radioactivity and Health* most interesting and *Power Production* least interesting as topics, the opposite was the case for boys. Both boys and girls were equally interested in *Radioactive Waste* management.

4. **The approach to context in the *Energy Foresight* resources which situated learning in relation to students' personal concerns and related these to wider social issues demonstrating how science can be applied to inform personal and community decision-making was very successful in engaging students. The *Energy Foresight* approach should be used as a model and exploited across the science curriculum to engage students, particularly girls.**

Typically school subjects fail to give students insights into the nature of different jobs and what they entail and what their social purposes are. Research has found girls and boys lack awareness of science-related careers.

5. The way that the *Energy Foresight* approach involved people in specific careers talking about their use of science was a major strength of the resources. The Programmes made working practices explicit. Further Programmes that extend this aspect would be invaluable especially if more emphasis was given to the relationship between working practices and their scientific basis.

The approach to teaching in the new science curriculum creates challenges for both teachers and students to discuss the nature of evidence and to debate alternative positions and ethical dilemmas.

6. To an extent the *Energy Foresight* Programmes and activities provided some explicit models of this new pedagogy for both teachers and students. It would be very beneficial if further audio- visual representations of these pedagogic and learning strategies were developed across other science contexts which could be used as professional development resources.