The Australian Hydrogen and Fuel Cells Education Program

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ABSTRACT:

The next generation of engineers and scientists will face great technical, economic and political challenges to satisfy increasing demands for a secure, reliable and affordable global energy system that maintains and enhances current standards of living. The Australian Hydrogen and Fuel Cells Education Program aims to bolster the quality and relevance of primary and secondary school teaching in emerging areas of science, technology and environmental/sustainability studies using hydrogen, in its capacity as a versatile energy carrier, as the educational basis for teacher and student learning. Critical advances in specific areas of hydrogen production, distribution, storage and end-use technologies arise when students are engaged to develop and apply a broad range of disciplinary and interdisciplinary knowledge and practical skills.

A comprehensive hydrogen and fuel cell technology teaching module will be developed to complement existing fuels and energy curricula across Australian schools. The pilot program will be delivered via the collaboration of nine trial schools, a broad range of technical and pedagogy experts and representatives of professional bodies and industry.

The program features essential and extensive teacher consultation, a professional learning and development course, industry site visits and a dedicated research and evaluation study. This initiative aims to bolster teacher literacy and student participation in the design, construction and operation of various hydrogen and fuel cell devices and extended activities. Students will reflect on and formally present their learning experiences via several dedicated fora including an awards ceremony where outstanding performance of leading schools, teachers and student groups within the cluster will be acknowledged.

KEYWORDS: education, hydrogen, fuel cells, teaching

INTRODUCTION

The Australian Hydrogen and Fuel Cells (H&FC) Education Program is a new initiative representing the first steps in the development of a consistent and uniform teaching syllabus of H&FC technology for Australian primary and secondary schools. The program concept was developed by Luigi Bonadio & Associates (LBA) in 2004, inspired by the content and quality of the Japan Hydrogen Fuel Cell Program and the US Department of Energy H&FC educational programs. The program continues an escalation of industry, media and public interest in H&FC technology across Australia following the release of the National Hydrogen Study and Australian Hydrogen Activity reports and Australia’s recent commitment to the International Partnership for the Hydrogen Economy.

The program aims to bolster the quality and relevance of teaching in emerging areas of science and technology using hydrogen, in its capacity as a versatile energy carrier, as the educational basis for teacher and student learning. A comprehensive teaching module will be developed via a thorough exploration of technical development and social aspects related to the advancement of H&FC technology. The program will promote the critical role of scientific and engineering research that facilitates industry development as students and teachers alike acquire new knowledge and develop relevant skills in the assessment and evaluation of future fuels and energy technologies.

The program cluster comprises a multi-disciplinary team of representatives from several universities, professional and research organizations and industry working with 864 students (aged 10 to 16/Year levels 4 to 10) and 44 teachers from 9 trial schools located across the Melbourne-Geelong region of Australia.

PROGRAM OBJECTIVES

- To promote excellence and best practice innovation in the teaching of science and technology
- To increase teacher base knowledge and literacy in scientific fundamentals
- To utilise H&FC technology and related concepts as a the basis for teacher and student learning
- To raise the profile of H&FC technology in the Australian educational curricula
- To promote sustained student and teacher interaction with environmental educators, scientists, engineers and professional bodies
- To explore the fundamentals of engineering design, materials development, reactions, electronics and resource and environmental management
- To motivate students to develop theoretical and practical knowledge in emerging fuel and energy technologies
- To raise awareness, knowledge, attitudes and develop specific skills that can empower students to become actively involved in the development of sustainable and clean industries
- To expand critical reasoning skills and nurture conceptual, strategic and innovative thinking capabilities
- To develop self-management, leadership and communication skills in autonomous and shared student activities

PROGRAM STRUCTURE

Each of the program tasks has been designed to promote extensive interaction and knowledge transfer between technical and education specialists, teachers and students. The program developmental model presented in Figure 1 is characterized by the repeated delivery of teacher consultation, a dedicated professional learning and development (PD) course and school implementation (Tasks B, D and E, respectively). The program also features a dedicated research and evaluation study (Task C). The resultant teaching module from Phase A will be trialed, evaluated and revised throughout 2007 in the Phase B of the program with the cooperation of schools from Brisbane, Australia and select Phase A schools.

Figure 1: The Australian Hydrogen and Fuel Cells Education Program Developmental Model
(Note: Task A covers program administration)
PROGRAM BENEFITS TO STUDENTS

- increase experience and knowledge in the application of science fundamentals with a focus on engineering design and materials development
- bolster appreciation of science, engineering and technology
- promote the critical role scientists and engineers play in resource management and environment protection
- heighten student confidence in the attainment of practical skills
- expand critical reasoning and problem solving skills and conceptual and strategic thinking
- nurture self-management, leadership, teamwork and communication skills in autonomous and shared roles
- project on the future mix of fuels and energy systems and consider the broader economic and social issues relating to development of fuels and energy infrastructure
- broaden knowledge of local air quality, greenhouse gas, resource and waste management issues and their impact on our natural and built environment
- engage in real life tasks to recognise and appreciate the importance of technological development in supporting societal needs
- raise awareness of the complex nature of environmental issues and interdependency of environmental protection and development

PROGRAM BENEFITS TO TEACHERS

- enhance scientific and technical literacy
- boost capability in the delivery of teaching programs across science, technology and environment studies subjects
- encourage leadership to shape program outcomes that address ongoing and specific professional learning
- raise confidence in the handling of educational material in science and engineering disciplines as they relate to broader energy and sustainability issues
- gain new knowledge within the context of professional practice
- acquire specific knowledge and teaching skills to incorporate supplementary curricula within regular school curricula
CLUSTER PARTICPANTS

Project Management

- Luigi Bonadio, Senior Consultant, Luigi Bonadio & Associates
- Glenn Davidson, School Co-ordinator, Sustainable Schools Initiative – Victoria/CERES (Deputy)

Professional Development Course

- Luigi Bonadio, Senior Consultant, Luigi Bonadio & Associates (Leader)
- Dr. Andrew Dicks, Department of Chemical Engineering, University of Queensland/Australian Institute of Energy Hydrogen Division
- Judy Glick, CERES Education Team
- Prof. Annette Gough, Head, School of Education, Royal Melbourne Institute of Technology (RMIT)
- David Peck, Ceramic Fuel Cells Ltd./Eng-Com Pty Ltd/Swinburne University of Technology

Research team

- Prof. Annette Gough, Head, School of Education, RMIT (Leader)
- Dr. Jane Edwards, Research, School of Education, RMIT
- Dr. Andrew Dicks, Department of Chemical Engineering, University of Queensland/AIE

School implementation team

- Glenn Davidson, School Co-ordinator, Sustainable Schools Initiative - Victoria, CERES (Leader)
- Luigi Bonadio, Senior Consultant, Luigi Bonadio & Associates
- Eric Bottomly, Sustainable Projects Team, CERES
- Mike Horne, CSIRO, Division of Minerals
- Cara Horner, Sustainability Education Facilitator, Sustainable Schools Initiative, CERES
- Tim Moodie, Graduate, Department of Social Science, RMIT
- Bernadette Rees, PhD candidate, Department of Psychology, Swinburne University of Technology
- Catherine Rees, PhD candidate, Department of Chemical/Biomolecular Engineering, University of Melbourne
- Ass. Prof. Russell Tytler, Faculty of Education, Deakin University

Table A: Statistics for staff, teacher and student participation by Phase A cluster school

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<thead>
<tr>
<th>Cluster school</th>
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<th>Staff hours</th>
<th>No. of teachers</th>
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<th>No. of lessons</th>
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<td><strong>1,111</strong></td>
<td><strong>28</strong></td>
<td><strong>37</strong></td>
<td><strong>342</strong></td>
<td><strong>864</strong></td>
<td><strong>377</strong></td>
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TASK B: TEACHER CONSULTATION

Objectives

1. To assist teachers with program development and translation of critical knowledge
2. To advise teachers on program administrative requirements and processes

The program acknowledges that teaching is complex and consequently is supported by diverse forms of professional knowledge for practice. Traditional education practice has identified benefits of professional learning and development for teachers, but knowledge transfer, particularly in areas of emerging technologies and concepts, requires additional resources to monitor and facilitate sustained teacher and student learning. Translating curricular specifications into productive learning experiences involves interpretations and judgements about what knowledge is important, what students are interested in and capable of, which teaching resources are available and likely to be useful. In addition to an introductory
briefing session and the PD Course, the program supports teacher participation in three sets of direct consultations with teacher associates to facilitate this critical process of information exchange.

Teachers learn best when actively working within Communities of Practice\(^{3,4}\) to examine and develop ways of working, learning and teaching. This reflexive practice\(^{5}\) allows teachers to interrogate their professional knowledge and practice to ultimately work towards enabling rich engagement for learning within their classrooms and amongst the program cluster. The design and delivery of student learning experiences are aligned with recent theories of learning such as New Learning\(^{6,7}\). The program is school-oriented and includes the administration of pre, interim and post surveys, teacher interviews, student fora and the building of Communities of Practice to engage innovation in learning and teaching.

In October, 2005, 30 teachers engaged in **Teacher Consultation 1** to discuss the program objectives and learning formats, receive briefing on the PD Course and initiate an exchange of ideas for School Implementation. Teachers discuss and report on the development and progress of their respective implementation programs in **Teacher Consultation 2**. Teachers reflect on their implementation program, communicate the learning outcomes of teachers and students and discuss opportunities for program revision and improvement during **Teacher Consultation 3**.

**TASK C: RESEARCH AND EVALUATION STUDY**

**Objectives**

1. To evaluate the project's processes and outcomes against the program objectives
2. To reflect on curriculum development and pedagogical processes and outcomes
3. To make recommendations for future pilots/roll-outs

**Methodology**

1. Participate in and monitor initial school visits
2. Participate in and monitor Professional Learning & Development days
3. Conduct classroom observations, teacher interviews and student focus groups during and after School Implementation in order to:
   i) record teacher reflection of the practicalities of introducing the program;
   ii) question the addressed/deficient program elements for teachers;
   iii) elicit teacher opinion regarding the benefits/deficits of the program for student learning; and
   iv) determine teacher recommendations for future implementation of program phases

**Actions**

1. report on teacher/school preparedness to teach H&FC technology from teacher interviews and participation/observation of teacher engagement in Professional Learning & Development sessions;
2. report on school implementation through case studies of classrooms, teacher reflections on their experiences of the project and student understanding as a result of their classroom participation; and
3. report on the match between program objectives, PD organisation and teachers' experiences to recommend structure for future PD days.

The research and evaluation study is lead by the School of Education, Royal Melbourne Institute of Technology School of Education, ensuring that the program is in keeping with best practice in education. The development of the Education Module and other curriculum materials will be the result of an action research methodology\(^{8,9}\) where research input from teachers and teacher associates will drive the educational change in professional practice of participating schools. The program research includes a review of current program and teaching methods in H&FC Education, a review of the methodology for module development and an evaluation of program elements.

The meta-research analysis is characterised by an evaluation process at each phase cycle to measure how the expectations and needs of the participating teachers are being met. Teacher interviews and classroom observations will focus on the teacher experience of developing and implementing this new curriculum material. Student focus groups will centre on the student outcomes and learning from the program. Due to the age range of potential student groups, no single set of questions will be appropriate, and will need to be tailored accordingly. Draft surveys and questions for teacher consultation, interview and student fora are listed in **Appendix 1**.
TASK D: PROFESSIONAL LEARNING & DEVELOPMENT COURSE

Objectives

1. To bring together technological content input with pedagogical considerations to inform School Implementation
2. To bolster teacher confidence in the use of H&FC kits and other educational materials
3. To gather specific data from teachers relating to their school implementation plans

The Professional Learning & Development (PD) Course consists of nine sessions held over three days, including a series of lectures, a master class, workshops and an industry site visit. Sessions are focused on either the dissemination of technical knowledge or the development of pedagogy as illustrated in Figure 2. The course provides a revision of key theoretical concepts, assists with program pedagogy development and evaluation and allows teachers to familiarize themselves for the utilization operation of H&FC kits as educational tools and share ideas with other teachers. The objectives, themes and revision tasks for Sessions 1-6 are presented in Table B. Thirty teachers from the nine participating schools attended six PD sessions over Day One and Two in November, 2005.

Figure 2: Professional Development course sessions (1-6) by technology and pedagogy development categories

Sessions 1 and 2 provided technical information as the basis for revision of relevant theory. In Session 3, this information was linked to practical applications of H&FC technology through hands on exploration with fuel cell kits issued to teachers for review and evaluation. Teachers communicated and shared ideas for school implementation with other participants from the program cluster. In the week between PD Days 1 and 2, teachers were provided with an opportunity to trial, discuss and reflect on the curriculum possibilities of the kits and materials.

In Session 4 teachers engaged in a master class on the use of H&FC kits as an educational tool lead by Judy Glick, a CERES Education teacher with several years H&FC teaching experience. In Session 5, teachers provided feedback on and shared experiences in their investigation of the educational materials and made presentations on how each school could them for their respective teaching programs. This Session concluded with a presentation on H&FC technology research and development from Dr Andrew Dicks, a fuel cell systems expert from the University of Queensland.

Session 6 was held at Ceramic Fuel Cells Ltd in Noble Park (Melbourne). Marketing manager, David Peck presented an overview of the fuel cell industry and teachers were lead through a site tour of the facility. This Session provided an opportunity for teachers and other program participants to interface with industry specialists working in leading fuel cell research and development and manufacture.

Teachers engage in action learning through reflective practice to explore their classroom issues and negotiate their professional learning™. The coordination of Sessions 7, 8 and 9 will promote teacher leadership as a means to encourage greater ownership and control in teacher’s professional learning. The objectives, formats and content of the workshop sessions for PD Day Three will therefore be determined by teachers in consultation with other cluster participants. PD Day Three is scheduled for October, 2006.
<table>
<thead>
<tr>
<th>PD Session</th>
<th>Objectives</th>
<th>Themes covered</th>
<th>Teacher revision tasks</th>
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</thead>
</table>
| **S1: Energy and related issues** | 1. To provide a general background of the energy sector  
2. To discuss broader issues relating to energy systems development  
3. To discuss relevant environmental issues  
4. To provide revision on basic scientific principles | 1. Overview of the Australian energy sector  
2. Energy supply and demand  
3. Energy for transport and power generation sectors  
4. Centralised and distributed energy systems  
5. Energy efficiency  
6. Life cycle analysis of energy systems  
7. Urban air quality and climate change phenomena | 1. What are the differences between criteria pollutants and greenhouse gases?  
2. What strategies could be pursued to abate these emissions? |
| **S2: Introduction to H&FC technology** | 1. To provide a technical overview of H&FC and related technology | 1. Hydrogen as energy carrier and working fluid  
2. Properties of hydrogen and hydrogen safety  
3. Hydrogen production, storage and end use technologies  
4. How an electrolysis unit works  
5. How an internal combustion engine works  
6. How a fuel cell works  
7. Fuel cell types and applications  
8. How a battery works  
9. Integrated and renewable hydrogen energy systems | 1. What is an integrated hydrogen system?  
2. What are the technical limits to the advancement of H&FC technology? |
| **S3: Workshop A**  | 1. To promote open discussion and an exchange of views on school implementation methods  
2. To introduce the FC kits to teachers  
3. To review local and international H&FC educational programs  
4. To introduce the educational materials  
5. To discuss options for the teacher and student support materials | 1. Familiarisation with educational materials  
2. Consideration of the curriculum opportunities provided by the educational materials | 1. Critically evaluate the teaching and learning possibilities of the kit and educational materials in terms of  
- what is likely to work in your context?  
- what do you find challenging?  
- what you see as supporting 21st century learning?  
- what you would use?  
- what is not useful?  
- what else you will need before you can implement the program  
2. Develop an outline of how your school intends to implement the H&FC educational materials in the classroom |
### Table B: Objectives, themes and revision tasks of PD Session (continued)

<table>
<thead>
<tr>
<th>PD Session</th>
<th>Objectives</th>
<th>Themes covered</th>
<th>Teacher revision tasks</th>
</tr>
</thead>
</table>
| S4: Using H&FC kits in the classroom | 1. To demonstrate and discuss the use of fuel cell kits as an educational tool  
2. To elaborate on anticipated problems with the use of fuel cell kits | 1. Practical experience with the use of H&FC kits as an educational tool  
2. Demonstration value of H&FC kits | 1. List the methods you would employ in using the H&FC kits to demonstrate three key scientific principles to your students  
2. What problems do you anticipate in this learning exercise and how could you overcome them? |
| S5: H&FC education | 1. To review the educational materials  
2. To allow teachers to outline their proposed implementation plans  
3. To identify program relevance to VELS principles  
4. To receive program input from a leading academic and industry leader | 1. Critical reflection on and discussion of educational materials  
2. Consideration of the suitability and the curriculum opportunities provided by the educational materials  
3. School outlines of their proposed implementation plans | 1. Select three H&FC research projects from the Australian Hydrogen Activity report. List the scientific principles of relevance to the stated objectives.  
2. Identify the relevant VELS* dimensions to your proposed H&FC school implementation program. |
| S6: Hydrogen and fuel cells in industry | 1. To illustrate the broad range of applications of H&FC technology  
2. To investigate the technical operations of a global leading H&FC company  
3. To learn about industry developments in the field of H&FC technology  
4. To promote Australian capability in the field of H&FC technology  
5. To seek program input from an industry perspective | 1. Applications of science and technology for industry fuel cell development  
2. Site tour @ Ceramic Fuel Cells Ltd, Noble Park, Melbourne. | 1. What are the commercial advantages and disadvantages of SOFC compared to PEMFC? |

* VELS – Victorian Essential Learning Standards (Victorian Curriculum and Assessment Authority– State Curriculum Reform 2005)
TASK E: SCHOOL IMPLEMENTATION

Objectives

1. To teach scientific fundamentals across a diverse range of interdisciplinary learning
2. To increase experience and knowledge in the application of science fundamentals with a focus on engineering design and materials development in the fuels and energy sector
3. To trial the use of H&FC model kits as an illustrative example of real life applications
4. To bolster student confidence in the attainment of practical skills
5. To develop student self-management, leadership, problem solving, critical thinking skills and communication skills in autonomous and team-oriented activities,
6. To allow students to project on the future mix of fuels and energy systems and consider the broader economic and social issues relating to development of fuels and energy infrastructure

Resources

The central objective of all educational initiatives administered under the ASISTM program is to increase student interaction with representatives from academia, industry and other specialist areas referred to as “teacher associates”. The School Implementation Task is lead by Glenn Davidson, an experienced coordinator of school programs and qualified teacher from CERES. The nine teacher associates engaged in Phase A of the program are either employed in the fuels and energy industry or have direct experience in working with students in schools.

The role of teacher associates is to:

- excite teacher and student interest in Science, Engineering and Technology
- act as role models and student mentors
- help drive innovative initiatives through provision of subject expertise and enthusiasm for both student learning and the context of the application of their specialist knowledge

In addition to theoretical and practical support at the PD Course, teachers were provided with an expansive set of reference material and resources to assist with implementation plan development. Each school has received fuel cell model hardware with operational guides (shown Figure 3) and four volume lesson book sets and DVDs (shown in Figure 4) from Heliocentris Energiesysteme GmbH (www.heliocentris.com). These materials can be used over many years as a versatile complementary education tool for a range of subject material.
Activities

There has been a natural ecology in the development of program content as each school develops and refines a unique school implementation plan. The diversity of program content and variety of approach methods and outcomes across the 37 different trial classes and 342 lessons provides considerable scope and breadth for evaluation and a solid basis for case study and teacher module development. The school implementation statistics are provided in Table C.

Implementation plans are based on the execution of specific activities that vary from one class to another on the basis of:

1. the teaching level – Year 4 through Year 10
2. the subject being taught – junior and senior science
3. the duration and timing of activities – 1 to 3 hours lessons, 1 to 3 lessons per week
4. the format of the activities – individual and group exercises
5. the nature of the activities pursued

Activities include:

- contemplation of futures, lifelines, future wheels and scenario development
- reflection and projection on major historical events
- force-field analysis
- debates, spelling tests, future images poster and video development
- design, construction, testing and operation of regular and modified fuel cell car models or other fuel cell devices, and
- design, construction, testing and operation of solar-hydrogen models

Activities are executed as individual or group activities with varying levels of guidance from teachers and teacher associates and in most cases necessitate an element of student research. Students will form teams to develop and apply “thinking” and “communication” skills in most activities and present their individual or group learning via written, audio-visual or oral presentation.

Themes to be explored would vary across a number of pertinent issues to Australian industry, including resource and environmental management, energy efficiency across the transport and power sectors and pursuit of sustainability milestones. Many of the Phase A school teachers are revising their respective programs for a repeat class or extending their program for other teaching levels and subjects.

The program will culminate in an awards ceremony where outstanding performance by schools, teachers and student groups within the cluster will be acknowledged.
MODULE DEVELOPMENT

The program design is based on the development of a practical and accessible teaching module for implementation across any Australian school at specific levels. The module will contain a teacher and student manual detailing numerous activities and experiments and includes supportive reference material. Chapters of the manual will be developed to cater for specific teaching requirements that differ on the basis of

i) education level and student learning capacity
ii) subject taught and corresponding objectives
iii) implementation methodology (nature of activities, duration, timing and formats)

The program employs the services of Dr Andrew Dicks, a H&FC industry expert and Prof. Annette Gough, an expert in pedagogy development to peer review all of the Module teaching material for accuracy and relevance and ensure that all of the module content is commensurate with state-of-the-art knowledge.

The Module will be sufficiently flexible to be utilised as a complementary educational tool for an existing energy education program or tailored to meet specific lower/higher level teaching requirements. The module is a flexible, fluid educational tool, designed for simple modification to reflect the latest advances in H&FC technology. The resultant teaching module from Phase A will be trialed, evaluated and revised throughout 2007 in the Phase B of the program with the participation of schools from Brisbane, Australia and select Phase A schools.

ACKNOWLEDGEMENTS

The Australian Hydrogen and Fuel cells Education Program is managed by Luigi Bonadio & Associates (www.lbaa.com.au) and is sponsored by the Australian Schools Innovation in Science, Technology and Mathematics Program (www.asistm.edu.au) co-ordinated by the Commonwealth Government of Australia, Department of Education, Science and Training. The author acknowledges the support of staff from the Department of Education, Science and Training, the Curriculum Corporation, Engineers Australia, Heliocentris Energiesysteme GmbH, Prof. Russell Tytler, Senior Lecturer, Deakin University (and the Program critical friend) and extends thanks to all cluster participants for their continued support and cooperation.

Provision of school photographs is with permission and courtesy of Geelong Grammar School and Princes Hill Secondary College.

REFERENCES

APPENDIX 1: RESEARCH, EVALUATION AND TEACHER CONSULTATION MATERIAL

APPENDIX 1.1: Draft teacher consultation questions (for Task B)

- How have you adjusted the program objectives, during your Professional Learning and Development Course, during school implementation and after completion of your school program?
- Did your students feel the same way about these successes and pitfalls? If so how and why?
- How did student observation/questioning/approach change your initial understanding and pedagogy?
- To what degree did you revise your program during the implementation phase? How and why?
- Did students offer any advice on adopting alternative approaches to learning?
- Which part of the school implementation task was a student highlight? Which was yours?
- Have you adjusted your approach based on transmissive versus transformative education processes?
- How do you see this approach being effective in the bolstering of science and science education?
- Has this process been a good ‘advertisement’ or springboard for science and/or sustainability contexts?
- Will you use this program as a consistent part of your curriculum – if so why, if not why?

APPENDIX 1.2: Draft student consultation questions (for Task B)

- Will hydrogen and fuel cell technology impact on the way you might live in the future?
- What are the implications if we do not adopt this technology?
- Can you suggest some ideas on how we might better use these contexts in class lessons?
- If up to you – would you spend more time exploring fuel cells and fuel cell cars?
- Is the communication focus a worthwhile component of this program? If not why?
- Do you see yourself undertaking science as an element of a vocational future? Why or why not – how?
- Do you consider the environment context to be important to this project why/why not?
- What methodology or approach would you use to teach younger students how to use a fuel cell?
- Did you enjoy meeting people from industry? If so why?
- Would you like to see more real-life science practitioners in your classrooms?
- Is there a way we can make science more attractive to young people? If so what are your ideas?

APPENDIX 1.3: Draft teacher interview questions (for Task C)

- Describe your experience of implementing this new program?
- What were your main objectives for teaching this program?
- Which aspects of the program do you feel were most/least successful? How/Why/Evidence?
- In what ways could the program be improved – for you as a teacher/for your students?
- What do you think your students gained from the program?
- What are your recommendations to teachers implementing the program in the future?

APPENDIX 1.4: Draft student forum questions (for Task C)

- What did you enjoy most about the program? Why?
- What did you least enjoy? Why?
- What was the most interesting/surprising/exciting thing you discovered from the program?
- Tell me all about hydrogen and fuel cell technology.
- Why do you think hydrogen and fuel cell technology is important?
- Can you think of any way that you may choose to use a fuel cell?
- Why might you decide to use a fuel cell?

APPENDIX 1.5: PD Course evaluation form (for Task D)

1. What did you know about H&FC before today and ii) H&FC education before today?
2. What were the three key ideas you learned today?
3. How will the program change the teaching of alternative energy in your school?
4. Which activities were useful (1 = not at all useful, 5 = extremely useful)

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5. What else would you like to have included on Day 2 that was not covered on Day 1?
6. Other comments