Understanding science, or the science of understanding?

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Abstract

This brief report summarises the results of the FEAST (Facilitating Engagement of Adults in Science and Technology) initiative, a 3-year project funded by the EU Commission aimed at fostering adult engagement in children's learning. The project groups investigated how the general public engage with science, and then designed workshops to support inquiry-based learning, to encourage critical reflection and to build methodologies for the explainer (the scientist) to mediate this interaction. We can apply the FEAST rationale in New Zealand to make complex science more accessible to the public, for example, to help combat the perceived 'CSI effect' and thereby nurture greater understanding of forensic science in future generations of potential jury members.

It is imperative for scientists to enhance and maintain effective communication, both within their professional communities, and with the public. We need to be pro-active, taking advantage of all the accessible distribution channels and opportunities to engage external parties and strengthen the position of science in New Zealand's future.

Introduction

Founded 20 years ago, Ecsite is a European network of science communication professionals from more than 400 institutions in 50 countries. Members include science centres and museums, science festivals, natural history museums, zoos, aquariums, universities, research organisations and companies communicating and engaging the public in science through accessible, interactive exhibits and programmes [1]. Ecsite connects member institutions through projects funded by the EU Commission and also facilitates the exchange of ideas and best practice on current issues. A number of concurrent projects have been completed over the last three years, targeting the communication of science to different target groups. These include PLACES, VOICES and DESIRE [2].

Parents and care-givers play a key role in supporting their children's understanding and engagement with science concepts. The depth of the parents' involvement depends on their own self-confidence and learning experiences, as well as how they approach learning at home. This has also been shown

[1] http://www.ecsite.eu
[2] http://www.ecsite.eu/activities_and_resources/projects

in New Zealand case studies, where 'parents as empathisers' seemed to dominate the family interactions [1]. These parents listened to their children's comments and made an effort to build them into discussions around the topic, with invitations to find out more.

Science centres, museums and other institutes can use their own expertise in the area of 'informal learning' to offer explicit support and guidance for parental engagement with scientific learning. A variety of approaches may be adopted to promote and foster family engagement, helping adults to understand their role as facilitators of inquiry-based learning. FEAST identifies explainers in science centres and museums as key personalities in informal education of adults and families. The professional development of this category in an international setting, and the creation of a European model for developing and delivering informal science workshops for adults, is a way for the consortium to contribute to the field, combining the efforts of museum practitioners, academic researchers, networking and media experts in the creation of high quality products.

Techniques for Facilitating Communication

The FEAST training course provided explainers with a forum in which to practise a number of well-documented communication processes, to expand on the role as facilitators for family interaction during the workshops. As explainers, we participated in the workshops in order to experience what the families would, and learn how to recognise and manage different scenarios that arise. Some of the techniques included:

- Observation of and responses to the different family dynamics due to ethical, cultural, and gender reasons
- Asking open-ended questions to encourage a discussion
- Creating an environment where the participants feel safe to make mistakes, and allow this to occur instead of pre-empting the correct answer
- Having a fun, relaxed atmosphere helps to encourage open-minded thinking
- Balancing creativity with direct instruction
- Working with restrictions (e.g. time constraints, small budgets and availability of resources)
- Helping the participants to discover the answers themselves, rather than providing the answer
- Facilitating interaction between different parent-child groups, considering the effect of the explainer on how the families interact

Evidence that these reflections would apply in the New Zealand environment can be found in a recent study by Williams *et al.* (2013), where teacher participants indicated that they found that real inquiry-based learning means that the teacher needs to stand back and let that inquiry happen [2].

The FEAST Workshops

Five workshops were presented at the training course, comprising a range of useful approaches to facilitate the engagement of adults within the science activities. The full repertoire is available for other institutions to adopt, or to adapt their own versions to continue to promote the aims of FEAST [3]. The following outlines of each workshop include some of the discussion points that arose during the training course. It is important to consistently ensure that the participating parents are aware of the true purpose of the workshop, which is communicating with their children, rather than learning about the science facts themselves.

Talking About Science: Floating and Sinking

This workshop challenges both parents and children to address the misconceptions around the Archimedes' Principle, and was designed by explainers at NEMO Science Center in Amsterdam, Netherlands. Firstly, the parents attend a theoretical introduction to integrate new information with their existing knowledge, while the children are engaged in a demonstration. The parent-child pairs then re-combine to take a quiz, predicting whether certain objects will sink or float. The parents' quiz forms are taken away, and from then only the children's answers are referred to for the workshop duration.

The families are then allowed to experiment with few of the questions for themselves, to test their predictions, and discuss what they believe is happening, this session being guided by the explainer where needed. The workshop concludes with a demonstrated explanation of the principles of density, and provides suggestions for objects to test at home together, thus continuing the exploration and discovery beyond the workshop.

Vehicles that Roll

The challenge of this particular workshop is open-ended, so there is no single correct outcome. The initial task is to 'build a gravity car and test it on an inclined plane.' The developers, Teknikens Hus (Luleå, Sweden) provided a kit comprising a range of materials for families to experiment and build with, which can also be taken home. The introduction for parents focuses explicitly on problem solving and the process of working together, after which they join the children in inventing and

building their vehicle. Once the vehicle achieves the first goal, the groups are able to improve and enhance the vehicle's performance as they wish. While the children complete their vehicle, parents are taken aside and are introduced to some of the concepts they inevitably encountered during the workshop, such as Newton's laws of motion. A group discussion concludes the process of sharing and reflection, as participants are able to see the variety of solutions obtained.

The overall purpose of the explainer here is to steer and motivate, rather than supply an answer. One of the strengths of this workshop is that participant creativity is stimulated without being overwhelming. For example, the prepared kits limit the number of options for the design of the vehicle to ensure a positive outcome, but provide a range of available combinations for extending the task beyond the initial challenge.

Aeronautic Space Area Practice: Space

The use of a storyline is extremely effective in this astronomy workshop, designed by Techmania Science Centre (Plzen, Czech Republic). To begin, parents are given a short introduction to the theory behind the workshop, while the children engage in imaginative physical activities such as reaction time tests. The parent and child then pair up to complete a series of tasks related to the space travel mission, namely:

- Designing a 'spacesuit'
- Building and launching a rocket
- Creating a model of the moon's surface

This topic appeals to a range of age groups, and the continuation of the storyline helps to maintain the children's attention. All the items created during the workshop can be taken home, thus allowing families to modify and improve on their designs. Parents are given background information to empower them to engage in further exploration with their children. The workshop is designed so that each participant is given a specific role, but must collaborate with the other to achieve the goals.

A Robot in the Family

The use of computer programming and mechanical robots is unfamiliar territory for many people, which can mean that both parents and children are often operating at the same level. In the experience of the National Museum of Science and Technology Leonardo da Vinci (Milan, Italy), it is often the children who take control and lead this activity, due to their confidence in using technology. The first phase is a group discussion about robotics, and a demonstration on programming specific instructions. The NXT Mindstorms LEGO kits and software are explained, and

the family groups then begin to program their robot (speed and direction) to follow a specified path, with the fastest robot winning at the end. Groups are then able to discuss their strategies and learn from each other.

This workshop can incorporate different levels of complexity, and there is scope for creativity, such as making the robot do a victory dance at the end. However it is important to monitor the competitive aspect of the activity, as there may be adverse reactions to what is perceived as failure. Due to the highly technical nature of the project, the explainer needs to ensure both participants are able to contribute.

Mobile Parents Meeting

Developed by Hiša Eksperimentov in Ljubljana, Slovenia, this workshop model consists of two separate sessions held one week apart. The topic demonstrated here is the properties of sound, but can be applied to any topic of choice.

During the first session, parents meet with the teacher at the Science Centre and interact with a number of exhibits relating to sound. Experts and exhibit designers are available to offer insights on the specific topic. Parents participate in a tactile and interactive workshop process to understand the concepts. The materials are everyday household objects, and the accompanying booklet suggests ideas for families to try at home over the rest of the week.

During the second session, parents visit the Science Centre with their children. First they enjoy the science show “Soundology.” Parents are then encouraged to take up the role of explainers and lead their children in interacting with the exhibits. During this session it is important that the explainer monitors the parent-child interaction levels, as there is a danger that the attention remains on the ‘entertaining’ explainer, rather than on the family communication processes.

Methodology Checklist

This list was supplied as a useful tool to support the implementation and evaluation of a workshop designed to engage both adults and their children [3]. The key points are based on existing literature on teaching and learning in informal settings, and include questions about whether the workshop would:

- Help parents understand the key role that they play in supporting their children’s learning
- Help parents reflect on their role as mediators
- Equip parents with skills to enhance their own and their children’s engagement with the topic

- Enhance the interest of parents and their knowledge of the subject matter
- Support collaboration between parent and child
- Encourage activities in which each member of the family finds his/her own role
- Use parents' and children's already-existing knowledge as the starting point for investigations
- Support engagement in the processes of inquiry and research
- Encourage "hands on" experimentation and conversation
- Strengthen learning by linking it to family life

Science Engagement in New Zealand

One New Zealand survey to gauge public engagement with science found that majority of respondents enjoy finding out about new ideas in science [4]. Significant drivers for scientists' communication include a consistent public interest in science, the relevance of science for daily life, and how science knowledge intersects or interacts with public and indigenous knowledge.

This country does not lack enthusiastic science explainers or facilities, yet there is still much ground to be covered towards developing future generations of inquiring minds. Over the years, a number of scientists have made varied attempts to stimulate scientific discussions among the public, from Open Days, to school talks, to newspaper articles and DVD's [2, 5]. However, there is still a gaping divide between practicing scientists and the general population when it comes to conveying the scientific message, despite access to modern and novel technologies.

Previous research has focused mainly on the teachers and the education system in finding new ways to deliver educational material. Yet it has also been shown that some of the factors influencing students' decisions to study science include personal interest and family background and it is suggested by Cooper *et al.* (2010) that although students are interested in science, they are not enjoying studying it ([6]. It is important that children learn how to link scientific knowledge with everyday activities [6], and this requires some level of input from the family network.

A Forensic Science Perspective

In order to foster understanding of forensic science in future generations of professionals we should be able to provide potential jury members with the knowledge necessary to allow them to competently assess complex scientific evidence. We already have research demonstrating that jurors struggle with understanding technical aspects of scientific evidence presented in court [7-9].

Marsden funded research undertaken by ESR and University of Canterbury researchers revealed that confidence in DNA profiling held by potential jurors was completely undermined when they heard DNA evidence, resulting in their inability to form a judgement about the meaning and strength of the evidence [10]. This could be partly due to the fact that DNA evidence is a mixture of biological science, and applied mathematical probability, difficult topics even for scientists to combine [8]. Furthermore, professionals within the criminal justice system tended to attribute inappropriate certainties with regard to the meaning of DNA profiling results.

There are a number of individuals and groups at ESR already developing skills and procedures to improve the efficiency of the criminal justice system, such as an interactive evidence platform (IEP), and reviewing explanations of DNA evidence. It would be of benefit to review the wealth of educational research on how people learn, how they process information, and how they respond to specific stimuli when faced with a decision to make [7, 8, 11]. If people learned at an earlier age to feel comfortable when exploring and investigating a problem beyond their comfort level, it may become easier for forensic scientists to convey the technical aspects of their work, as well as the inferred strength of the evidence being discussed.

A number of New Zealand school teachers have developed their own forensic science module to include in their curriculum, and often request expertise and input from various New Zealand forensic professionals. This appears to be related to a deliberate response to the declining science enrolment numbers and the popularity of forensic science in today's media. However, Peter Griffin warns that it is not enough to make people 'science-literate' in the hope that they would then factor scientific evidence into their decision making - other skills are required to sustain a knowledgeable population [12]. A New Zealand trial using a forensic science-based workshop, aimed at family learning and designed with the FEAST principles in mind, would be an interesting pilot project to add to the research in both areas of science communication – informal learning, and jury decision-making. The FEAST training course provides valuable tools to use in the process of reviewing and evaluating our approaches, and implementing modifications for further improvement.

Summary

There is clearly need for concerted efforts to be made in the area of science communication in New Zealand, not just in forensic science but in all other science disciplines. This summary only scratches the surface of the available literature to provide a snapshot of the issues. The European projects investigating informal learning provide an interesting perspective on the challenges faced when communicating science within a mixed audience. New Zealand has its own unique set of social and

political challenges, so as citizens and scientists we must find ways to adapt and implement theories advanced through international collaboration, thereby developing a more science literate and inquiring population. The presentation of evidence in courtroom trials is also changing in this new technology age, and it is important that the lessons learned in other science communication fields be integrated to the best advantage.

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References

1. Donald, C. and M. Barker, *Conversing about Science at Home.* New Zealand Science Teacher, 2011(128): p. 34-37.
2. Williams, J., et al., *Networked inquiry learning in secondary science classrooms.* Teaching and Learning Research Initiative Project Report, 2013.
3. Rossi-Linnemann, C., et al., *Engaging Parents as Facilitators of Children's Learning in Science: Materials for Training and Design of Family Workshops*, 2013.
4. Winstanley, A., M. Hepi, and A. Ahuriri-Driscoll, *Research into scientists' views and preferences for communication activities with the general community, the business community, to government and researchers in other disciplines: An interpretive literature review*, 2010.
5. Campbell, J., *Promoting Science: John Campbell Reminisces.* New Zealand Science Teacher, 2012(129): p. 27-29.
6. Cooper, B., B. Cowie, and A. Jones, *Connecting teachers and students with science and scientists: The Science Learning Hub.* Science Education International, 2010. **21**(2): p. 92 - 101.
7. Fessel, F. and N. Roese, *Hindsight bias, visual aids, and legal decision making: timing is everything.* Social and Personality Psychology Compass, 2011. **5/4**: p. 180 - 193.
8. Hewson, L. and J. Goodman-Delahunty, *Using multimedia to support jury understanding of DNA profiling evidence.* Australian Journal of Forensic Sciences, 2008. **40**(1): p. 55 - 64.
9. Tait, D., *Rethinking the role of the image in justice: visual evidence and science in the trial process.* Law, Probability and Risk, 2007. **6**: p. 311 - 318.
10. Veth, J.S. *Interdisciplinary research with systems thinkers and social scientists: A forensic scientist's perspective*. in *Systems Thinking and Complexity Science: Insights for Action: Proceedings of the 11th Anzsys/Managing the Complex V Conference (Held in Christchurch, New Zealand, 5th-7th December, 2005)*. 2006. Isce Publishing.
11. Martin, M.E., et al., *The influence of sample type, presentation format and strength of evidence on juror simulation research.* Psychology, Crime and Law, 2007. **13**(2): p. 139 - 153.
12. Griffin, P., *Science Literacy is Vital!* New Zealand Science Teacher, 2012(129): p. 23-24.