The Journal of Emergent Science

Issue 10 Winter 2015/2016

The Association for Science Education
Promoting Excellence in Science Teaching and Learning

Contents

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The Journal of Emergent Science (JES) is published by ASE in partnership with the Primary Science Teaching Trust (PSTT).

It is free to access for all.

Editorial

■ Sue Dale Tunnicliffe

The *Journal of Emergent Science (JES)* was founded by Jane Johnston and myself to fill what we considered to be an unoccupied niche between the academic journals concerned with early childhood, and journals focused on primary science and technology. We envisaged this journal, in comparison with the traditional academic journals, as carrying shorter, more readily accessible papers about emergent scientists – children from birth to 8 years old. Our belief was that to have papers and other relevant information in one journal would be beneficial to both students and practitioners. And so it has proved. Practitioners may want to apply research findings in their own teaching, as they reflect on their role of facilitating a young child's observations and experiences in science and technology, both in formal educational settings and outside, in the home and other places, such as museums. Thus we welcome the partnership of the Association for Science Education (ASE) and the Primary Science Teaching Trust (PSTT) and hope this will help us to more readily achieve our aims.

In the last quarter of the 20th century, interest in the start of science learning began to be shown and governments started to invest more in science education in the primary sector. Hitherto, science was usually, in England, focused on nature study, which in fact encouraged children to observe everyday biology, in particular in their immediate surroundings. However, in reality, the physical sciences were not particularly emphasised in the primary schools. Some science teachers and researchers began to question the wisdom of the classic approach to science learning, which was particularly focused on secondary schools and the more academic scholars. The Schools Council, the Nuffield Foundation and the Scottish Education Department (1967 to 1975) sponsored the Science 5/13 project. This produced an invaluable series of science activities that set a high standard for primary science. I used them in 1976, when I gave up teaching in secondary schools to find out more about how children learned science before they had reached my O- and A-level classes.

Osborne, Bell and Gilbert (1983) wrote a paper in the *European Journal of Science Education* (now the *International Journal of Science Education*, published as an 'A' and 'B' journal, the 'B' journal focusing on informal education), identifying that young children interpreted the world they encountered in their own way; this they named 'Children's Science'. However, as the authors pointed out, these interpretations by young children are not misconceptions to them, but what they think. They are the explanations and ideas from the children making sense of what they have observed from what they know. Hence they may well not fit the understanding of accepted science, because these emergent scientists have not yet learned what scientists believe to be the explanations, but nevertheless are real to the children. Indeed, these authors identified that the next stage in learning the science knowledge that scientists and governments expect is found in school science, which may develop into an understanding of scientist's science. Of course, it may not. These first observations and hands-on experiences of children in the everyday world, which represent science in action, are critical to their future learning.

In this journal, we are very much concerned with children's science. We bear in mind that constructing meaning about the world is a social activity (Bruner, 1990) and meaning is heard through voices. We are not seeking to teach the children science facts, but instead are hoping that these emergent scientists, fascinated by their world and as intuitive scientists in their early years (Gopnik, 2009), will be encouraged to talk about it (if they have mastered language), but also think and investigate their observations, supported by an adult who will, when they ask *'Why?'* or *'I wonder what happens if…'*, encourage and follow up the child's interest.

The skill of the adults is to encourage talking whilst doing science activities in the early years, and to help in the development of language and observations, with accurate 'seeing' so that the child acquires a relevant vocabulary with which s/he can communicate their observations and findings. This leads to the emergence of the child as an intuitive scientist, with the role of the adult as essentially a facilitator. Learning science in the early years is thus collaboration between adult and child, with the facilitation and talking with the children as the most important part of a child's education, albeit that these early years are not considered to be formal schooling.

Expensive equipment is not needed to provide hands-on experiences in science in these essential early interactions. Items that are available in an ordinary home or other setting provide the necessary equipment, as do the everyday and varied environments that a child encounters.

The adults do not need to be formal science educators. All adults working with young children are science educators, because they are aware of the experiences and observations that are for the developing child to encounter. Talking about these, with the child asking questions, wondering 'what' and 'why', is a vital element in both the development of understanding and in communication and social skills. Without these early first encounters, children miss these crucial experiences, most important in their science learning.

Of course, when the child enters formal schooling, the education staff take on the facilitator role and this is supported by the adults in out-of-school settings with whom the child interacts.

In this, our tenth issue but a milestone in our new collaboration with PSTT, one contribution discusses briefly how research, particularly in biology in this case, can help teachers of all kinds to elicit the developing concepts of learners and build further interaction into these. This issue also reprints an invited editorial from the *American Biology Teacher*, which considers how important it is to build the curriculum upwards from the early observations of children, rather than simplify the scientist's science and, giving a simpler version of science, accept what they say but gently provide further explanation, if appropriate and in simple terms, so they can gradually piece together the 'bytes' of information into a bigger picture, aided by school and other sources, so building up to school science from the children's interpretation of their world. 'Floating and sinking' are popular topics in primary science. The paper from Tang Wee Teo and colleagues in Singapore considers aspects of the teaching and learning of this topic and describes how the implementation of a particular teaching sequence (POER) helped the children structure their learning of these complex ideas.

Several book reviews provide information on excellent resources available to teachers who would like to refresh their science knowledge and read about suggestions of how topics can be introduced to young children.

We look forward to carrying accounts of Action Research carried out by members of PSTT, in addition to research from academics in the future. The journal has shown the way for others working with young children and also demonstrates that research happens and informs. We hope that you enjoy this issue and urge you to consider submitting your own articles – full guidelines of how to submit follow this Editorial.

References

Bruner, J. (1990) *Acts of meaning*. Cambridge, MA: Harvard University Press

Gopnik, A. (2009) *The Philosophical Baby: What Children's Minds Tell us About Truth, Love and the Meaning of Life.* New York: Farrar, Straus and Giroux

Osborne, R.J., Bell, B.F. & Gilbert, J.K. (1983) 'Science teaching and children's views of the world', *European Journal of Science Education*, **5**, (1), 1–14. DOI 10.1080/0140528830050101

Science 5-15 Project: https://www.stem.org.uk/elibrary/collection/3157/science-513. Accessed 22/01/16

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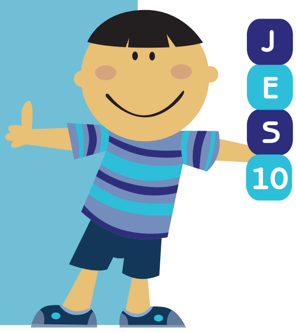


Contributing to the Journal of Emergent Science

About the journal

The *Journal of Emergent Science (JES)* was launched in early 2011 as a biannual e-journal, a joint venture between ASE and the Emergent Science Network and hosted on the ASE website. The first nine editions were co-ordinated by the founding editors, Jane Johnston and Sue Dale Tunnicliffe, and were the copyright of the Emergent Science Network. The journal filled an existing gap in the national and international market and complemented the ASE journal, *Primary Science*, in that it focused on research and the implications of research on practice and provision, reported on current research and provided reviews of research. From Edition 9 in 2015, *JES* became an 'open-access' e-journal and a new and stronger Editorial Board was established. From Edition 10, the copyright of *JES* has been transferred to ASE and the journal is now supported by the Primary Science Teaching Trust (PSTT).

Throughout the changes to *JES*, the focus and remit remain the same. *JES* focuses on science (including health, technology and engineering) for young children from birth to 11 years of age. The key features of the journal are that it:

- is child-centred;
- focuses on scientific development of children from birth to 8 years of age, considering the transitions from one stage to the next;
- contains easily accessible yet rigorous support for the development of professional skills;
- focuses on effective early years science practice and leadership;
- considers the implications of research into emergent science practice and provision;
- contains exemplars of good learning and development firmly based in good practice;
- supports analysis and evaluation of professional practice.

The Editorial Board

The Editorial Board of the journal is composed of ASE members and PSTT Fellows, including teachers and academics with national and international experience. Contributors should bear in mind that the readership is both national UK and international and also that they should consider the implications of their research on practice and provision in the early years.

Contributing to the journal

Please send all submissions to: janehanrott@ase.org.uk in electronic form.

Articles submitted to *JES* should not be under consideration by any other journal, or have been published elsewhere, although previously published research may be submitted having been rewritten to facilitate access by professionals in the early years and with clear implications of the research on policy, practice and provision.

Contributions can be of two main types; full length papers of up to 5,000 words in length and shorter reports of work in progress or completed research of up to 2,500 words. In addition, the journal will review book and resources on early years science.

Guidelines on written style

Contributions should be written in a clear, straightforward style, accessible to professionals and avoiding acronyms and technical jargon wherever possible and with no footnotes. The contributions should be presented as a word document (not a pdf) with double spacing and with 2cm margins.

- The first page should include the name(s) of author(s), postal and e-mail address for contact.
- Page 2 should comprise of a 150-word abstract and up to five keywords.
- Names and affiliations should not be included on any page other than page 1 to facilitate anonymous refereeing.
- Tables, figures and artwork should be included in the text but should be clearly captioned/ labelled/ numbered.
- Illustrations should be clear, high definition jpeg in format.
- UK and not USA spelling is used i.e. colour not color; behaviour not behavior; programme not program; centre not center; analyse not analyze, etc.
- Single 'quotes' are used for quotations.
- Abbreviations and acronyms should be avoided. Where acronyms are used they should be spelled out the first time they are introduced in text or references. Thereafter the acronym can be used if appropriate.
- Children's ages should be used and not only grades or years of schooling to promote international understanding.
- References should be cited in the text first alphabetically, then by date, thus: (Vygotsky, 1962) and listed in alphabetical order in the reference section at the end of the paper. Authors should follow APA style (Author-date). If there are three, four or five authors, the first name and *et al* can be used. In the reference list all references should be set out in alphabetical order

Guidance on referencing Book

Book

Piaget, J. (1929) *The Child's Conception of the World.* New York: Harcourt

Vygotsky, L. (1962) *Thought and Language.* Cambridge. MA: MIT Press

Chapter in book

Piaget, J. (1976) 'Mastery Play'. In Bruner, J., Jolly, A. & Sylva, K. (Eds) *Play – Its role in Development and Evolution*. Middlesex: Penguin. pp 166-171

Journal article

Reiss, M. & Tunnicliffe, S.D. (2002) 'An International Study of Young People's Drawings of What is Inside Themselves', *Journal of Biological Education*, **36**, (2), 58–64

Reviewing process

Manuscripts are sent for blind peer-review to two members of the Editorial Board and/or guest reviewers. The review process generally requires three months. The receipt of submitted manuscripts will be acknowledged. Papers will then be passed onto one of the Editors, from whom a decision and reviewers' comments will be received when the peer-review has been completed.

Books for review

These should be addressed and sent to Jane Hanrott (JES), ASE, College Lane, Hatfield, Herts., AL10 9AA.

WANTED

Editor(s) for the Journal of Emergent Science (JES)

In 2015, the Co-Founders of JES, Jane Johnston and Sue Dale Tunnicliffe, stood down from the positions of Co-Editors after steering the journal from inception through to issue 9, and from a 'niche' subscription journal to an open access forum for all those interested in Early Years science. The journal is published twice a year.

Sue is remaining as Commissioning Editor, and we are looking for one, or possibly two, Content Editors for issue 11 (Summer 2016) onwards.

The Editor is responsible for the content and quality of the journal, and for ensuring that it covers a suitable range of subjects and interests. S/he is supported in the role by an Executive Editor and an Editorial/reviewing Board.

Editorial tasks include:

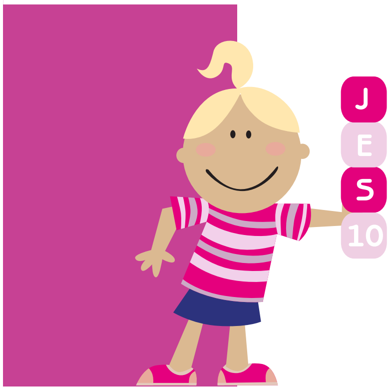
* skim reading articles and allocating reviewer(s) to each;
* moderating and mediating reviewers' comments for authors;
* editing articles, including rewriting and advice/guidance;
* responding, along with the Executive Editor, to queries from authors;
* requesting/commissioning articles (along with the Commissioning Editor);
* overseeing the content of each issue and providing an Editorial and news items;
* maintenance and recruitment of Editorial Board members; and
* liaising with the ASE Journals Co-ordinator and ASE Publications Specialist Group.

Thanks to support from the Primary Science Teaching Trust (PSTT), there is a small honorarium attached to this position, to be shared in the case of co-editorship.

For full details, please contact Jane Hanrott (ASE Journals Co-ordinator) at:

janehanrott@ase.org.uk, by 31st March 2016

The Association for Science Education
Promoting Excellence in Science Teaching and Learning



News from the Primary Science Teaching Trust (PSTT)

New Primary Science Teacher College Directors appointed

Our current Primary Science Teacher College Director, Kathy Schofield, will be stepping down in Autumn 2016 to spend more time with her family. She will still be an active Fellow of our College, which we are delighted about. However, the scope and activity of the Primary Science Teacher College has grown so rapidly that the Trust has decided that two new roles are needed to support the College, **Programme Director** and **Academic Director.** These roles expand significantly the remit of the College Director. Therefore, we are delighted to announce that **Alison Eley** will become **Academic Director** and **Sue Martin Programme Director,** both effective from August 2016.

The PSTT International Primary Science Conference 2016
9th - 11th June 2016
Belfast Waterfront, Belfast, BT1 3WH

The Primary Science Teaching Trust (PSTT) will celebrate excellence in the teaching and learning of primary science across the world with its inaugural International Primary Science Conference in the cultural city of Belfast.

The three-day programme will feature inspirational speakers, including Professor Alice Roberts, Dr. Stuart Brown, Professor Danielle George and Dr. Maggie Aderin-Pocock, a wide range of workshops led by outstanding educators, and showcases of the best primary science there is on offer from across the world. The Conference will provide opportunities to meet colleagues and establish contacts, with time to share and discuss exciting ideas to use in your own practice.

The Primary Science Teaching Trust is determined that there should be no barriers to every child receiving an outstanding education in primary science, and is committed to its vision that teachers are the key to making this happen. Through crossing boundaries between the classroom and academia, between policy and practice, and between one nation and another,
this Conference will empower us all to achieve this.

For more information please visit:
www.primaryscienceconference.org/

There will be a special issue of JES celebrating this Conference in Winter 2016/17.

For further information about the work of PSTT, please visit www.pstt.org.uk

Primary Science Teaching Trust
INTERNATIONAL CONFERENCE 2016
NO BOUNDARIES. NO BARRIERS.

Primary Science Teacher Awards (PSTAs) 2014

These Awards, sponsored by PSTT, have been running since 2003, with up to 25 teachers being awarded every year. One award, the Keith Bishop Award, is a special one that recognises the achievements of a teacher working in challenging circumstances.

Recipients are awarded two monetary prizes of £500 for their schools and £1,000 for personal use and they also receive a set of science resources from TTS. The teachers' achievements are celebrated at an awards ceremony at which family, friends and colleagues gather together to watch their friends and loved ones be recognised for their outstanding achievements. The importance of recognising talented teachers has not gone unnoticed and the awards are now endorsed by five Learned Societies: The Royal Society of Chemistry, The Royal Meteorological Society, The Royal Society of Biology, The Geological Society and The Institute of Physics. The Comino Foundation, SHINE Trust, Ogden Trust and National Science Learning Network have also recently joined as endorsers of the PSTAs.

The 2014 recipients of the Awards are:

Eleanor Atkinson (Keith Bishop Award)
Westmorland School, Chorley
Ellie has written bespoke, engaging STEM workshops to enthuse and inspire the students of Bolton and to train primary and secondary teachers on new and innovative teaching and assessment methods. Ellie inspires and support staff in her school, with the positive impact she has had on science teaching and learning clearly evident.

Arlene Bannerman
Knowepark Primary School, Selkirk
Arlene has raised the profile of science within the school and the community. Arlene is a SSERC (Scottish Schools Education Research Centre) school mentor and a coach for a local cluster of schools. Teachers are supported and happy to ask her for help in delivering science.

Jon Beattie
Glencraig Integrated Primary School, Holywood, Co. Down
Jon's many exciting initiatives include teaching about Victorian engineers and then using materials to make bridges with both his class and as a whole school. Over the past four years, Jon's students have been looking at a project on sterilising water with UV in sunlight (solar disinfection) and findings, drawings and photographs of the project were sent to their partner school in Uganda.

Jodie Blincow (Royal Meteorological Society)
St. Mun's Primary School, Dunoon
This school was awarded the prestigious Rolls-Royce Science Prize Eden Award in November 2014. The success of the project caused a noticeable 'buzz' around the school, which was due in no small measure to the hard work and commitment shown by Jodie and the way everyone embraced the project.

Louise Bousfield
Bradshaw Hall Primary School, Cheadle, Stockport
Louise has run several INSET days for all staff on developing child-led investigations based on children's questioning. Louise now leads a cluster of primary schools, and is very much changing the teaching ethos of the whole school to a child-led enquiry-based one, not only in science but also in other subjects.

Beth Budden (Royal Society of Biology)
John Ball Primary School, Lewisham, London
Beth maintains a blog about science, assessment, teaching and learning, and supports numerous teachers. Now undertaking a Masters' in primary science, she keeps colleagues up-to-date with research findings and national developments in teaching. Beth led the school through PSQM (Gold) in 2014, the first school in Lewisham to gain this award, and won a Royal Society Partnership Grant.

Janine Carpenter (Ogden Trust)
Ellison Primary School, Newcastle-under-Lyme
Janine is able to influence and encourage peers to take risks and try new approaches. Janine shares her work with the local primary science consortium. Staff have enormous respect for the work that Janine has put into the subject, and are happy and enjoy teaching science.

Gail Eagar (Comino Foundation)
Barton Primary School, Isle of Wight
Gail joined Barton Primary School in September 2014 and has restructured the science curriculum, introduced science displays around the school and encouraged the use of floor books, which showed exceptional use of science language. She has built up a science library and excellent science resources, e.g. 'Science in School', 'Science at Home' and a 'Science Challenge'.

Dr. Craig Early (Science Learning Network)
Tower Road Academy, Boston, Lincolnshire
Craig delivers INSET through the Science Learning Network, has published articles in ASE's *Primary Science* and written science materials for BBC *Bitesize*. He has developed a science resources area for practical science using recycled materials and there is a science question box and science display in every classroom (and throughout the corridors).

Jo Fenton (Institute of Physics)
Orchard Junior School, Dibden Purlieu, Hampshire
Previously, the children in Jo's school were following a very prescriptive curriculum, with structured, closed investigations, and Jo's innovations made the science 'real' to the children. She arranged trips, organised 'Meet the Scientist' sessions and involved professional scientists from a range of fields to show children how their knowledge can be applied in real life.

Sue Fielding (Geological Society)
Pinfold Primary School, Scarisbrick, Lancashire
Some of Sue's activities have become routine parts of school life, while others have been highlights of the year. She has strong links with the University of Liverpool, often using their STEM Ambassadors. The school has won a 2013 Rolls Royce Award – the Eden Award given for the best ecology project.

Jo Jarvie (SHINE Trust)
Thornton Primary School, Fife
Joanne is a Cluster Mentor for the SSERC (Scottish Schools Education Research Centre) Primary Cluster Programme in Science & Technology and, along with other mentors, organises CPD to help raise levels of engagement in science and technology within the cluster. Joanne is also the Edina Trust Consultant for Fife.

Ashleigh Longhurst (Royal Society of Chemistry)
Culcrow Primary School, near Coleraine, Northern Ireland
Ashleigh was an NQT in 2012 and has stimulated the whole school to embrace science and to teach science in context to engage children. The pupils view themselves as young scientists who investigate, evaluate, estimate and problem-solve, whilst learning the core elements of the science curriculum in a fun and engaging manner.

Dr. Ruth Smith
East Cowton CE Primary School, Northallerton, North Yorkshire
Ruth has a chemistry degree and a PhD and was the Headteacher of this very small rural school. Ruth led and taught science throughout the school. Ruth has good links with the local secondary school and, through an Enthuse Award, offered CPD in science to the Northallerton cluster of primary schools.

Aine Toal
St. Patrick's Primary School, Mullanaskea, near Enniskillen, Northern Ireland
Aine allows children's voices be heard and they have a strong scientific vocabulary. She encourages children to become independent thinkers and learners; they respond well to effective questioning strategies and are not afraid to take risks. They value the notion that they are all scientists, continually developing their scientific skills.

Dr. Alison Trew
St. Mary's Catholic Primary School, Axminster, Devon
Alison is an outstanding scientist (with a PhD in Biochemistry) whose lessons are well planned, allowing children to explore, make their own hypotheses and to test them out. Grasping difficult concepts in science is impressive, but the ability to explain these concepts in a clear and concise way to all learners is more so.

Tracy Tyrrell
Irchester Primary School (Lab 13), Northampton
Tracy's school achieved PSQM (Gold) and she has excellent links with local secondary schools, works with NQTs and delivers science INSET to other primary schools in the area. Secondary school science teachers report that pupils entering from Tracy's school show greater subject knowledge and have more developed practical skills than their peers.

Kathy Schofield (Comino Foundation)
PSTT Primary Teacher College Director, PSTA winner 2004
Kathy won her PSTA in 2004, but endorsement from the Comino Foundation was well deserved. As the inaugural PSTT College Director, she has excelled. Her vision, energy and pastoral care of the Fellows has been exemplary and her own contributions to innovations within the College are noteworthy.

Primary Science Teacher Awards 2016

We are pleased to announce that nomination forms are now available for the 2016 round of Primary Science Teacher Awards. If you know an outstanding teacher in primary science, please consider nominating him or her for this prestigious award.

For further details and to download the nomination form, please click:
www.pstt.org.uk/primary-science-teaching/primary-science-teacher-awards.aspx

The deadline for nominations is 22nd July 2016.

For further information about the work of PSTT, please visit www.pstt.org.uk

Primary Science Teacher Award Winners 2014

Using Prediction-Observation-Explanation-Revision to structure young children's learning about floating and sinking

■ Tang Wee Teo ■ Yaw Kai Yan ■ Mei Ting Goh

Abstract
In this article, we describe how prediction-observation-explanation-revision (POER) was adopted as a teaching strategy to structure Grade 2 (aged 8) children's learning about floating and sinking. The researchers presented the children with spherical objects of different materials, colours, sizes and mass. After holding and manipulating the objects, the children predicted whether each object would float or sink. They labelled their predictions on a whiteboard to show the relative positions of the objects when dropped into water. The children then dropped the objects into water and observed whether the objects floated or sank. They explained their observations and revised their answers. This POER strategy helped to structure children's learning about the complex ideas of floating and sinking. Notably, POER was observed to be a versatile teaching strategy, as the sequence of P-O-E-R could change, and 'E' for 'explanation' could be substituted with 'evaluation'. Allowing other children's POER statements to be interjected will also help to enrich the overall POER discourse.

Keywords
prediction-observation-explanation-revision (POER), structure, young children, float, sink

Introduction
This article describes a study that adopted prediction-observation-explanation-revision (POER) as a teaching strategy to enact an activity on floating and sinking for Grade 2 (aged 7-8) Singaporean students who have not formally learned science in school. In Singapore, children begin formal science education at Grade 3 (aged 9) and are assessed on the subject from Grade 3 onwards. The Ministry of Education writes the syllabus and the topics are divided into four themes: *diversity*, *cycles*, *interactions* and *energy.* At the end of Grade 6 (aged 12), the children will take the national examination in science, along with other subjects – English, Mother Tongue, and Mathematics (Tan, Teo & Poon, in press; Poon, 2014). The concepts of floating and sinking are included in the Grade 3-4 (aged 9-10) science syllabus under the theme of *diversity* (some materials can float in water, while others sink), but students are not expected to understand the concept of density or the principle of flotation.

This article aims to illustrate how POER can be engaged as a teaching strategy to structure the discourse and children's learning of the ideas of floating and sinking. Although the concepts of floating and sinking surround children's everyday lives, these concepts are not easy to grasp, because they involve other complex science concepts including density, displacement and surface tension. Children construct different explanations for why things float or sink and attribute the observations to different factors, such as the size or length of the object, depth of the water level, size of the tub and the amount of water displaced (Biddulph & Osborne, 1984; Bulunuz, 2013; Havu-Nuutinen, 2005). In Dentici, Borghi, Ambrosis and Massara's (1984) study with Grade 1 (aged 7) and 2 students, more children provided answers based on only one relevant variable, such as weight, material or buoyancy, rather than integrated variables. This suggests that children may have difficulty putting together different variables required to predict and explain why objects float or sink.

Children may experience difficulty in learning the ideas of floating and sinking due to their limited language ability. In Siry, Ziegler and Max's (2012) study of 5 and 6 year-old children in Luxembourg, they observed children using lifeworld languages (Gee, 2004) such as 'swimming' to describe a plastic bowl floating in a tub of water. Biddulph and Osborne (1984) also found that children do not have a good idea of the meaning of floating and sinking and are thus confused if an object is partly immersed in water.

The approach in which the same task is presented to children will affect their learning of the science concepts (Andersson & Gullberg, 2004; Hardy, Jonen, Möller & Stern, 2006; Kloos, Fisher & van Orden, 2010). Andersson and Gullberg's study of pre-school children engaging in a floating-sinking experiment showed that, when the epistemological goal of the science teaching of pre-school children was the development of their conceptual understanding, the children's misconception of density was reinforced. This contrasted with the epistemological approach that valued participation and inclusivity, which generated positive experiences for children in learning about density.

In our work, we adopted the POER teaching strategy to structure young children's learning of the ideas of floating and sinking. The revision component was added to the POE (prediction-observation-explanation) strategy devised by White and Gunstone (1992). Accordingly, we discuss the literature on POE and then describe the activity around floating and sinking that we designed for the Grade 2 students, which included the element of revision.

Prediction-Observation-Explanation (POE)

POE (Kearney, Treagust, Yeo & Zadnik, 2001; Palmer, 1995; White & Gunstone, 1992) is a student-centred teaching strategy used to engage learners in making predictions, justify why they think something will happen, test their predictions experimentally, make observations, and then explain any differences between what they predicted and observed. This strategy, aligned to the constructivist nature of learning, values and uses the prior knowledge and experiences students bring into the learning context when making predictions (Driver & Easley, 1978; Duit & Treagust, 1998; Oh & Yager, 2001). Additionally, learners actively construct knowledge to support the justification for the predictions. Their observations are influenced by their prior knowledge, assumptions, theories and biases. In deriving explanations to account for the predictions and observations, learners interpret their observations, make modifications of their predictions based upon the reality and construct new knowledge. They may engage in this process individually, or socially to negotiate and co-construct ideas with others (Driver, Asoko, Leach, Mortimer & Scott, 1994).

POE can also be used to probe students' conceptions (White & Gunstone, 1992), and it can be more effective at eliciting students' understanding as compared to the more common approach of presenting students with an event and asking them to explain their observations. In the latter case, students are likely to suggest an answer without considering what they have learnt previously.

POE strategy can be applied to the development of concepts in early childhood education. Hsu, Tsai and Liang (2011) examined the concept acquisition and alternative conceptions of pre-schoolers about the concepts of light and shadow. In their study, they compared the effect of the use of a computer game incorporating POE (experimental group) to that of a computer game without POE (control group). They found that, although children in the experimental and control groups retained certain alternative conceptions after playing the computer game, the experimental group improved in their conceptions as compared to the control group. This study shows the benefits of using POE to identify alternative conceptions and facilitate concept acquisition in pre-schoolers. This study also shows that the POE strategy need not be accompanied by empirical enquiry.

As with any teaching strategy, POE must be conducted with proper planning and care in order for it to be effective. Students have to be provided with information on the event, otherwise they are more likely to suggest multiple predictions without proper substantiation (White & Gunstone, 1992). Additionally, it is possible for initial thoughts and predictions to distort one's observations. For example, in White and Gunstone's (1992) study, they conducted a demonstration using a pulley with a block of wood and a bucket of sand hung on opposite sides. The participants were asked to predict what would happen when a small amount of sand is added to the bucket. Many participants who predicted that there would be a small movement reported seeing it happen, although most of the other participants saw no movement at all. The finding is coherent with the nature of science literature, which informs us about the theory-ladenness of observation (Brewer & Lambert, 2001).

In our work, we extended POE such that children *revised* their predictions after explaining what they observed. The aim was to increase the richness of the children's discourse and elicit their ideas of floating and sinking. This additional step provided them with the opportunity to refer back to their original answers and make changes when needed. In the next section, we explain the POER activity design and procedures.

Activity design and procedures

The researchers designed, planned and wrote eight science activities, and the activity plans were shared with the Head of Department (Science) and the teachers of the participating children. Based on the teachers' knowledge about the students and the science syllabus for Grade 3-6 students, they selected four activities, one of which was on the topic of floating and sinking. The teachers and researchers were aware of the complexity of the concepts of floating and sinking, but agreed that the focus would be on understanding how POER provided the structure for students' learning.

The floating-sinking activity began with a teacher (researcher)-guided section that made use of the POER strategy. Next, the children observed that a piece of plasticine would always sink no matter how small the size. Then, we challenged the students to explore ways to mould a piece of plasticine such that it could float and carry the most number of paper clips.

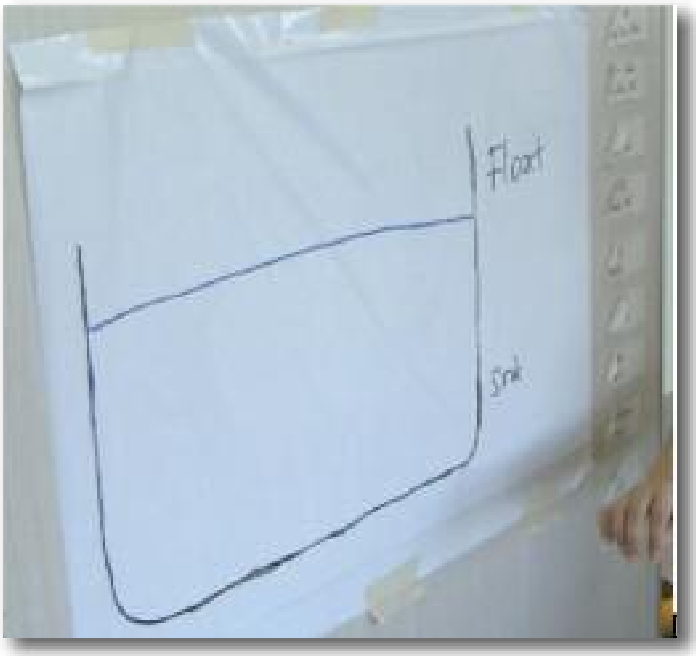


Figure 1: A sketch of a tub of water on the whiteboard. (The row of stickers on the right contained the names of the objects (e.g. white ping-pong ball, yellow ping-pong ball and wooden ball) given to the children).

This article describes only the teacher (researcher)-guided POER portion of the activity, which was organised into five stages. In Stage 1, we began the activity with an opening question *'What is the meaning of "float" and "sink"?'* to elicit the children's prior knowledge of the two ideas. To engage with the children's personal experience, we asked them if they had the experience of swimming or watching objects float or sink. In Stage 2, the teachers brought out two ping-pong balls, one white and one yellow. The children were asked to identify the similarities and differences between the objects. The children took turns to pass the objects around so that they had a chance to touch them. In Stage 3, the children's predictions were elicited by asking them questions such as *'Do you think the object will float or sink?'* and *'How deep would it go?'*. Then the children were invited to paste labelled stickers on the whiteboard showing a drawing of a tub of water to indicate the position of the objects when dropped into the water. The children were prompted to explain their prediction by asking questions such as *'Why do you think the object will be at this level in the water?'* and *'Why do you think it would float / sink?'*. In Stage 4, the children dropped the objects into a tub of water and observed the positions. The children were asked questions such as '*Is your prediction correct?*' and '*Why or why not?*'. In Stage 5, the teacher invited the children to revise their answers (if needed), using red labels to show the observed position of the object in water.

Stages 2-5 were repeated for each set of objects given to the children. These objects were given out in the following order: (a) white and yellow ping-pong balls, (b) lighter and heavier white ping-pong balls, (c) big and small rubber balls, (d) big and small glass marbles, (e) wooden, Styrofoam and sponge balls, and (f) an orange. The objects in each set varied only in one aspect (e.g. colour, mass or size) to reduce the number of factors that needed to be considered in predicting floating and sinking.

Research context

Participants

This article reports on a group of five Grade 2 children (aged 7-8) from a Singapore elementary school that participated in a larger study on early childhood science education. The children were from the same form class. They were selected by their teacher to attend science lessons as an enrichment programme outside formal curriculum time.

Context

The school was located in the southwestern part of Singapore. It was a typical co-educational public school attended by students from average socioeconomic backgrounds. The student demographics were similar to the Singapore racial composition comprising of Chinese as the majority and other races including Indians and Malays.

Data collection and analysis

The entire science activity was video-recorded and audio-recorded to capture all interactions. Photographs of the whiteboard were taken to capture the children's predictions and revised answers. The videos were analysed using software called HyperResearch™ to code for evidence of POER. Among the coded video excerpts, we selected the ones that showed POER for illustration and discussion below.

Excerpt 1: White and yellow ping-pong balls

The children took turns to hold the ping-pong balls. The teacher referred the children to the whiteboard with a sketch of a tub of water (see Figure 1) and asked for their predictions of the positions of the ping-pong balls in water.

Teacher:	Where do you think these [ping-pong balls] will be?	Eliciting prediction
Children:	[Chorus] Floats.	Predicting
Teacher:	All of you think they will float. Float where? Here, here, here, here, here? [pointing to the different water levels]	
Jialing:	Between the line.	Predicting
Kelly:	Between the line.	Predicting
Teacher:	Somewhere here? [circling her hand around the water surface] [Dhupa was invited to place the stickers on the whiteboard to show his prediction (see Figure 2)]	

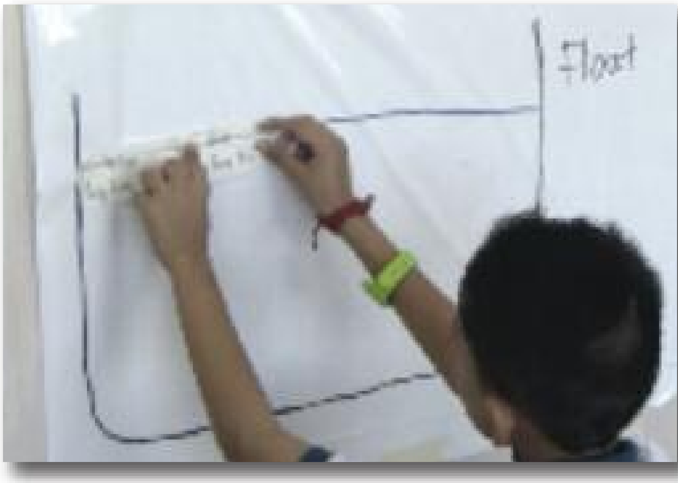


Figure 2: Dhupa pasting the beige stickers to show his predictions of the positions of the white and yellow ping-pong balls.

Thank you, Dhupa.
Dhupa thinks it would be along this line, but Zhen Zhen [shaking her head] seems to disagree.

Children:	[Chorus] Yes.	
Teacher:	You all seem to disagree. Why?	
Fiona:	Because it should be in the middle.	
Kelly:	I think the bottom should be less in the water.	
Teacher:	Is that what you are thinking about, Zhen Zhen? [Zhen Zhen nods her head.] Fiona also thinks that these [stickers] should go up a little bit more? Jialing, what about you?	
Jialing:	I didn't say I agree or disagree. I don't know. See the test.	
Teacher:	Okay. Dhupa is going to put the ping-pong ball into water and we are going to observe (see Figure 3).	Observing

Figure 3: Dhupa placing the ping-pong balls gently on water.

Children:	Yes. Yay!	Evaluating
Teacher:	We're going to make a correction. The red stickers show what we actually observed. So, Dhupa, where should this be? [Dhupa gets up from his seat and walks to the whiteboard to stick on the red sticker. As he is about the stick on the red sticker (see Figure 4), three children shout out.]	Revising

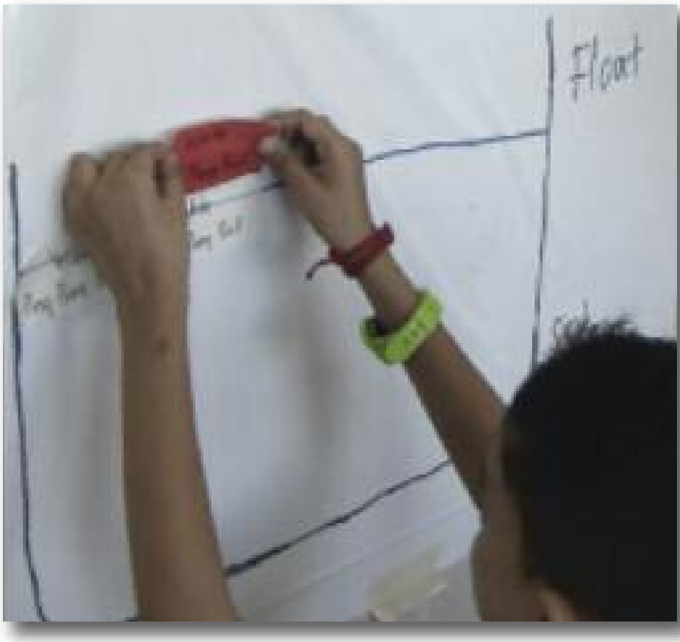


Figure 4: Dhupa sticking on the red sticker for 'white ping-pong' above the line.

Jialing, Fiona, and Kelly:	No!	Evaluating
Teacher:	Why no?	
Jialing:	It's floating in the air. [Dhupa shifts the stickers to position them on the line.]	Evaluating Revising

The teacher first elicited the children's predictions on whether the white and yellow ping-pong balls would float or sink. The children did not agree on the same prediction. To ensure that every child's views were valued, the teacher had the children take turns. Dhupa, who was seated on the left of the teacher, was nominated by her to indicate his prediction on the whiteboard using the labelled beige stickers. However, three other children voiced out their disagreement and felt that the sticker should be higher above the line as the ping-pong balls would only rest lightly on water. Jialing did not make a prediction, claiming that she did not know the answer, and suggested carrying out the test to confirm Dhupa's prediction. The children were elated when they observed that they were more accurate in their prediction than Dhupa. Dhupa revised his prediction, using the red sticker to indicate the observed position of the ping-pong balls. However, the children disagreed with his revision. He took on their suggestions and revised his answers again.

Three things could be noted from this excerpt: Firstly, the children did not provide any explanations of their observations, possibly because it was not emphasised that they had to substantiate their assertions with justifications. This suggests that it may be necessary for the teacher to teach the skill before engaging in the POE activity.

Secondly, the children disagreed with Dhupa's predictions, which could be interpreted as an indirect form of evaluation. In this case, 'E' for 'explanation' was replaced by peer 'evaluation'. Similar to our previous point, we acknowledge that the children's evaluation often lacked justification, as the requirement was not always emphasised or they had not acquired the skill. This episode also illuminated the social constructivist nature of learning, as Dhupa accepted the other children's suggestions and modified his own answer.

Thirdly, POER did not stop after Dhupa revised his answers. When the other children evaluated Dhupa's 'correction', he revised his answers a second time. Hence, POERER rather than POER was enacted. This illuminated the evolving nature of POE and, hence, it should be engaged flexibly to bring about rich learning experiences.

Excerpt 2: Big and small marbles

The children were presented with two glass marbles of different sizes after they have compared the white and the yellow ping-pong balls, heavy and light ping-pong balls, and big and small rubber balls.

Teacher:	Okay. So, let's guess. How far would these [big marble and small marble] go?	Eliciting prediction
Kelly: and Zhen Zhen:	It will sink.	Predicting
Teacher:	Sink. All the way down?	
Kelly:	Float a bit; sink a bit.	Predicting
Teacher:	Jialing, what do you think?	
Jialing:	Erm, maybe about the rubber ball; up a little bit [float higher than the rubber ball].	Predicting
	[Jialing walks to the board to paste the beige stickers to indicate where she thinks the marbles will be (see Figure 5)]	Predicting

Figure 5: Jialing pasting the beige sticker at where she predicted the small marble would be in water.

Teacher:	Okay. So, Jialing, why do you think that the marbles will still float?	
Jialing:	Since the rubber ball is so heavy but it still floats, so maybe this marble will maybe float.	Explaining
Teacher:	Okay.	
Kelly:	But I thought this one [pointed to big marble] is heavier than that.	Evaluating
Teacher:	Which one is heavier? Feel it, feel it. [Jialing holds the rubber ball and the big marble.]	

Jialing:	This [marble].	
Teacher:	Which one?	
Jialing:	Oh, it [marble] will sink.	Revising, Prediction
Kelly:	It [marble] will sink, it will sink, it will sink, it will sink.	Predicting
Teacher:	Okay, now, now you are saying that this [marble] one will sink. You [Kelly] think it [marble] will sink?	
Other children:	[Chorus] Sink.	Predicting
Teacher:	So, Jialing, you want to change your mind? [Jialing walks to the board.] Really? You want to change your mind?	
Other children:	[Chorus] Sink! Sink! Sink!	Predicting
Jialing:	Over here? [Jialing moves the beige stickers (see Figure 6)]	Revising, Prediction

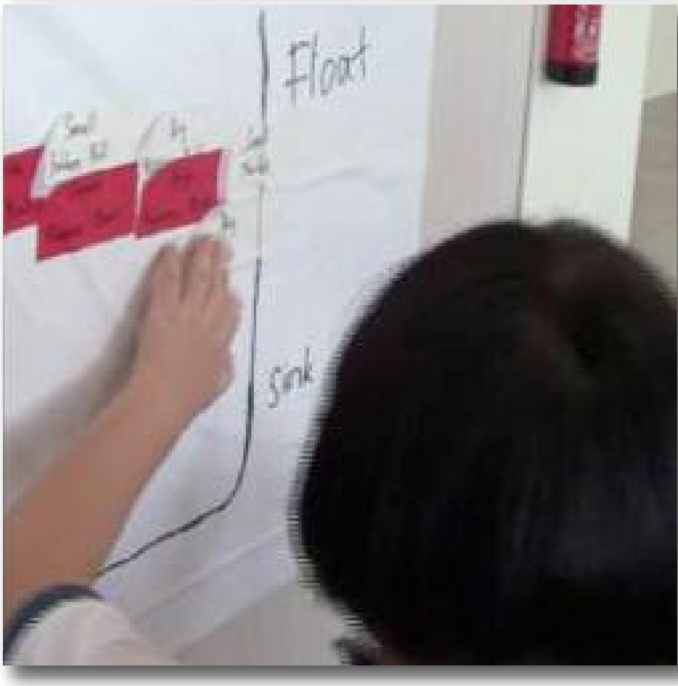


Figure 6: Jialing shifted the beige sticker for the big marble.

Teacher:	Do you all agree?	
Other children:	Yes.	
Teacher	Here? Here? [Points at where Jialing pasted.] [...] [Jialing drops the small marble into water.]	
Children:	[Chorus] Wah!	Observing

Teacher:	So what do you think will happen to this one [big marble]?	
Kelly:	Erm, it will sink?	
Fiona:	Sink.	Predicting
Teacher:	Sink? To the same extent? [Jialing drops the big marble into the water.]	
Children:	[Chorus] Yah!	Observing
Jialing:	Drop on the floor [bottom of the tub].	Observing
Teacher:	Why, why do you think, why do you think it sinks all the way down?	
Jialing:	It's made of glass.	Explaining
Teacher:	Made of glass? So what if it's made of glass?	
Jialing:	Because the glass maybe is heavier than all the other stuff.	Explaining
Teacher:	So, where is it? Where is it? [Referring to the whiteboard.] [Jialing walks to the whiteboard and uses the red stickers to show her corrections (see Figure 7).]	

Figure 7: Jialing pasting the red stickers at where she observed the marbles to be.

Revising prediction

The teacher started by eliciting the prediction for the big and small marbles. Kelly thought the marbles would float a bit and Jialing said they should float more than the rubber balls, which they had tested earlier. When it was Jialing's turn to predict, she pasted the beige stickers at where she thought the big and small marbles would be in the water, near the surface of the water. When asked to explain why she thought so, she used what she observed in the previous set of objects, and made reference to the rubber ball. Here, we see how a child had used her prior experience to make a prediction. Additionally, we saw how Jialing's conception had changed, as previously, like the other children, she had the idea that heavy objects would sink, but now she argued that even a heavy rubber ball could float.

However, Kelly, who argued that the rubber balls were heavier, challenged Jialing's idea. Hence, the teacher encouraged them to hold the objects again. In making comparison with the rubber balls, which were larger in size and made of different material than the marbles, the children found it difficult to make their prediction. It is noteworthy how, after Kelly raised her point, Jialing took it into consideration and revised her own prediction. This episode was similar to that described in Excerpt 1, where Dhupa revised his answers after being challenged by other children, thus illuminating the social constructivist nature of the POER activity.

The children then observed that the small marble sank in water. Based upon their observations, they revised their prediction for the big marble. Jialing then dropped the big marble into the water. When asked by the teacher, Jialing went on to explain that the big marble sank because it was made of glass and, hence, heavier than other objects. It was interesting to note that she had earlier justified her prediction based on her feeling of how heavy the object was. After the test and observation, the type of material was used to justify the observation. This illuminates the richness of the thinking and discourse as POER progressed.

Excerpt 2 showed more variation in the sequence of POER than Excerpt 1, in two ways. Firstly, POER was interjected with more elements; for example, when Jialing explained her prediction before carrying out the test, she revised her prediction after her peers challenged it. Hence, if we tracked through Jialing's sequence, she was predicting, followed by explaining the prediction, revising the prediction, observing, explaining and, finally, revising (PEROER). Secondly, her POER sequence became richer because of her interaction with the other children. This was able to happen because the teacher allowed other children's voices to be heard and she encouraged them to do peer evaluation. This reflects the benefits of adopting the constructivist approach to learning.

In this episode, the children had experienced the processes of science and engaged several science process skills, including making predictions, observations, explanations and evaluations. Through this process, they experienced the nature of scientific discoveries, i.e. discoveries begin with initial ideas about a phenomenon and these ideas can be subject to change (Abd-El-Khalick, 2012). It is noteworthy that, as the activity progressed, some of the children (Jialing and Kelly) demonstrated the ability to use the knowledge gained from the earlier part of the activity (Excerpt 1) to inform their predictions and explanations in the later part (Excerpt 2). This process of building on prior knowledge also mirrors that of scientific discovery. Based on this observation, we propose that it is advantageous to incorporate several POER cycles into an activity to provide students with the opportunity to participate in knowledge building.

As mentioned earlier, the concepts of floating and sinking are not easy to grasp and we set out only to understand how POER could structure children's learning of the two ideas. The activity described in this paper provided the students with a starting point to think about the factors determining whether an object would float or sink. At the higher grade levels, the same activity may be extended to introduce the concepts of density, buoyancy and other scientific concepts related to the phenomena of floating and sinking. For example, the children could be presented with a bar of plasticine and asked to predict, with reasons, whether it would float or sink. The children would then observe that a bar of plasticine sinks when placed into the water. If their prediction differs from the observation made, they could be asked to suggest explanations for the difference. Children could then be introduced to the idea that the plasticine can float if it is moulded into an appropriate shape. They could be challenged to make a piece of plasticine float by moulding it into different shapes, and testing and refining the shapes. Finally, they could be asked to explain why certain shapes float better than others. Hence, POER affords a platform for extended learning experiences to be built on for the children's learning of science across different grade levels. Future studies may investigate how the POER strategy could be enacted with students in different age groups.

Conclusion

This article describes how POER was used as a strategy to scaffold a group of Grade 2 students' learning of the ideas of floating and sinking. The study offers an example of how POER, when engaged in a versatile manner by teachers that allows for children to voice their multiple viewpoints, can promote children's active participation in rich discourse. Specifically, the versatility can stem from allowing: (1) evaluation to replace explanation; (2) changing the sequencing of P-O-E-R; (3) individual P, O, E, and/or R to be interjected into POER; and (4) overlayering of POER from several students to enrich the discourse.

Acknowledgements

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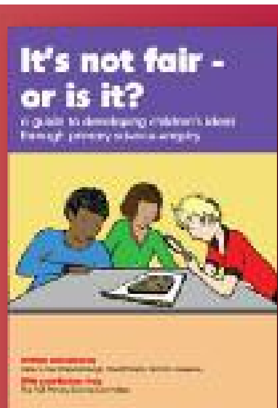

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Biology education research with early years children

Sue Dale Tunnicliffe

Children form their understandings of their everyday world from birth; they acquire their view of the world, which forms their original understanding of science (referred to by Osborne, Bell and Gilbert, 1983, as 'children's science'). These are their ideas, or alternative conceptions (not misconceptions) to those that are considered the conceptions of school science, and later scientist's science – these they learn through school. Hence it is important for science educators to find out just what the children notice, and their explanations of phenomena, in their early years and plan the interventions of parents, carers, early years workers and teachers accordingly, building on such understanding.

Most research in biology education has been with older primary and secondary children, although some studies have listened to and analysed conversations of young children. For example, research by Tunnicliffe (1996), Tunnicliffe, Lucas and Osborne (1997) and Tunnicliffe and Scheersoi (2010) seeks to inform educators of the early biological knowledge development of young children, as well as explain to those working with older children how concepts are constructed from fundamental observations and what sense young children make of the living world. Young children are intuitive scientists (e.g. Gopnik, 2009), asking questions, seeking patterns, hypothesising and experimenting.

Children can be observed at play and going about everyday tasks, and field notes taken can be interpreted. Videos of these can be analysed to note actions, but there are other techniques that can be employed to try to elicit the knowledge and understandings of young children and their emergent science.

One such technique is 'listening in' whilst children are generating spontaneous conversations and actions, such as when they look at animals and plants, or perform an action of their choice in 'free play' that has a natural history context, or during a prescribed task such as looking at leaves brought into a room. Children may be with other children or/and with adults or carers at out-of-classroom sites: a garden or park, botanical gardens, zoo, museum or farm, or on a walk. Conversations with learning objectives may be with teachers or teaching assistants in 'school' while, for example, looking at flowers, a tree or feeding birds. The conversations heard can be recorded through writing contemporaneously or transcription afterwards. Various techniques for analysis of content and meaning can be employed, which reveal the content of the dialogues recorded (Patrick & Tunnicliffe, 2013).

However, sometimes we want to find out specific information, what the children think about a particular topic, and so interviews are carried out. These can be open-ended, of the nature: *'Please would you tell me about this...* ', or *'What can you see in this garden? What do you like, why?'*. Alternatively, set questions can be used. The question might focus on a probe, e.g. a photograph, drawings, real specimen of an organism (e.g. Tomkins & Tunnicliffe, 2007). Using the name of something, e.g. *'Can you tell me about a cat?'*, prompts the child to recall a mental picture. An extension of this technique is to ask a 'challenge' question such as *'How many animal names can you tell me in one minute?'*, as used by researchers (Bartoszeck, 2009) in an investigation into what children know about everyday animals. Children can be invited to talk, to tell a story or give personal narratives about something specific. This technique has been used with rich results when talking about museum exhibits or with reference to bio facts, real specimens and in real life situations, e.g. in a garden or a street. A development of this technique is using one word alone as a probe: e.g. the researcher may say, *'Tell me about...'* referring, for example, to an everyday organism or an item (object or specimen) on a nature table. Such a situation can be extended into the affective domain by asking what specimens the child likes or dislikes and why.

Researchers being observers can listen to and observe the children playing, e.g. cooking or gardening, and seek to explain what they hear or see. Intervention in such play scenarios can reveal further understanding. Asking particular questions about an instance, *'What are you doing? Why? What can you see?'*, can reveal their understanding. The researcher showing a learner a staged simulation of something also provides information about children's understandings. For example, recording a child's verbal response to an incident in a context

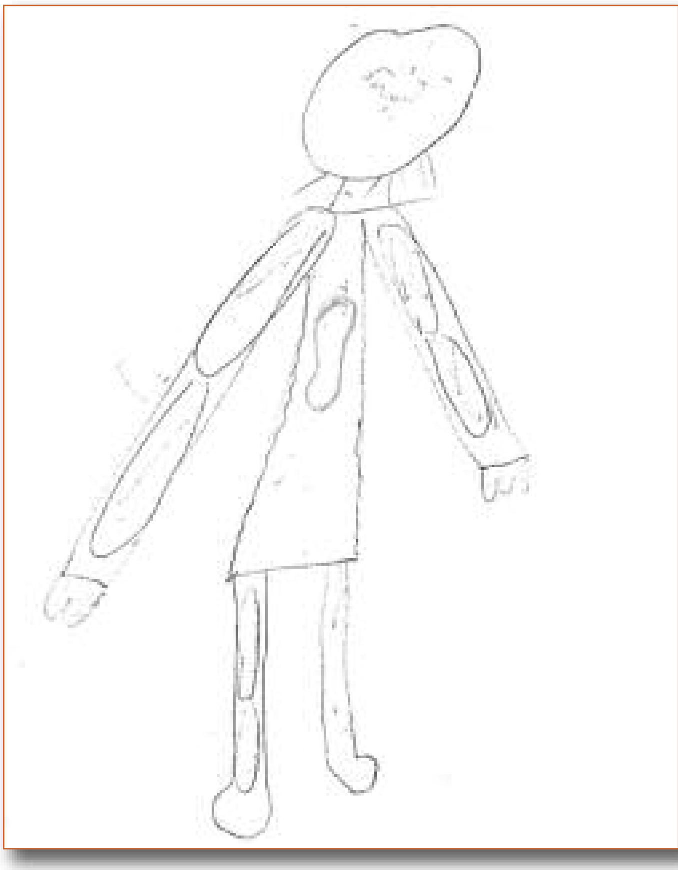

Figure 1: A 7 year-old boy's (English) idea of what is inside himself.

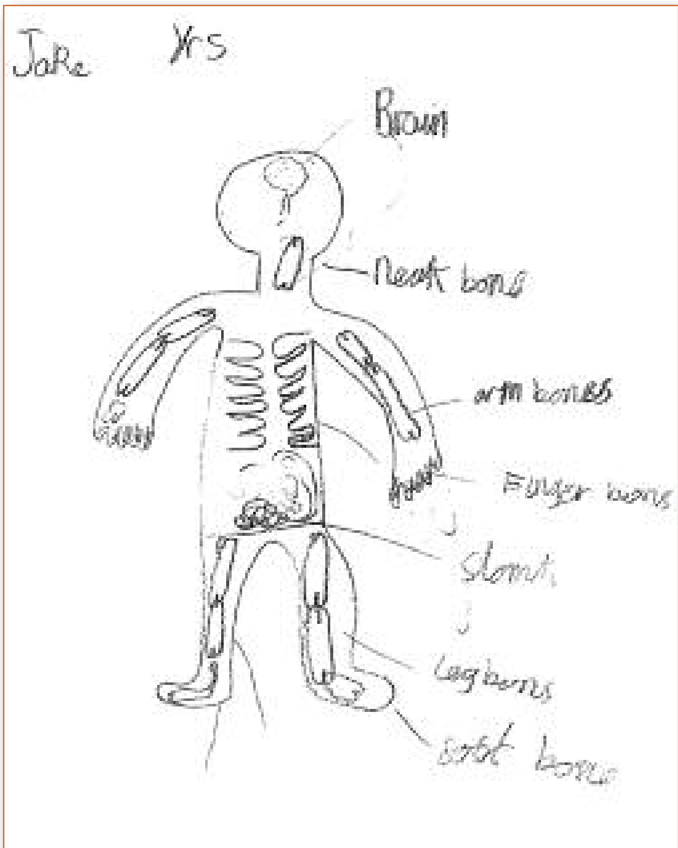

Figure 2: What's inside the body? (2 years later).

such as in the *Teddy Bear First Aid* case study during a discussion about context (Johnston, 2013), in the same genre, but with free choice role play, provides the researchers with some understanding of the child's knowledge of basic first aid relevant to the injury simulated by using the teddy bear as the 'injured' party.

Drawing is a useful technique for ascertaining knowledge. Children can draw real objects from life and, as an extension, they can draw the same objects some time later from memory (Minter, 2004). The technique of drawing from memory is a useful way of finding out what is retained from an experience or learning situation. Some researchers have asked children to draw what they remember from looking at a specific diorama, or what they found most interesting in a visit to a zoo or science museum. Asking someone to draw a visual representation of information, such as the human skeleton, where a particular body system is, or a physiological pathway, can be very revealing about real understanding and the stages in which a concept is developed, Children in Year 3 (age 8) and, again, in Year 5 (age 10) were asked to draw where what they drank went. Older children showed a greater understanding than they had had a few years before (Tunnicliffe, 2004). In another, as yet unpublished, longitudinal study, children from Reception (age 4) to the end of the primary school were followed, and asked, throughout their primary school years, at the same time in the school year, each year, to draw and then explain what they thought was inside their bodies. Drawings and interviews showed a gradual increase in understanding (personal unpublished data):

Observation is the mainstay of biology and asking children to observe and record and then explain biological phenomena can indicate what they observe and how they interpret it. Watching the stages of the growth of a seed through a transparent container is one way of doing this, e.g. looking at specimens, looking under a stone in a garden (see Figure 3).

There are practical issues with all the above techniques. Often, young children do not have the vocabulary to express their ideas and observations. They have a short concentration span and resent

Figure 3: What's there? Observations in the garden.

being taking from a task, and can thus be unco-operative. They may tell you what you want to hear, as they understand it, or may tell you 'stories' or embellish the truth for fun.

We, as educators in science in the early years, and of children this age in general, need to be aware of that which catches the interest of the children, and how they explain such observations within the parameters of their understanding. The approaches outlined above can be a useful tool in this task. We do not need to lecture them and give them complex understandings – that will come later at school – but we do need to be aware of what it is they do notice and how they explain it. Our teaching in formal education should be built on this, and not derived from simplified higher curricula content (Tunnicliffe, 2015).

The section on research in the *ASE Guide to Research in Science Education* (Oversby, 2013) (see page 24) is an ideal reference for those readers wishing to learn more about research techniques.

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Guest Editorial

GUEST EDITORIAL

Sue Dale Tunnicliffe

Considering the Needs & Interests of the Youngest Biologists

Children are born science learners and often possess a particular interest in the part of the natural world that is the focus of biology. They learn much about biology long before they encounter formal educators or the requirements of the curriculum and the knowledge assessed by school tests. Children are surrounded by the life sciences, so biology might be considered the most accessible of the science disciplines (Lindemann-Mathies, 2005, 2006; Patrick et al., 2013).

Interviews with 4-year-old children who had just begun formal schooling revealed that these young "scientists" already possessed an understanding that there were organs, bones, heart, and a brain inside a body (Reiss & Tunnicliffe, 2001). Somehow these children learned these things just by paying attention to their environments and listening to everyday comments. Schreck Reis et al. (2014) point out that young children (5–10 years of age) are both sensitive to and interested in living organisms and possess inquiring minds. Often the first word that a young child gives to a new phenomenon, such as something moving in the sky, may then be ascribed by them to anything they see in the sky, until they start learning to differentiate. For instance, one little girl called all birds a "plane" until she began to recognize that birds are different from aircraft. Young children intuitively explore through their senses and notice phenomena – many of which are biological–because of their interest in, and exposure to, animal representations, in particular as portrayed in various forms such as soft toys, books, and perhaps through preschool media on television (Gatt et al., 2007; Tunnicliffe et al., 2008).

This is not to suggest that everything children learn on their own is accurate. For instance, some 4-year-old English-speaking children, when asked to talk about plants, revealed that the word "plant" meant to them only a flower in a garden – not a weed, which was different. Trees and other members of the plant kingdom were referred to with their everyday name, such as "tree" or "bush." "Grass," according to these and many other older children interviewed in other projects, is a word synonymous with "lawn" – that is, grass is not a plant. Likewise, it is usual for children in English-speaking countries to equate the word "animal" to mammals and not to all members of the animal kingdom (Bell, 1981; Villabi & Lucas, 1991).

Such depictions may provide only basic views that could be considered scientific and, at the same time, offer biologically inaccurate portrayals due to anthropomorphic features and habits that may, for example, include cupcake-eating caterpillars (Carle, 1970) and talking plants (Tavares, 2013). However, all is not lost. Prokop et al. (2008) discovered that if children looked after pets of any type, they had a better understanding of these animals; and young children in some countries do notice the plants and animals of their surroundings and have reasonably accurate notions about the natural world. In any case, teachers must realize and build upon prior biology knowledge – accurate or not – that children possess.

Given this reality, we should begin our teaching plans for young biology learners with the topics they already know in everyday environments. We should begin instruction with what children know and what interests them. The starting point for science is observation, and that occurs during play, a crucial element in child development. Play is essential for intellectual achievement and emotional well-being. Moreover, play is one of creative thinking (Robson, 2014). Ogborn et al. (1996) argued that science knowledge can be reworked into story-like forms. This is what preschool children do as they investigate and observe biological phenomena and apply their existing understanding in new situations. Consider Josh, who noticed some young frogs with tails in the long grass near a pond. He was concerned because he had watched the tadpoles develop in their pond into these young frogs but associated them solely with living in water. An adult explained that they had left the water but still had to live in moist surroundings. So, applying what he knew, Josh decided to build them a home at the edge of the long grass and made up a story about the frog's house, which he amply watered once it was constructed from grass and twigs.

Thus, I suggest that we need a paradigm shift in thinking about the curriculum of early biology. Instead of providing a simplified version of advanced knowledge, we need to analyze the big ideas of biology and match these ideas with the observations and interests of these young emergent biologists. This builds on their prior notions and impressions. Adults find it difficult to limit the story in this fashion because we know what comes next. However, we must curb our enthusiasm and even restrict the information we want to convey. We must listen instead to the learners and assist them in incrementally constructing further understanding without overpowering them with information that does not yet fit their conceptual model.

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Notes & News

The Centre for Research on Play in Education, Development and Learning (PEDAL) – now launched!

In October 2015, the University of Cambridge launched a groundbreaking research institution to examine the role of playfulness in learning and development in young children.

The Centre for Research on Play in Education, Development and Learning (PEDAL) has been established with a £4 million donation from the LEGO Foundation, a Danish corporate foundation funded by LEGO whose aim is to use play to improve learning for children all over the world.

PEDAL acting director Dr. David Whitebread said: *'Play opportunities for children living in modern urban environments are increasingly curtailed, within their homes, communities and schooling. At the same time, play remains a relatively under-researched area within developmental science, with many fundamental questions still unanswered. Therefore, an invigorated research effort in this area will constitute a significant contribution to cultural understandings about the importance of play and the development, internationally, of high quality education, particularly in the area of early childhood'.*

For more information on PEDAL, please visit www.educ.cam.ac.uk/pedal/

PLAY IN EDUCATION DEVELOPMENT AND LEARNING

2016 Faraday Science Communicator Award

We offer our huge congratulations to Sue Dale Tunnicliffe, Co-Founder of *JES*, on the news that she is to be the recipient of this prestigious award, granted by the NSTA Awards and Recognitions Committee.

Sue will receive her Award at the 2016 NSTA National Conference in Nashville, Tennessee and will be speaking at the Global Conversations Conference (see page 31).

The ASE Annual Conference 2017 University of Reading, UK 4th – 7th January 2017

It's not too early to put the dates of the 2017 ASE Annual Conference in your diary! Over 400 sessions, many of which focused on primary and early years science education, plus a major educational suppliers' and publishers' exhibition – not to be missed!

Keep an eye on the ASE website (www.ase.org.uk/conferences) for updates on next year's exciting programme.

NSTA 2016 Global Conversations Conference
Science Goes Global: The Next Generation
March 30th 2016 in Nashville, TN, USA

This pre-NSTA one-day Conference will be co-hosted with the national NSTA Conference in Nashville, TN. The theme for the 2016 Conference will be *Science Goes Global: The Next Generation.*

In alignment with the national Conference themes, the Global Conversations Conference encourages submissions from diverse areas of science education, including formal elementary to college science education, policy standards, best practices, novel content delivery, scientific literacy and informal education. Interspersed with the oral presentations will be round-table discussions on specific topics relevant to the international science educator community, which also allow for networking and ideas exchange. The poster presentations will be held as part of the Wednesday afternoon Conference programme.

For more information and history of the Global Conversations Conference, please visit our website at http://www.nsta.org/international/

NSTA National Conference 2016
Science: Empowering Performance
31st March – 3rd April 2016
Music City Center, Nashville TN, USA

There are four main strands to the Conference:

- Setting the Stage: Scientific Literacy
- Building the Band: Involving Community Stakeholders
- Harmonizing Concepts: Integrating Instruction
- Stringing It All Together: Three-Dimensional Learning

You can obtain more information about the 2016 national NSTA Conference at: http://www.nsta.org/conferences/national.aspx

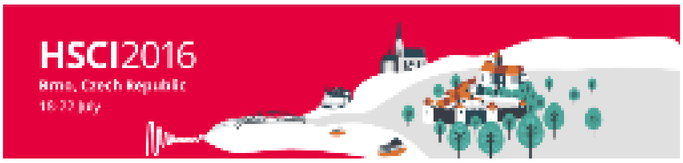
National Science Teachers Association

HSCI2016
Hands-on – the Heart of Science Education
Brno, Czech Republic
18th – 22nd July 2016

The 13th annual international conference on Hands-on Science, HSCI2016, will be held in Brno, at the Faculty of Education, Masaryk University, Czech Republic, from July 18th to 22nd 2016. This year, the main theme of the conference is *Hands-on – the Heart of Science Education.*

The Conference will provide the ideal opportunity for presentation of work and in the widest range of perspectives related to science education. The Hands-on Science Network is open to all views on and approaches to science education. However, we advocate an active learning of sciences through an enlarged use of hands-on experiments in the classroom. The aim of the Conference is to promote friendly and broad exchange of experiences of good practices, syllabus and policy matters, social factors and the learning of science, and other issues related to science education and its development.

For more information on the Conference, please visit www.hsci.info/hsci2016



ERIDOB 2016
The Eleventh Conference of European Researchers in Didactics of Biology
5th – 9th September 2016
Karlstad, Sweden

For more information about this Conference, please visit www.kau.se/eridob-2016

eridob
European researchers in didactics of biology

ICASE World STE2016
5th World Conference on Science and Technology Education
Titanic Beach Lara Hotel, Antalya, Turkey
1st – 5th November 2016

The theme for this year's Conference will be *Interdisciplinary Practices in Science and Technology Education*, and strands for the event include:

- Impacts of national and international projects on classroom practices
- Science teaching and learning: teaching resources developed and tested by teachers
- Science learning in informal contexts such as science centres and museums
- Curriculum development, evaluation and assessment...

And many more!

For more information about the Conference, please visit www.icase2016.org

Teacher Scholarship announced for NSTA Conference in Nashville, USA
from 30th March – 3rd April 2016

This scholarship, made possible through grant-funding from Northrop Grumman, will sponsor a teacher to attend this landmark conference to share best practice, with travel, registration and subsistence included.

Applicants are required to:

- Be an ASE member
- Be currently teaching at primary or secondary level
- Display a poster about their teaching activities
- Willing to write about their experience

Applicants are required to submit a CV and up to 200 words about how the trip would benefit them both personally and professionally.

For more information and to download an application form, please visit www.ase.org.uk/news/ase-news/expense-paid-trip-to-nashville/

Deadline: by 5pm on Wednesday 24th February.

The PSTT International Primary Science Conference 2016
9th - 11th June 2016
Belfast Waterfront, Belfast, BT1 3WH

The Primary Science Teaching Trust (PSTT) will celebrate excellence in the teaching and learning of primary science across the world with its inaugural International Primary Science Conference in the cultural city of Belfast.

The three-day programme will feature inspirational speakers, including Professor Alice Roberts, Dr. Stuart Brown, Professor Danielle George and Dr. Maggie Aderin-Pocock, a wide range of workshops led by outstanding educators, and showcases of the best primary science there is to offer from across the world. The Conference will provide opportunities to meet colleagues and establish contacts, with time to share and discuss exciting ideas to use in your own practice.

The Primary Science Teaching Trust is determined that there should be no barriers to every child receiving an outstanding education in primary science, and is committed to its vision that teachers are the key to making this happen. Through crossing boundaries between the classroom and academia, between policy and practice, and between one nation and another, this Conference will empower us all to achieve this.

Early Bird Offer Extended till the end of March 2016. 40% off prices on our website using promo code 'PSTT40'. Prices start from £60, Ts&Cs apply

For more information please visit:
www.primaryscienceconference.org/

There will be a special issue of JES celebrating this Conference in Winter 2016/17.

Resource Reviews

Teaching Primary Science: Promoting Enjoyment and Developing Understanding (2nd edition)

By Peter Loxley, Lyn Dawes, Linda Nicholls and Babs Dore. Published in 2014 by Routledge, Abingdon, UK, price £30.00.
ISBN 978-0-2737729-8-9

This book is a must for every staff room. It is clearly written and illustrated and very much focused on talking with the children and their peer-to-peer discussions using their prior knowledge. Part 1 (9 chapters) deals with the pedagogy of teaching and learning science in primary schools, whilst Part 2 covers the content knowledge relevant in this age range, in Chapters 10 to 21. Chapters 1 to 9 cover varied topics: *The pressure of finding things out, Views of science teaching, Organising how children learn science, Scientific understanding and mental models, Talk for learning in science, Scientific inquiry and the passionately curious, Planning and assessing children's science, Learning outside the classroom,* and *The origins of scientific knowledge*. All these chapters are well referenced. The text is divided into sections of pertinent topics very relevant to teachers and the style is extremely readable all through this book.

After a brief overview, each chapter of Part 2 *(Ideas for practice)* has sub-sections. The first discusses the topics to be addressed and then the second has ideas for practice in the classroom. The topic *Friction* for the lower primary age group introduces the scientific view, followed by a list of scientific inquiry skills. The *Exploration* stage describes how teachers can encourage the children to talk and try out their ideas and suggests giving them a puzzle so they can all talk together about possible causes, one example being a shoe with hole in its sole. The authors then consider a 'Re-describing' phase, in which children are encouraged to talk about possible causes for the hole in the shoe and try out their ideas using a simple simulation of a shoe and different surfaces. An *Application* stage involves trying out the scientific ideas with suggested links to design technology.

This section discusses the science inquiry which the children may use, and includes a decision and making section with some ideas for the teacher. Ways of assessing the work, by illustrating their talk and asking them to examine their thoughts, as well as probing whether they can describe the forces that have been involved, follow. The second part of this section deals with air resistance in the same structured manner. Each chapter has a similar sequence, with several topics being presented in this structured way, which can guide the teacher through.

I was most impressed by this book, with its coverage of not only pedagogy, but also subject knowledge and really practical ways to deliver the subject to the learners. It is one of the best books in this area that I have ever seen and I would unreservedly recommend it for the theoretical perceptive in the first half and the practical subject knowledge and suggestions for teaching in the second.

Sue Dale Tunnicliffe

Research in Early Childhood Science Education

Edited by Kathy Cabe Trundle and Mesut Saçkes.
Published in 2015 by Springer, Dordrecht,
price £90.00 Hb. ISBN 978-94-017-9504-3
(eBook £72.00, ISBN 978-94-017-9505-0)

This book reports on research in a wide range of topics relating to science for children from birth to age eight. The topics covered in the 16 peer-reviewed and edited chapters, all by different authors, include: motivation for learning science; the development of children's ideas, skills and dispositions; the interface between science and literacy and mathematics; the importance of play; teaching children with special needs and those whose home language is not English; curriculum; and assessment. Most chapters include a useful summary of research findings, directions for further research and implications for early childhood teaching.

The editors are from the USA and Turkey and the choice of authors and research studies reflects their backgrounds, the large majority of authors being from the USA. Although this means that the book may well offer new research to a UK readership, it also means that the discussion of research findings omits reference to some research from the UK and indeed other parts of Europe. There is no reference in the chapters on children's own ideas to the extensive research carried out by the SPACE (Science Processes and Concept Exploration) project, nor mention of the research surveys assembled by the Cambridge Primary Review, which have considerable relevance to science education even though more widely focused. The range of research covered varies considerably from topic to topic. For example, the chapter by Constance Kamii on 'developing logico-mathematical knowledge' is wholly devoted to the ideas of Piaget and, of the 35 references given, 21 are to the research of Piaget and 11 to those of the author, with only three others.

That said, it remains true, as pointed out in several chapters, that the amount of research in some topics specifically addressing early years science education is severely limited. A case in point is the research on motivation for learning science. The authors of the chapter on this topic, Helen Patrick and Panayota Mantzicopoulos, point out that, whilst there is a large body of research with high school students, very little has involved young children. What evidence there is shows that children's questioning and interest in the world around them declines as they move from early to later primary school and into high school. However, drawing on their own research, the authors suggest that this decline is not inevitable if children are involved in well-designed science activities.
But it is a recurring a theme throughout the book that pre-school and early years provision includes few opportunities for learning science. Moreover, they claim that children not only need experience of scientific activity, but that this experience should be clearly identified as science, that is '*even though other subjects (e.g. art, writing) may be integrated with science lessons, the discipline boundaries of each should be clear*' (p.28).

The three chapters concerning children's ideas about the world around draw quite extensively on Piaget's work. In addition, the chapter on physical science concepts by Yannis Hadzigeorgiou includes interesting views on how research methodology reflects a view of how children construct their ideas. He suggests that the interview approach of Piaget and his followers assumes that children develop their ideas individually. Some later studies are based on a social/constructivist perspective, reflecting the view that thinking and learning are social activities. One of the implications of this is that '*what the researcher registers or interprets is not the personal knowledge of each student*', leading to the conclusion that '*From this perspective, therefore, there is a question of validity of studies based on Piagetian constructivism*' (p.85).

One of the most interesting chapters concerns research on children's development of ideas *about* science. Significantly entitled *Too little, too late: addressing nature of science in early childhood education*, the authors, Randy Bell and Tyler St. Clair, make several key points. First, that it is '*more important than ever*' to teach children how scientific knowledge is gained (p.125). Second, that not enough is known about how this knowledge develops (even though progressions are set out in some curricula, these are not research-based). Third, that, contrary to some views, young children are capable of learning about the nature of science (how science works). Fourth, that learning about science should be integrated into science activities, not experienced in decontextualised activities. Finally, that the success of activities designed to develop children's understanding will depend on teachers' own ideas about science, which may be simplistic and positivist, requiring attention in teacher education.

A series of chapters on research on various aspects of methods and contexts for teaching science concern the use of technology, books, play and the outdoor environment. Technology here means information technology; there is nothing in the book for anyone looking for research on the impact of design technology. The chapter on literacy is also rather limited in scope, relating to the use of textbooks and information books read by, or read to, children, rather than wider concern with how science may impact on children's reading, writing, listening and speaking, and *vice versa*. Various 'text-integrated inquiry science programmes' used in the USA are described, but there is little evidence of their impact to report.

In the chapter on play, authors Berrin Akman and Sinem Güçhan Özgül provide brief outlines of the theories of play of Freud, Erikson, Piaget and Vygotsky, pointing out differences but also the common element – children finding ways of expressing themselves through play. They note studies that claim benefits of play, based on arguments of how it enables children to deal with feelings and events, but the number of empirical studies of the effectiveness of play on general concept and skill development is limited. A small number of studies that have compared direct instruction, scaffolding and play-based activities have, however, shown that *'children involved in play-based activities perform better on learning tasks'* (p.245). In relation to learning in science, four studies are described from which the authors conclude that, although young children can benefit from structured interventions, it seems that *'unstructured learning experiences appear to initiate the use of scientific thinking skills in early childhood'* (p.249). The chapter includes a discussion of inquiry-based science education, but is mainly concerned with argument and pedagogic methods rather than research evidence of effectiveness.

The authors of a chapter on teaching science to young children with special needs adopted a systematic review procedure, setting out details of their literature search and the criteria they applied in identifying the most relevant and dependable studies on the topic. This is the only chapter where this approach has been consistently used. The selected 12 studies mainly relate to children with various learning disabilities and behaviour disorders, rather than visual, hearing and physical impairments. Each of these is discussed, with examples leading to the conclusion that *'young children with special needs benefit most from hands-on, activity-based inquiry instruction that is supplemented with appropriate levels of guidance and explicit instruction'* (p.321). The chapter also provides a useful critique of the research studies and how they were reported.

The USA-centred view in this book is particularly evident in the chapter on assessment. Using the terms 'assessment' and 'evaluation' interchangeably, the chapter covers evaluations of teachers, or teaching practice and classroom provision, as well as formative and summative assessment of children's learning. The author, Daryl Greenfield, comments on the lack of research specific to assessment of young children in science, giving most attention to his own and colleagues' work on creating multiple-choice tests administered using physical materials or on-screen. These tests are translated into Spanish in view of the rapid increase in the USA of children from Spanish-speaking homes. Formative assessment is discussed in the context of screening (identifying children requiring remedial attention) and treated as similar to summative assessment, apart from being carried out more frequently. There is no mention of the extensive reviews of research in formative classroom assessment conducted in the UK and other countries.

Given the wide range of topics covered in this book, overall it makes a valuable contribution to the literature on science education in the early years. It draws attention to the need for more research in almost every aspect of work in relation to developing young children's scientific understanding and skills. Although much of the research cited is from the USA and a few other countries, the findings have wider relevance. There are also implications for education policy, where other countries can learn from the experience in the USA. The effect of the' No Child Left Behind'

Act of 2001, which required testing in science only from Grade 3, has been to minimise the time for learning science for children up to the age of 8. As long as what is regarded as 'basic' to young children's education is confined to reading, writing and arithmetic, other subjects will be neglected in these years. Only when science is treated as part of basic education and attention is given to research and development that co-ordinates learning in science with development of literacy and numeracy, will children be able to enjoy the benefits indicated by Kathy Cabe Trundle in the introduction to this book.

Wynne Harlen

Science Through Stories – Teaching Primary Science with Storytelling

By Chris Smith and Jules Pottle, published in 2015 by Hawthorn Press, Stroud, price £40.00.
ISBN: 978 1 90735 945 3

'Talk for writing' has widely accepted benefits for literacy teaching, so it is not so surprising, though gratefully received, that the idea has caught on throughout the curriculum, and *Science Through Stories* is the answer for science! It is the result of collaboration between Chris Smith, one of the pioneers of *Storytelling Schools*, and Jules Pottle, a primary science specialist teacher. The book aims to use stories as a foothold to engage children in science, by combining scientific explanation with storytelling.

The book follows the *Storytelling Schools* model, which is outlined in some depth in the first twenty pages, so that even those who have never encountered the approach are tooled with the relevant strategies for making the stories work in the classroom. The main idea is that the stories are told, rather than read, by the teacher, and the children then learn the stories verbally and take ownership of them. In this way, they become acquainted with scientific concepts and vocabulary in a context-driven manner.

Those who are familiar with a storytelling approach will recognise the format of the book, which is consistent across the *Storytelling School* series; however, this volume gives much more structure and ideas for using the stories than its predecessor. Each story is prefaced with a short introduction including a plot synopsis and the most obvious relevant science links. This makes it quick to choose a story, as you don't have to read each in detail first. The introduction also outlines any relevant cross-curricular links; for example, the story 'Little Rabbit Goes Home' can be used to teach about sound, animal habitats, or as a fable for self-esteem! Following each story, there are 'Top tips for telling', which are ideal for less experienced storytellers, but also give a good emphasis on the drawing out of the science most effectively. The authors then provide ways to work with the story using the storytelling method and the directly and indirectly linked science. Pottle's teaching expertise is clear in the numerous suggested practical science activities that can be used with the story, and a detailed page on how other curriculum areas can be associated.

There are over 25 stories in the book, arranged into biology, chemistry and physics chapters, and then into topic within each of these disciplines. The stories cover the main areas taught in primary school science, but there is no formal mention of curriculum objectives; the book should stand the test of time. There is also no ordering by Key Stage or year group, as the stories are meant to be adapted and are versatile enough to be used across the school; however, for speed of use, within each chapter the stories are in 'general order of difficulty'.

The stories are a range taken from history, biography and world cultures as well as a huge proportion that have been made up by the two authors. Teachers are also encouraged to adapt stories from the book, or even make up their own story, to either access a particular teaching point or engage a particular group of children. For example, when teaching electricity, it was not too difficult to modify 'The Lighthouse Keeper's Son', which is the story that acts as inspiration for the cover of the book, to give it a Christmas twist, while using the same scientific concepts to make it relevant to the term of teaching and mood of the class.

Some of the stories end in a problem, which the children are tasked to solve, others open up questions for discussion, but in all the stories the science is not fully explained, so there is plenty left for discussion, exploring and, ultimately, learning. It may be argued that the time taken to tell and learn a story takes away time from activities and, while it undeniably does take time to use this approach, that time is not wasted, as scientific concepts and understanding are being developed through the verbalisation of the story. Indeed, a particular strength of the book is the repetition of scientific vocabulary, which the authors weave into the telling. These keywords become part of the children's retelling and, in the same way as talk for writing, the words become familiar and understood. One example is 'The Children of the Water God', which primarily covers the water cycle and includes the terms 'evaporate' and 'water vapour'.

It is certainly true that science taught skilfully does not 'need' stories but, if they help children to be engaged and have context for understanding, they are more likely to access deeper learning, which jumping ahead to practical activities may not achieve for all students.

It is refreshing to see a book that puts science at the heart of learning, and links other subjects to the science, rather than the other way around. Schools that are already embracing the storytelling approach will find this book an integral part of science teaching, but even schools who have never ventured into the approach will find there is plenty to be gained by accessing this book, and teachers should feel hugely supported using the stories, thanks to all the extra material.

Amy Strange

About ASE

ASE and you!

Interested in joining ASE? Please visit our website www.ase.org.uk to find out more about what the largest subject teaching association in the UK can offer you!

The ASE Primary Science Education Committee (PSC) is instrumental in producing a range of resources and organising events that support and develop primary science across the UK and internationally. Our dedicated and influential Committee, an active group of enthusiastic science teachers and teacher educators, helps to shape education and policy. They are at the forefront, ensuring that what is changed within the curriculum is based on research into what works in education and, more importantly, how that is manageable in schools.

ASE's flagship primary publication, *Primary Science*, is produced five times a year for teachers of the 3–11 age range. It contains a wealth of news items, articles on topical matters, opinions, interviews with scientists and resource tests and reviews.

Endorsed by the PSC, It is the 'face' of the ASE's primary developments and is particularly focused on impact in the classroom and improving practice for all phases. *Primary Science* is the easiest way to find out more about current developments in primary science, from Early Years Foundation Stage (EYFS) to the end of the primary phase, and is delivered free to ASE members. In the past, the Committee and Editorial Board have worked closely with the Early Years Emergent Science Network to include good practice generated in EYFS across the primary phase. Examples of articles can be found at:
www.ase.org.uk/journals/primaryscience/2012

There is now an eemembership for primary schools. This enables participating schools to receive all the current benefits electronically, plus free access to the exciting *primary upd8* resources, at a discounted price. For more information, please visit the ASE website (www.ase.org.uk)

The Committee also promotes the Primary Science Quality Mark, (www.psqm.org.uk). This is a three-stage award, providing an encouraging framework to develop science in primary schools, from the classroom to the outside community, and gain accreditation for it.

The ASE Annual Conference is the biggest science education event in Europe, where over 3000 science teachers and science educators gather for workshops, discussions, frontier science lectures, exhibitions and much more... Spending at least one day at the ASE Annual Conference is a 'must' for anyone interested in primary science. The next Annual Conference runs from Wednesday 4th to Saturday 7th January 2017 at the University of Reading, UK – look out for details on the ASE website (www.ase.org.uk).

To find out more about how you could benefit from joining ASE, please visit: www.ase.org.uk or telephone 01707 283000.