ISSN 2046-4754

The Journal of Emergent Science

Sponsored by Jonathan's Jungle Roadshow

ISSN 2046-4754

Contents

Issue 1 – March 2011

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Publisher:
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c/o ASE
College Lane
Hatfield
Herts
AL10 9AA
UK

ISSN: 2046-4754

The ***Journal of Emergent Science (JES)*** is published by the **Emergent Science Network** and is supported by the **Association for Science Education (ASE)**. This edition has been kindly sponsored by **Jonathan's Jungle Roadshow**.

This first edition is free to all readers and we hope that you will find it interesting and informative. Future editions will be available free to ASE members and ES network members and by subscription to non-ASE members.

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ISSN 2046-4754

Editorial

The paradigm shifts

Sue Dale Tunnicliffe
Jane Johnston

Recent years have seen two paradigm shifts in science education. The first is a shift from a focus on the science – the concepts and skills of scientific inquiry, to greater focus on education – the pedagogical approaches that support scientific and holistic development. The second is a shift from a 'top down' to a 'bottom up' approach, with increasing recognition that early years science or emergent science; that is, science for young children aged between 0 and 8 years of age, is the foundation of all later development and is not well understood. In 2007, **The Emergent Science Network** was set up as a first step in this paradigm shift, with the aim of:

- facilitating communication between people interested in emergent science;
- developing understanding of young children's scientific development;
- supporting professional working with young children; and
- evaluating the impact of emergent science research on early years pedagogical practice.

Since 2007, the Network has grown to involve nearly 300 professionals, academics and others interested in early years science from across the world. We have published three newsletters a year, collaborated on research, presentations and publications, communicated ideas and supported each other. This first edition of the ***Journal of Emergent Science (JES)*** is the next step in this development and the paradigm shift.

One result of the paradigm shift is greater understanding of emergent science. Theoretical underpinnings of early years activities, such as the value of holistic and thematic development, play, social and emotional development, are well recognised in the early years (e.g. BERA, 2003). Emergent science is now being more widely discussed and we know that young children develop scientific skills, attitudes, understanding and language in a holistic way (Johnston, 2008; Johnston & Tunnicliffe, 2008). Indeed, it is now accepted that children are intuitive scientists from the earliest age (Gopnik, 2009) and that active social participation in scientific development is the most effective pedagogical approach (Johnston, 2009).

Understanding of science concepts involves children in making cognitive and verbal links between their observations, exploratory findings and scientific phenomena. Tunnicliffe (2007), in research about children's understanding of keeping healthy, has found that experience of injuries led to an improved vocabulary of health and safety. This latter work illustrates the key role of children's own everyday experiences. The development of children's scientific skills is also thought (Johnston, 2009) to be dependent on dialogic social interaction in play, so that understandings and skills are developed through adult and peer interaction (Vygotsky, 1962). A common theme in recent research findings (see Bartoszeck *et al*, 2009) is the importance of scientific talk that challenges (Tunnicliffe, 1990) or dialogic teaching (Alexander, 2008).

Emergent science introduces children to the world of science based on their existing knowledge and observations, leading them into finding out more about science for themselves. It develops the four aims of science:

1. To acquire knowledge and understanding of the body of knowledge that is considered to be science through experience.
2. To acquire the practical skills of using instruments in order to be able to investigate phenomena.
3. To help children acquire scientific thinking skills, by identifying the issue, hypothesising, designing and investigating, measuring outcome and evaluating the results.
4. To be able to communicate all stages in their scientific inquiry with others through a variety of means.

These aims can be achieved through challenging, scientific experiences. Challenge in science introduces pupils to situations where established specific skills and concepts enable them to solve problems and develop thinking and communicative skills. Challenge science is a process by which the learner combines various rules, observations, knowledge and skills acquired elsewhere to a new situation, which is challenging them. In solving challenges, pupils have to interpret data, formulate a hypothesis, control variables and define in operational terms what they are seeking to do (Tunnicliffe, 1990).

Return to Front

ISSN 2046-4754

The most effective experiences are based on everyday experiences and begin in the home. Parents and carers can give children a good start to their scientific development, as science is all around us. Parents and carers can help their children by encouraging them to:

- develop their skills through initial observations;
- develop linguistic skills and vocabulary by 'labelling';
- develop their thinking skills through Thinking and Doing!
- engage in the scientific process by asking themselves questions, such as ***'What is this?', 'What do I know?', 'What can I do to find out?', 'What do I need?', 'What do I do?', 'What happens?', 'What does it mean?'***

Parents and carers are the first educators of their children and childhood is a critical period for scientific development. Young children are intuitive scientists (Gopnik, 2009) and parents and carers can observe this and talk about the scientific phenomena observed. As children develop, the ideas of others will begin to influence them; in their family, their friendship groups, the community in which they live; educators, etc. As a result, their intuitive ideas begin to change as a result of further observation, greater experience, teaching, and discussion with others. Without this early years foundation in science, the structure that ensues is shaky indeed – as the voices of pupils are beginning to reveal. Effort and money poured into the secondary school appear futile if similar effort, recognition and money are not put into the child's earliest years of education, before school and then in primary school. Is recognition of the importance of the first few years of development the next critical paradigm shift in science education? Are we at last beginning to recognise that, without a sound foundation at the start of learning, the resultant edifice is shaky?

The ***Journal of Emergent Science (JES)*** is designed to support these paradigm shifts, by making research on early years science accessible to all, encouraging debate on issues raised about early years science and so to increase the impact that research has on practice and provision. The Editors are very grateful to the **Association for Science Education (ASE)** for their support in setting up the journal and hosting it on their website. We are also very grateful to the contributors and reviewers who have supported the idea and we hope that readers of ***JES*** find the contents useful in their work of supporting early years development.

References

Alexander, R. (2008) *Towards Dialogic Teaching: Rethinking Classroom Talk (4th Edition).* York: Dialogos

Bartoszeck, A., Campbell, C., Johnston, J., Kallery, M. & Tunnicliffe, S.D. (2009) Multi-paper Set on Emergent Science presented to the *European Science Education Research Association Conference 2009*, Istanbul, Turkey, 31 August to 4 September 2009

BERA, (2003) *Early Years Research: Pedagogy, Curriculum and Adult Roles, Training and Professionalism.* Southwell, Notts.: BERA

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

Johnston, J.S. (2009) 'How does the Skill of Observation Develop in Young Children?', *International Journal of Science Education*, **31,** (18), 2511–2525

Johnston, J. & Tunnicliffe, S.D. (2008) 'The Emergent Science Electronic Network', *Research Intelligence,* June 2008, (103), p.26

Tunnicliffe, S.D. (2007) 'No time to teach life saving skills? Essential first aid within biology lessons', *Journal of Biological Education*, **42,** (1), 3–4

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

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Return to Front

ISSN 2046-4754

Contributing To The Journal of Emergent Science

The ***Journal of Emergent Science (JES)*** focuses on science (including health, technology and engineering) for young children from birth to 8 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 of the journal is composed of **Association for Science Education (ASE)** members, 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.

The Editorial Board

Submitting to *JES*

Please send all submissions to: **janehanrott@ase.org.uk** in an 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 books and resources on early years science.

Contributing To The Journal of Emergent 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) in Helvetica point 12 preferably with double spacing.

- 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.
- Web addresses should be checked at time of submission.

Guidance on referencing

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

Chapter in book
Piaget, J. (1976) 'Mastery Play'. In Bruner, J., Jolly, A., and Sylva, K. (Eds) *Play – Its role in Development and Evolution.* Middlesex: Penguin, 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 procedures

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.

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Return to Front

ISSN 2046-4754

Vocabulary in four to eight year-old children in inner city schools

Katie Deighton
Mellissa Morrice
David Overton

This paper describes initial research into the development of scientific vocabulary in children aged between four and eight years by using various media, specifically fictional stories, scientific equipment and toys. These initial findings are those of a university lecturer in education working with teachers in their settings, plus the findings of two undergraduate teacher education students working on their final year degree dissertations under the former's supervision. The lecturer undertook unstructured interviews and observation (supported by visual methods, i.e. filming using digital media). The undergraduates took a mixed-methods approach following reviews of the literature. Their selected methods comprised the use of observation and questionnaires. Key findings suggest that child-initiated exploration of resources, accompanied by pupil-teacher dialogue, supports pupil acquisition of science vocabulary.

Keywords: scientific, vocabulary, early, years, stimuli

1.0 Introduction

The principal researcher, a lecturer in education specialising in primary science education, has an interest in how children develop their understanding of science. In this instance, the intention was to explore ways in which scientific vocabulary emerges as children undertake science-related learning experiences. The study was to include children undertaking each of three possible activities: pursuing free play; exploring resources in the form of scientific equipment; and discussing a science investigation arising from storybook stimulus.

These research intentions were outlined during informal conversation with a group of final year BA primary education undergraduates. Two of these students (co-researchers on this paper), working independently, decided to adapt these ideas and to use this as a basis for their final year dissertations. One co-researcher focused on children's use of resources in developing acquisition of scientific vocabulary and introduced the children to teacher-initiated activities. The second co-researcher instigated research based upon child-initiated, discovery learning using resources. This article is a collation of the findings of the three small-scale independent studies. It is a work in progress.

2.0 Literature review

The National Curriculum in England (DfES, 1999) states that, by the time they are seven years old, children should use scientific vocabulary in their explorations and investigations**.** It is important that children are given the opportunity to acquire and use scientific vocabulary as they pursue scientific discovery, both in the classroom and elsewhere. Ollerenshaw and Ritchie (1998) found that children were eager to learn new scientific vocabulary and were readily willing to use these new words in everyday communication between peers and adults but, to begin with, the words may serve a loose fit in which the children use their new vocabulary in the wrong context. Modelling the correct terminology with children through teaching can help to ***'equip them with tools for developing understanding of scientific concepts.'*** (Brunton & Thornton, 2010 p.13)

Feasey speaks about the importance of general scientific vocabulary, through practical experience, and identifies that ***'the teacher might need to help by scaffolding, using everyday and scientific words in tandem until children are confident in their use of the scientific term'*** (Feasey, 1999 p.10). ASK (2008:1) states that there is a wide range of vocabulary that children need to develop over a period of time spent on an area of learning. Examples of these include: names of scientific equipment; science concepts; scientific methods; names of organisms; and words relating to scientific enquiry.

Return to Front

In 2009, Thulin and Pramling (2009) carried out a study into anthropomorphic speech within science lessons; that is, assigning human attributes to non-human objects. Lakoff and Johnson (1980) argue that this type of language allows us to make sense of phenomena in the world in human terms, terms we can understand on the basis of our own motivations, goals, actions and characteristics. It is important to notice that anthropomorphic speech is not particular to purely children or indeed science, but can be frequently found in the school setting and in other areas. The study carried out by Thulin and Pramling (2009) showed that out of the 128 instances where anthropomorphic speech was found, 24 of these were made by children and 102 by class teachers. Their study showed that this type of speech was used to encourage children into first using language easy enough for them to remember and relate to, before gradually beginning to learn and incorporate the correct scientific vocabulary for a certain concept or happening. An example given by Thulin and Pramling of anthropomorphic speech that can be found within the classroom is when the ozone layer is described to children as being like a 'blanket', surrounding earth.

Siraj-Blatchford (2000, p.39) develops the scaffolding theories of Vygotsky (1962) in a scientific context by identifying that:

> ***'the teacher initially provides all of the structure required for children to participate in the game of "being a scientist". Progressively this scaffolding is reduced so that the children are able to investigate for themselves.'***

Leonard (2002, p.34), in discussing how a class of children engaged in dialogue relating to the science of stormy weather, noted that this stimulus or context produced students who ***'were gradually learning to use the "language" of science and how to communicate it to others'***. Leonard says that such development of dialogue stimulated by everyday contexts encourages what she calls 'emergent classroom discourse'. This discourse is achieved more through dialogue than through what she calls the traditional teacher-student question and response pattern.

Science should be incorporated into the emergent curriculum as defined by Siraj-Blatchford (2000, p.36), as this allows for the diversity of experience, interest and development that children have (particularly in early years.) An emergent curriculum ***'respects the power and importance of play – and supports children in becoming more accomplished players – good at choosing, constructing and co-constructing their own learning'*** (Siraj-Blatchford, 2000, p.36). Practitioners strive to develop children's intrinsic curiosity and a learning environment in which children can explore the world in search of meaning. Children come to the classroom with a wide range of experience and interests and a curriculum driven by child-initiated activities caters for this by encouraging the use of play. This gives children the opportunity to explore, both in a practical sense and in a cognitive sense, so that they can challenge each other's ideas with some psychological safety in terms of 'right and wrong' answers. This, of course, is achieved partly through social interaction. Barnes (1976) argued that children's thinking and talking are intimately connected and so the more children can 'think aloud' in informal discussions, such as in child-initiated time within the lesson, the more they can take responsibility for formulating their own ideas. Mercer *et al* (2004) also found that talking about science with teachers or other children does in fact raise children's attainment in this subject. Johnston (2009) supported the importance of peer interaction and dialogue, as she believes that it has a profound impact on the development of observational skills. She conducted a study of children, aged between one and three years, as they played with some toys. Johnston stressed the importance of social interaction and play. She encouraged consideration of more specific scientific play and observation, as this enabled children to negotiate social boundaries more fully.

Children also need resources in order to promote this discussion with their peers and help develop scientific vocabulary, and this is particularly apparent with young boys. Brunton and Thornton (2010) found that boys in particular benefit from resources and equipment that help children to put forward ideas, find out what things can do, solve problems and overcome challenges. They urge that many young boys have to try things out, take things apart, and test out ideas and this can be productively channelled into interesting and exciting scientific exploration and discovery. Clarke (2000), in her study focusing on encouraging young children to talk about their scientific ideas about materials, found that children as young as three have shown that they are willing and able to express ideas on classification and properties of matter.

Siraj-Blatchford and Siraj-Blatchford (2002) considered how schemes or schemas were developed in five year-old children. They explored children's use of construction kits, either with or without instruction, and found that scientific development that depends on scientific knowledge needs instruction and cannot be discovered through exploration and play.

Return to Front

Furthermore, in conclusion, they say that ***'some kind of "instructive" stimulus, instructive challenge or environment is necessary and that the pupil must be motivated to engage with it. Instruction, engagement and involvement may therefore be considered to be conditions for effective learning'*** (2002, p.213).

In terms of 'emergent science', as considered by the writers' current study, Siraj-Blatchford and Siraj-Blatchford (2002, p.208) specify that ***'despite all of these difficulties, these data did clearly show that the children's own constructs for the bricks fell into three basic categories: (1) Constructs referring to simple descriptive characteristics, e.g.: "short", "long", "fat" or "It's got …on it"; (2) Constructs involving the use of specialist terminology, e.g.: "axle", "wheel", "spindle", "base"; (3) Constructs defined in instrumental terms, e.g.: "I can make … with it". Virtually all of the children applied each of these categories at times but a few children (all members of the group provided with instruction) took Category 3 responses further, to make statements that referred to the technological purposes that they made of the bricks'.***

It would appear that a stimulus, e.g. practical resources (be they scientific or everyday objects) or fiction books, is needed to provide a focus or provoke discussion, but that there may need to be some scaffolding by a more experienced learner. This notion would be explored, independently of each other, by all three co-researchers.

3.0 Methodology

One of the schools identified for participation was a co-educational community primary school that was known by the researcher to have a desire to improve its pupils' scientific awareness. The number of children entitled to free school meals (an indicator of economic deprivation in the UK) was below the national average and the school was situated in a sound economic area. The proportion of children with learning difficulties or disabilities was also below the national average. Two different methods were focused on and used for the research. Firstly, questionnaires were given out to the teachers within the school, one questionnaire per year group. Secondly the children were studied using observations.

Within the school there were approximately 40 pupils per year group. The study focused on ten 8 year-old children who were randomly selected. This was in order to highlight any differences in vocabulary usage between two year groups. Data collected from the 8 year-old children will be the focus for this paper. In order for the research to be completed, a whole day was spent in the school, split between two age groups. As part of the study within this school, the teachers were invited to complete questionnaires. The aim of the questionnaires was to look at teachers' perceptions of the use of scientific vocabulary by children within their classes. In addition, the questionnaire was designed to look into not only teachers' views of scientific vocabulary but also their support of it, and whether they believed the use of resources would encourage children to apply their knowledge of scientific vocabulary. The questionnaire was designed in order to produce quantitative data using closed, highly-structured questions alongside qualitative data, whereby teachers had the opportunity to respond in greater depth to open-ended questions. Furthermore, data were collected by observing children who had been randomly selected. The aim of the observation was to watch, listen and notice the use of scientific vocabulary used by the participants as they undertook investigative activities. The participants were given resources that would be needed to show scientific concepts and left to 'investigate'. The children were asked to work together in pairs and to explain to their partner exactly what they were doing and why. Participant observation took place in the sense that the researcher was working with the children and was prone to intervening in order to progress the learning activity. Robson (2002, p.313) states that what the observer told the pupils about the observations could influence their behaviour. The pupils were told that the reason for the observers' presence was to watch how they used resources, so as not to influence their use of vocabulary. Their conversations were recorded using a digital voice recorder. Questionnaires were also chosen as a data collection method as part of the second study. The questionnaires were similar in design to those referred to above and also, as with the first study, they were piloted to improve their effectiveness. During the study, a total of 14 questionnaires were distributed to four different schools.

Whilst compiling the questionnaire, it was important to split the research question into three sub-questions in order to show teachers' viewpoints on each area. These were:

- Do teachers favour using child-initiated discovery learning in Key Stage 1 (age 5-7) science?
- Do teachers use resources in order to aid their teaching/children's learning in Key Stage 1 science?
- Do teachers feel that children are readily willing to use scientific vocabulary in child-initiated play?

Return to Front

Similarly, as with the first study, structured participant observations took place. In this second study, they focused on four pupils of mixed ability and gender from the same class of five and six year-old children in an inner city primary school.

The third study took place in an inner city primary school. Participant observations were made by the researcher and these were supplemented by filming activities using a digital camera. Observations were made, on separate occasions, of small groups of children. These were in two different age groups, specifically 4 year-olds and 6 year-olds. The resulting video footage was viewed and consequently analysed by the researcher alongside the children's teachers. This provided an opportunity for the researcher to interview the teachers using an unstructured process that basically resembled short ***'conversations with a purpose'*** (Burgess, 1984, p.102).
In each of the three independent studies, in order to make the research ethical, consent was gained from the Headteacher and all teachers who were asked to take part. Letters relating to the 'granting of informed consent' form were sent out to the parents of those children who had been selected to take part in the observation. Appropriate permissions were secured. Confidentiality was also ensured throughout the research; all teachers involved were informed that their confidentiality would be kept and children's parents were aware of the confidentiality policy that was put in place to ensure the anonymity of all children.

4.0 Findings

Of the teachers responding to the questionnaire in the first study, 83% felt that use of resources and hands-on experiences were the best ways to develop children's scientific learning, whereas 17% of teachers felt questioning was the most effective strategy. As can be seen from Table 1 below, teachers relied on modelling or scaffolding to develop children's use of scientific vocabulary or used a practical support. More specifically, 33% of teachers used practical support and 67% used encouragement and prompting. All teachers in this first study felt that children collaborated more effectively after using practical resources and were more likely to use scientific vocabulary.

Table 1

Teachers' principal strategies for developing pupils' scientific vocabulary
'If describing something, encourage children to use correct terminology, if not teach/mention the correct terminology that should be used'
'Introduce the vocabulary at the start of the topic and continue to use throughout'
'Correct children if wrong vocabulary is used after they have been taught the correct vocabulary'
'Use working wall/displays to show relevant vocabulary'
'Create a glossary of vocabulary in back of children's science books'
'Model vocabulary, prompt children to using it when doing experiments'

Comments from teachers included: *'They feel as if they are in the role of the scientist'* and *'Children enjoy using resources and having the opportunity to see this first hand, they are more likely to remember these times and use the relevant vocabulary next time'.*

Observations carried out in this first study were addressing the research question, ***'Do resources encourage children to use scientific vocabulary, word classes and anthropomorphic speech?'***
The frequency of vocabulary used by children during the observation can be seen in Table 2.

Table 2

Age of Children	**Scientific Vocabulary**	**Noun**	**Verb**	**Adjective**
8 years	48	100	40	60

The children in this study were undertaking activity using magnets.

Table 3 shows the degree of sophistication of the vocabulary used by the children. From the research, it was clear that, if the researcher asked questions, an answer containing more scientific vocabulary and word classes was given.

Table 3

Scientific vocabulary used by 8 year-olds
Magnetic Dissolve Nutrients Transparent Attract

Return to Front

Instances of anthropomorphic speech were also noted throughout the observation. An 8 year-old child did use this type of speech, but very briefly during one of the activities. He stated: *'Well, the flower is not alive any more and has been taken away from its family'* in the context of talking about a cut flower. The older children did not use any anthropomorphic speech.

In the second study, the structured observations assisted in gaining an overview of how readily children were willing to use scientific language. These data were transferred into a transcript, which contained both quantitative and qualitative forms of data. The transcript was analysed by organising the data using coding categories and highlighting the *scientific language, pseudo-scientific language* (language which vaguely represents scientific meaning) *and everyday terms* (used in place of vocabulary) in their discussion. In an activity using materials as a focus, it was clear that children were using scientific vocabulary, particularly terms that they had just learned in their science topic. The data were then analysed qualitatively, by looking at whether this scientific vocabulary was used correctly. It was found that all vocabulary was used correctly, although many instances were repeated several times.
One child even explained what *material* meant to the rest of the group: *'It's like the stuff it's made out of.'* This may be some indication that seeking clarification of scientific language helps to develop children's general vocabulary. Table 4 below is a summary of teachers' questionnaire responses in relation to children's vocabulary development stemming from child-initiated play in science. The sample size is very small but it does indicate common trends in teachers' opinions, whilst further confirming that child-initiated learning is a valuable science teaching tool. From this small sample, there seems to be a more positive attitude towards using this pedagogy from the teachers of the five year-old children.
All the teachers in this second study felt that use of discussion in developing scientific vocabulary was *'very important and is used in every lesson.'* Teachers also reached a consensus on children's perceptions towards learning scientific vocabulary, with the mode clearly being: *'They are eager to learn new words and choose to use them in peer conversation.'*

Table 4

	How do you use child-initiated learning in science (if at all)?	**Can you give a few examples of new vocabulary children learn in science lessons?**	**Do children use science vocabulary with other peers in child-initiated science-related play? If so, can you briefly describe?**
Teacher 1 (5 year-olds)	I allow for a group within most lessons to explore scientific meaning	Hot, cold, light, dark, senses, eyes	I am aware of scientific words in everyday discussions
Teacher 2 (5 year-olds)	Extended activities	Fast, slow, push, pull, hot, cold, dark	I can hear scientific words being used in and after lessons
Teacher 3 (5 year-olds)	Group/paired work	Metal, plastic, material, shiny	Occasionally but not always correctly
Teacher 4 (5 year-olds)	I use the role play area often to link into the science topic	Strong, soft, plastic, metal	Children like to use new words and I can hear them when they are talking to their friends
Teacher 5 (6 year-olds)	Outside activities	Diet, germs, leather	Yes, an example of this was a young boy explaining to another child (of lower ability) how their shadows were made
Teacher 6 (6 year-olds)	I do not use child-initiated learning very often	Boiling, cool, heating	I can hear children explaining new concepts to each other
Teacher 7 (6 year-olds)	I tend to use it as an extension, allowing children who have finished set work to learn through exploration	Batteries, wires, smaller, larger	I think they may, and often the teaching assistant and I listen out to see if they are doing this correctly

Return to Front

The third study involved 3 to 4 year-old children and, on separate occasions, 6 year-olds, using scientific resources in free play, or using similar resources with some adult practitioner intervention and also children undertaking scientific investigation following storybook stimulus. The younger children did not use any vocabulary at all, scientific or otherwise, when engaged in free play with no intervention. In fact, they hardly used any 'everyday' language in response to adult intervention. The children's teacher, a recognised leading teacher in Early Years provision, felt that the children could not focus on their play activity and offer verbal responses at the same time. The older children were able to use some scientific vocabulary, but this was restricted to the naming of resources; e.g. magnet or spring. They did not use any scientific vocabulary to describe actions or phenomena when using resources. For instance, they could say that magnets were made of metal but they did not use the word 'attraction', instead preferring the phrase 'sticking together'. Similarly, they did not use the word 'repulsion' and described the phenomenon as 'wobbling' or the magnets 'have blown a bubble and won't fit together'. The younger children did not recognise the word 'pole' but, when doing a magnet dance, they could demonstrate that their hands or feet (extremities) might be the parts of the magnet that might 'stick together'. In modelling magnets via dance, they could push as well as pull to demonstrate knowledge of repulsion and attraction respectively. In other words, they had knowledge of processes but not scientific vocabulary. One child used anthropomorphic speech when describing attraction of metal to a magnet pole, saying *'it only likes the purple one'*; i.e. the coloured pole of the magnet.

When considering the water absorption of biscuits, the younger children did not use any scientific vocabulary. The older children used terms like 'floating' and 'sinking' accurately when placing biscuits in water but misused terms to describe the disintegration of the biscuits in water. More specifically, they said that the colouring from the biscuits melted into the water rather than dissolved. However, they were praised for their powers of observation!

In one activity, investigating falling toy parachutes, the teacher had the support of some adult mentors whose role was to scaffold children's learning. Having given initial instructions, some of which involving measurement of length, the teacher asked the children to carry out the investigation. The teacher was subsequently approached by a mentor who said that the children did not understand the word 'ruler'. The children were Polish. The development of scientific language thus faces additional challenges in terms of international language barriers.

5.0 Conclusion

All three studies found that children's use of resources; e.g. equipment, puppets, artefacts, toys, ICT, big books, etc., helped to promote use of scientific vocabulary to varying degrees. The chance of successful use of resources is further improved when they are employed in a context that is relevant and engaging to the child. This supports the findings of Siraj-Blatchford and Siraj-Blatchford (2002). There were signs that the teachers, particularly those caring for 5 year-olds and younger, advocated child-initiated activity and peer discussion that complements the work of Mercer *et al* (2004) and Johnston (2009) respectively, i.e. these researchers found that pupil-teacher dialogue arising from child-initiated exploration. Similarly, use of questioning and modelling aided vocabulary development in many cases. In effect, the scaffolding of learning used in tandem with resources had a positive synergistic effect. However, Leonard's (2002) ***'emergent science discourse'***, or even the recognised teacher-pupil question and answer pattern, were not apparent in some areas of these studies. This may be due to shortcomings in the children's confidence in the use of general vocabulary.

The findings of these three studies need to be considered in the light of the subjective nature of classrooms. It must also be borne in mind that the schools participating in the research educated children from generally similar backgrounds. It would be interesting to compare these findings with those focusing on children from a wide variety of socio-economic backgrounds. Moreover, the research prompted us to think about investigating if there is any relationship between 'home' language and 'school' language, with particular attention being paid to the impact on children from different ethnic backgrounds. A strategy has been identified to help us to measure these aspects.

References

Advisory Service Kent, Kent County Council, The Learning Group (2008) http://www.kenttrustweb.org.uk/UserFiles/ASK8/File/Primary_Science/Primary_Science_Vocabulary/developing_childrens_vocabulary.pdf [date last accessed 18 Feb 2010]

Barnes, D. (1976) *From Communication to Curriculum.* Harmondsworth: Penguin

Brunton, P. & Thornton, L. (2010) *Science in the Early Years: Building Firm Foundations from Birth to Five.* London: Sage

Return to Front

Burgess, R. (1984) *In the Field: An Introduction to Field Research.* London: Allen and Unwin

Clarke, H. (2000) 'What's the Matter with a Subjective View of Objects? Encouraging Young Children to Talk about their Scientific Ideas about Materials', *SCIcentre 2000 and ASET Conference Report* (pp. 61–66). Leicester: SCIcentre

DfES (1999) *The National Curriculum.* London: HMSO

Johnston, J. (2009) 'Exploratory Play and Emergence in a Conversational Approach', *Emergent Science Newsletter,* **4,** (5), 16–20

Lakoff, G. & Johnson, M. (1980) *Metaphors we live by*. Chicago: University of Chicago Press

Leonard, J. (2002) 'Taking Science Dialogue by Storm', *Science and Children,* **39,** (4), 31–35

Mercer, N., Dawes, L., Wegerif, R. & Sams, C. (2004) 'Reasoning as a scientist: ways of helping children to use language to learn science', *British Educational Research Journal,* **30,** (3), 359–378

Ollerenshaw, C. & Ritchie, R. (1998) *Primary Science: making it work.* London: David Fulton
Robson, C. (2002) *Real World research*. Oxford: Blackwell

Siraj-Blatchford, J. (2000) 'Emergent Science', *SCIcentre 2000 and ASET Conference Report* (pp. 36–39). Leicester: SCIcentre

Siraj-Blatchford, J. & Siraj-Blatchford, I. (2002) 'Discriminating between Schemes and Schema in Young Children's Emergent Learning of Science and Technology', *International Journal of Early Years Education,* **10,** (3), 205–214

Thulin, S. & Pramling, N. (2009) 'Anthropomorphically Speaking: On Communication between Teachers and Children in Early Childhood Biology Education', *International Journal of Early Years Education,* **17,** (2), 137–150

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

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Return to Front

ISSN 2046-4754

Children talking; teachers supporting science

Jane Johnston

The importance of language for cognitive development is recognised (Vygotsky, 1962; Bruner, 1991) as is the role talk plays in scientific development (Johnston, 2010). This research looks at what dialogic teaching (Alexander, 2008) in early years science looks like and how it supports scientific development. It provides some answers to the following questions:

- ***What does dialogic teaching in early years science look like?***
- ***How does dialogic teaching support early years scientific development?***

Six groups of children from 15 months to 9 years of age were videoed playing with toys and supported by adult professionals. The interactions were transcribed to identify the effect that personal, adult participatory and peer participatory interaction had on scientific development (Rogoff, 1995).

The research findings are presented as dialogic case studies and appear to indicate the importance of social interaction in play, encouraging more scientific play with observations, and this needs further exploration.

Keywords: science, dialogue, play, social interaction

1.0 Background

Dialogic teaching

The importance of language for cognitive development (Vygotsky, 1962; Bruner, 1991) as well as for social development (Barnes, 1976) is well recognised. Dialogic teaching (Alexander, 2008) involves sharing ideas and challenging assumptions and is based on the principles that dialogue is:

- collective, so that children and teachers address learning together;
- reciprocal, so that each participant in the dialogue listens to others and there is sharing of ideas and viewpoints;
- supportive, so that there is clear articulation of ideas without fear or embarrassment;
- cumulative, in that it builds on ideas from all participants and these ideas are linked together in a coherent way; and
- purposeful, so that dialogical teaching and learning has clear educational goals. (Alexander, 2008: 28)

Dialogic teaching involves sharing ideas on an equal footing (Mercer, 2000) and, where the language environment is unequal and weighted in favour of the teacher, then it is ***'cognitively restricting'*** (Alexander, 2008: 14; Barnes, 1976). Where talk is seen as social and affective and takes the form of questions by the teacher and answers by the child, it is less effective than sustained dialogue, which can support cognitive development (Cazden, 2001; Alexander, 2008). Indeed, Cazden (2001: 94) found that teachers outside the United Kingdom provide a longer 'wait time' to allow children to respond to questions.

Science and language

A common theme in research findings is the importance of scientific talk (see Johnston, 2010). Kallery *et al* (2008) found that, in teaching about floating and sinking, formal didactic teaching approaches tended to be unsuccessful in supporting understanding and that teachers need to adapt teaching approaches to meet individual and class needs. Understanding of floating and sinking involves children in making cognitive and verbal links between their exploratory findings and scientific phenomena. Tunnicliffe (2007), in research about children's understanding of keeping healthy, found that experience of injuries led to an improved vocabulary of health and safety.

The development of children's scientific skills is also thought (Johnston, 2009) to be dependant on dialogic social interaction in play, so that understandings and skills are developed through adult and peer interaction (Vygotsky, 1962). This is endorsed by Campbell (2009), whose snapshot of science education in early childhood in Australia, through four case studies, identified differing views concerning the importance of language in scientific development. One view was that language plays an important part in scientific development and also in conceptual understanding, whilst the other view was that it was more important for science to be child-led.

Return to Front

Campbell suggests that successful approaches include play and questioning that is relevant, spontaneous and encouraging of deeper thinking and makes use of the rich experiences in the outdoor environment. Less successful approaches were rigidly planned and executed, often by less scientifically confident teachers, so that children's understanding was not extended through interaction and questioning.

Pedagogies to support scientific and language development

There has been increased understanding of the pedagogies that support early scientific learning (e.g. BERA, 2003; National Research Council of the National Academies, 2007; Fleer, 2007), with social interaction being a shared characteristic (Vygotsky, 1962; Siraj-Blatchford *et al*, 2002), especially where it involves practical exploration that builds upon previous knowledge. Active social participation and ***'sustained shared thinking'*** (Siraj-Blatchford, 2009: 77) in scientific development appears to be most effective with children learning alongside peers (Bruner, 1991) and teachers (Stone, 1993), in a complex social interaction identified by Rogoff (1995). This involves children learning through social interaction on three ***'inseparable, mutually constituting planes'*** (Rogoff, 1995: 139): personal, interpersonal and community/contextual, which have been found to be useful in analysing early scientific development (Fleer, 2002; Robbins, 2005).

2.0 Design and procedure

This research focuses on six groups of children from 15 months to 11 years of age playing with toys and supported by adult professionals. The research questions were:

- What does dialogic teaching in early years science look like?
- How does dialogic teaching support early years scientific development?

The youngest children (under 4 years of age) attended a private day nursery in a rural location and the older children (between 4 and 9 years of age) attended a one-form entry primary school. The schools volunteered for the research and parental permission was obtained. In all cases the research took place during the school/setting day, as part of normal practice, and all children whose parents had given permission were included in the research.

In the youngest children (under 4 years of age), free play was observed for 10 minutes, whilst the children played independently with adult interaction from the professionals who worked with them and with the researcher mainly observing. For these children, a collection of toys was placed on the floor. The toys included:

- moving toys, such as a battery-operated hen that danced while singing, and wind-up toys;
- aural toys that made sounds, such as a rattle, a battery-operated chick that cheeped and a jack-in-the-box;
- operated toys that involved some operation by the child, such as a ball and hammer set, a helicopter (whose propellers moved when pushed) and colour-change ducks (which changed colour when warm);
- soft toys, such as a large dog, a sheep rug that could be worn); and
- other toys, such as a large multi-faceted mirror, a magnetic elephant with magnetic body parts and a wooden person (with moveable limbs).

In the older children (4 years of age and above), toys were placed on a table, and an initial period of free play was followed by the researcher questioning about the toys. No other adult was involved in these interactions. The toys included:

- electrical toys, such as a cheeping chick, an electric car and flashing, sound and light balls;
- magnetic toys, such as a monkey and an elephant with magnetic body parts, magnetic frogs and magnetic marbles;
- a variety of wind-up toys, such as a spinning aeroplane and a jumping dog;
- spinning toys, such as a magnetic gyroscope and an electrical spinning top;
- toys that use air to move, such as a jumping frog and a jumping spider (which moved when air in a bulb is squeezed into their legs) and a snake (whose tongue stuck out when squeezed);
- other toys, such as a 'slinky', a sprung jumping man (who jumped up after being pushed down onto a sucker) and a trapeze artist and monkey (who somersaulted when the wooden sides of the trapeze were squeezed).

The play was videoed and the interactions were transcribed to identify the effect that personal, adult participatory and peer participatory interaction had on scientific development (Rogoff, 1995).

3.0 Findings

The findings are presented as a series of case studies that focus on the individual, peer and adult interaction and dialogue and analyses the effect of each on the children's scientific development.

Return to Front

ISSN 2046-4754

Case Study 1

This case study focuses on ten minutes of play and interaction with one child under 2 years of age. The play took place in a group of six children aged 15 months to 2 years of age, with two early years' professionals, plus the researcher.

Dialogue	Analysis
0-5 minutes Boy 2 is hammering by the side of Practitioner 1.	
He goes to Practitioner 2 with the dog and pats at the dog. The practitioner says *'Dog, dog'*. Boy 2 goes back to Practitioner 1 and picks up the moveable man.	By approaching the practitioner, the child initiates the social interaction, whilst the practitioner initiates the dialogue.
He begins to hammer. He picks up the elephant. He hammers some more. He picks up the moveable man. He puts the ball for hammering in the hammering box and starts to hammer.	The child moves from one toy to another, with no social contact. The only evidence of observation involves the hammer, where he is using his prior knowledge in his play.
Boy 2 sits down and watches the dancing chicken, which the researcher has introduced. He is very unsure and starts to move away.	This is an example of affective observations, although in a negative sense.
Boy 2 moves away from the chicken when it is brought close by a girl (he still has the hammer in his hand).	The child engages in superficial, broad observations in play and with toys in the room.
He picks up a duck (still with hammer in his hand) and watches the chicken. He looks around to see what else is going on in the room and sees the dog. Boy 2 goes back to hammering.	The child engages in functional observations, where he is observing the function of the toy and using his own prior knowledge of hammering.
5-10 minutes Boy 2 sits on the floor and watches a girl with the chicken and puts the balls in holes in the hammering box. Boy 2 watches the chicken and picks up the moveable man briefly.	
He goes to Practitioner 2 who has the colour-change ducks and takes two ducks. He gives one to a girl and then she gives it back to him. Boy 2 goes to the mirror and looks at his reflection. Boy 2 claps his two ducks together and wanders around the room. He puts one duck in his mouth.	The child initiates social engagement with the practitioner, but there is no dialogue – a missed opportunity?
Boy 2 kneels in front of Practitioner 1 and sits with two ducks in his hand. He points to a girl with two more ducks. Practitioner 2 brings a bowl of water into the room and Practitioner 1 encourages him to put the ducks in the water.	There is a missed opportunity for dialogue for the development of science knowledge. The boy initiates social interaction with the practitioner.
Practitioner 2 and three children (including Boy 2) begin to put the ducks in the water. They all look at the ducks as they change colour.	The practitioner responds by encouraging exploratory observation.
The professional asks *'What colour has yours gone?'*	This is not real exploration as it appears to be very directed.
They are joined by a fourth child who also plays with the ducks in the water.	The practitioner encourages observation through social interaction and dialogue.

In this case study, play was solitary and often aimless. Interactions, including affective responses, were non-verbal. Boy 2 watches other children but mainly interacts with them when encouraged and led by an adult, encouraging the children to put the ducks in the water and asking them *'What colour has yours gone?'* So, adult modelling of play or participation in play, as well as talking about the toys, was needed to encourage any social interaction and to focus on the functional aspects of the toys. In this way there is some evidence of Rogoff's personal and community/contextual planes (1995).

Return to Front

ISSN 2046-4754

Case Study 2

This case study was part of play and interaction in a group of nine children aged 2 to 4 years of age, with four professionals and the researcher. The case study focuses on the play and interaction of one child (Boy 1) and one adult professional/practitioner.

Dialogue	Analysis
0-5 minutes	
Boy 1 playing with Jack-in-the Box. Takes to practitioner and shows her. Boy 1 picks up toy dog and takes to practitioner and shows her. Boy 1 picks up colour duck and takes to practitioner and shows her.	The child initiates a number of social interactions, but there is not spoken dialogue.
Boy 1 hammers. The practitioner plays with megaphone and speaks to other children through it. Boy 1 picks up Jack-in-the Box, tries to negotiate with a child with the megaphone and then shows Jack-in-the Box to practitioner.	The practitioner models behaviour and functional observations. The child initiates peer social interaction with no spoken dialogue and so opportunities for scientific development are lost.
Boy 1 hammers. He watches chicken dancing. Boy 1 plays with the sheep and dog – *'a sheep dog'*. Puts sheep on his back and becomes the sheep.	The child speaks but there is no dialogue with others. This is an example of ludic play (Piaget, 1976) and using previous knowledge in play.
5-10 minutes	
Boy 1 is playing with moveable man and takes to practitioner and shows her. Dances to chicken. Picks up hammer and hammers own head. Watches butterfly as an adult demonstrates it. Picks up rattle and takes to practitioner. Watches butterfly again. Researcher shows small cheeping chick on the palm of her hand.	This is an example of affective observations. The child is observing but not engaging with others.
Tries out butterfly. Researcher shows kangaroo moving down a ramp.	Having previously watched the adult with the butterfly, the child plays with it and begins to explore it.
Boy 1 picks up megaphone and shows to practitioner. She says *'You sound like a robot. Are you a robot?'*	He initiates social interaction and the practitioner responds with some dialogue.
Plays with Jack-in-a-Box and adult says, *'How do you get that one to work?' 'Push it in'* (no response).	The practitioner encourages the child to explore.

In this case study, with a slightly older child, there was an occasional verbal response, such as when Boy 1 described the dog as a ***'sheep dog'***, although non-verbal responses still predominated; even the negotiation between children for the megaphone was mainly non-verbal with gestures and pointing. Boy 1 initiated some social interaction by taking toys to the practitioner and the practitioner responded by focusing attention on how a toy works (demonstrating how the megaphone works and asking questions about the Jack-in-the-Box). However, Boy 1 appeared aimlessly to pick up one toy after another, and had almost peripheral engagement with others, or engaged in parallel or companionship play (Bruce, 2004). Again there was evidence of Rogoff's personal, interpersonal and community/contextual planes (1995). The adult interaction involved questions that focused on the function of the toys, such as ***'How do you get that one to work?', 'push it in'*** (when encouraging Boy 1 to work the Jack-in-a-Box). Boy 1 did engage in a number of functional responses by looking very intently at different toys and watching how they worked, but self-initiated functional responses were not particularly seen.

Return to Front

Case Study 3

This case study involves two separate interactions. The first is with eight Reception children (aged 4 and 5 years of age) in a one-form entry primary school. The children had only recently started at the school and attended for part of the school day. The play was part of the normal school day. In the initial free play, which preceded this interaction, the children were solitary and static in their play; they did not leave their seats, even to pick up a fallen toy, possibly because they associated table-top play with more formal activities for which they were expected to remain in their seats. In the following interaction, between the children and the researcher, the children were questioned about the toys. The second interaction was with eight Year 1 children (aged 5 years of age) and the focus was on one toy: a trapeze artiste, (who somersaulted when the wooden sides of the trapeze are squeezed). In both interactions the adult is the researcher.

Dialogue	Analysis
Interaction 1	
Adult: What can you tell me about your toy? Boy 1: When I squash my toy sticks its tongue out (squeezy snake). Adult to Girl 2: What can you tell me about your spider? Girl 2: When I do this (squeezes it) it goes………(mumbles).	The adult initiates interaction with the children and the child responds. The children respond directly to the professional regarding the question posed but there is no self-initiated dialogue.
Boy 1: I've got a bird now – I've got a bird. You wind it up and then push it on the ground and ………(wind up bird). Adult: Oh, you wind it up. Boy 1: It's very very clever isn't it?	Boy 1 begins to interact with peers, but the interactions are still adult-led.
Interaction 2	
Adult: Can you tell me about your toy? Which toy are you going to show me? Boy 4 (holding up a trapeze artiste): This one. Adult: This one? And what do you have to do to that one? Boy 4: You twist it (swing the trapeze artiste). It swings!	The adult is still initiating and leading the social interaction, so that dialogue is between her and one child.
Adult: Right, like that? Does anyone know how else to make it move? (To Boy 5, sitting next to Boy 4) Can you get it to move? Boy 5 (swinging it).	The adult attempts to involve other children in the dialogue, but it is still predominately adult-led.
Adult: Right! Can anyone else get it to move? Pass it round. Girl 6: You can push it (pushes the trapeze artist).	The questioning helps to focus the children on the scientific workings of the toys.
Adult: Let me show you another way (squeezes the sides and the artist swings over the top) So what am I doing to make it go up? Boy 4: You…mmmm…pushing the sides to make it go up. Adult (agreeing): I'm pushing the sides to make it go up. Do you think you could do that? You try (gives to Boy 4). Boy 4 (does it). Adult: Well done! So why is it going up when you push the sides? Boy 1: Because it's got a button.	When an element of problem-solving is introduced, the children begin to interact more. However the adult is still leading the dialogue and focusing the dialogue on the function of the toys.
Adult: Because it's got a button? That might be true. You look closely as you press the sides. What's happening? Boy 4: Ah yes! You press that (the nail holding the supports to the side) Adult: You press that button in the middle? Boy 4: Gets it going.	Other children begin to get involved without being directly questioned. The children begin to engage in scientific exploration.

These interactions were very adult-led. However, all responses were mainly verbal and in response to the adult questioning. In the first interaction, with the younger children, the adult led the interactions and the children needed prompting from the adult to make responses. The questioning focuses on the function of the toys but did not appear to support social interaction and discourse. This is possibly because of their age, their limited scientific experiences and their unfamiliarity with the researcher. In the second interaction, although the adult was leading the discussion, there were more social interactions with peers and the beginnings of children focusing more closely on the function of the toy and using the ideas and answers of other children as starting points for their ideas. These ideas were more sophisticated and the discourse (both adult and peer) appears to be helpful in developing the children's scientific ideas.

Return to Front

ISSN 2046-4754

Case Study 4

This case study involves two interactions. The first is with eight Year 3 children (aged 7 and 8 years of age) and the second is with eight Year 4 children (aged 8 and 9 years of age). In both interactions, the play took part of the normal school day and involved free play with no adult interaction; the adult was the researcher who observed the interactions and later questioned the children about the toys they were playing with.

Interaction 1

Many of the interactions during the free play involved emotions and are characterised by exclamations such as ***'Wheee!'***. Many were also social, in that they were requests for attention: ***'Hey, look! Look at that mouse'***, ***'Look! Look! Look!'***, ***'Look at the aeroplane'***, and focused on the functions of the toys**:** ***'Look! It's jumping up. It's jumping up'***. Social interactions were characterised by increasing verbal negotiation with their peers (as compared to younger children):
' I want this'
'Can I look at this after you?'
'You've got this' (giving child the frog).
'I'm going to have a racing one' (racing spider and frog).
Some social interactions began to move from the functional to the exploratory, with children asking, ***'How do you do that?'***, ***'Look at the legs'*** (of the frog and pulling them down) and ***'I'm going to…'***. The functional interaction was later seen in the adult questioning phase of the activity that followed the free play:

Dialogue	Analysis
Girl 1: (with musical spinner) You wind it up like this. It goes and then it stops. Adult: So what happens when you spin it (Girl 1 tries unsuccessfully to spin it) Adult demonstrates and the spinner lights up and plays a tune. All the children giggle. Adult: Oh, so how do you think that one works? Girl 1: It's got a battery in. Adult: I think you're right. What else do you think it's got in it?	The adult initiates the social interaction by asking questions and the dialogue is predominately adult-led. The questioning focuses on the scientific knowledge.
Boy 1: A squeaky battery. Adult: Yes a squeaky battery (all laugh) What else happens as well as the squeak? Something else happens.	Here Boy 1 engages in the dialogue between the adult and Girl 1.
Boy 3: It goes round as well. Adult demonstrates again: Let's have another look. Boy 2: It lit up. Adult: It lit up. So it is going to have what inside it as well?	Boy 3 also joins the dialogue. The adult is still leading the social interaction and focusing the dialogue on the science.
Boy 4: Bulb. Adult: Why do you think it's now not lighting up (as it slows down). Boy 2: Because it's not going very fast. Adult: You think it's to do with the speed. Lets see (and spins it again).	A fourth child joins the dialogue.

Interaction 2

The interactions with these children (aged 8 and 9 years of age) were also characterised by emotional responses, but with more comments, such as ***'Oooh'***, ***'Wicked'***, ***'Ahhh'*** and ***'It's really fit'***, rather than social exclamations. Their interactions were more functional:
'Listen, it cheeps'
'Jumper'
'It spins'
'It flips'
'Oh look, it flips'
'It wobbles'
and social:
'Look at this'
'Watch this'
'Look at mine. It's good mine is. Look at mine'
'I'll swap you'
'Watch this, watch this!'
'Hey pass that'

There was only one example of exploratory play with one girl quietly exploring the working of three separate toys with no interaction with her peers. The adult questioning did not encourage peer interactions as can be seen by the following exchange, when children were being questioned about the electrical car as can be seen in the dialogue analysis overleaf:

Return to Front

Dialogue	Analysis
Girl 3: It moves (car). Adult: Why does it move? Girl 3: The wheels. Adult: And what do you have to do to make it move? Girl 3: You press that. Adult: Why does pressing that make it move?	The adult leads the dialogue by asking questions that focus on the function of the toys.
Boy 2: Is it the wires? (shakes his head) Don't know. Boy 1: Is it electric going to the wires to make it move? (Later) Adult: So what do you need to have in it if you've got electricity?	Boy 2 enters the dialogue and Boy 1 responds, thus initiating peer social interaction that focuses on the scientific aspects of the toys.
Girl 2: Battery. Adult: So do you think there is a battery there somewhere? Girl 2: Yes. Adult: Where?	A third child enters the dialogue, prompted by the adult question.
Boy 4: In both of them (car and handle)	A fourth child engages in the dialogue.

These interactions appear to indicate that the free play was more supportive of social interaction that leads to scientific exploration and the adult questioning had limited value, particularly in terms of social dialogue. In both interactions, the social dialogue encouraged the children to explore the toys' functions and to move from superficial, random engagement with the toys to a scientifically more focused, although limited, engagement.

4.0 Discussion of findings

The research indicates the importance of adult support and dialogic interaction to encourage children to observe, make links between ideas and develop further lines of inquiry.

It appeared that the balance of adult, peer and contextual support was different for different ages. Contextual support was equal in all age groups, adult support was greater in children under 2 years of age and peer support was greater in older children. In the youngest children (see Case Study 1), constant adult support took the form of a monologue of oral scaffolding and modelling, with the adult playing alongside the child (Stone, 1993), focusing the child's attention on some scientific aspects of the toys and supporting language development (Vygotsky, 1962). This monologue appeared to help participants to identify meanings (Bakhtin, 1981), which later can be further explored and negotiated through dialogue. With older children it seemed that the balance of adult and peer verbal interaction changed, with some occasional verbal and self-initiated social interaction (see Case Study 2), but adults were still needed to lead, encourage and challenge children (see Case Studies 2 and 3). The balance of adult, peer and contextual support appeared to change again in children over 4 years of age, with children exercising more autonomy and using prior knowledge in their scientific discourse. This concurs with findings of early years research about the power of social interaction and co-construction in developing understandings of the world (Siraj-Blatchford *et al,* 2002). With young children (see Case Study 2), the adult support was partial, the professionals watching the children and with interaction occurring when instigated by the children or when thought to be socially or pedagogically appropriate. This seems to require professionals who are not only aware of the importance of the complex balance between adult, peer and contextual support, but facilitate oral and social interaction, building on the rich and varied language opportunities found in the home and ensuring that formal settings do not restrict language development (Tizard & Hughes, 1984; Wells; 1987). There is evidence (Siraj-Blatchford *et al,* 2002; EPPE, 2002; EPPE, 2003; Alexander, 2009) that formal early years settings that achieve the best outcomes tend to view social and cognitive development as complementary and recognise that early education can benefit language development and support socialisation (EPPE, 2003). This concurs with the findings of this research and indicates that good outcomes are linked to adult-child interactions that challenge children and extend thinking through open-ended questioning (Siraj-Blatchford *et al,* 2002), thus raising the status of talk through dialogic teaching (Alexander, 2008).

In this research, the need for a balance between adult, peer and contextual support in older children was also evident. In Case Study 4, the adult observed during the free play but then tended to lead during questioning. The free play appeared to be more supportive of scientific development, even with limited social interaction, than adult-led questioning. What appeared to be needed with older children was a more ***'dynamically changing'*** (Rogoff, 1995: 151) combination of interaction, which cannot be planned for but is needed to scaffold scientific engagement and learning. In this way, adult-initiated rather than adult-led discourse appears to be effective, especially where social dialogue between peers is encouraged so that the adult initiates but does not lead or dominate.

Return to Front

The research findings appear to indicate the importance of social interaction in play, encouraging more peer discourse, scientific play and observations This social interaction enables children to negotiate social boundaries (Broadhead, 2004) and develop conceptual understandings through cultural mediation (Bruner, 1991). This confirms ideas concerning effective pedagogy for young children as including interaction between children, their environment and adults (Vygotsky, 1962). Children should be active participants in their own understanding of the world, exercising some autonomy and developing understanding from experiences that build upon their previous knowledge (Piaget, 1929). They should have opportunities to scaffold their own and others' learning (Bruner, 1977), through talk (Alexander, 2008) with adult support (Stone, 1993). However, it is unclear if this is a conscious pedagogical approach adopted by professionals working with young children. It may be that this needs to be explored more fully with professionals working with very young children, to ensure that the children move seamlessly from solitary and quiet to more socially and orally supported functional and exploratory scientific development.

References

Alexander, R. (2008) *Towards Dialogic Teaching: Rethinking Classroom Talk (4th Edition).* York: Dialogos

Alexander, R. (Ed.) (2009) *Children, their World, their Education: Final Report and Recommendations of the Cambridge Review.* London: Routledge

Bakhtin, M.M. (1981) *The Dialogic Imagination. Four Essays.* Austin, Texas: University of Texas

Barnes, D.R. (1976) *From Communication to Curriculum.* Harmondsworth: Penguin

BERA, (2003) *Early Years Research: Pedagogy, Curriculum and Adult Roles, Training and Professionalism.* Southwell, Notts.: BERA

Broadhead, P. (2004) *Early Years Play and Learning: Developing Social Skills and Co-operation.* London: RoutledgeFalmer

Bruce, T. (2004) *Developing Learning in Early Childhood.* London: Hodder & Stoughton

Bruner, J.S. (1977) *The Process of Education (2nd Edition)*. Cambridge, Mass.: Harvard University Press

Bruner, J.S. (1991) 'The Narrative Construction of Reality', *Critical Inquiry*, **18,** (1), 1–21

Campbell, C. (2009) 'Science Education in Early Childhood: a snapshot of Australian settings', paper presented to the *European Science Education Research sAssociation Conference 2009*. Istanbul, Turkey, 31st August to 4th September 2009

Cazden, C. (2001) *Classroom Discourse: the language of teaching and learning.* Portsmouth, NH: Heinemann

EPPE (2002) 'Measuring the Impact of Pre-School on Children's Cognitive Progress over the Pre-School Period', *The EPPE (Effective Provision of Pre-school Education) project Technical Paper 8a.* London: Institute of Education

EPPE (2003) 'Measuring the Impact of Pre-School on Children's Social/ Behavioural Development over the Pre-School Period', *The EPPE (Effective Provision of Pre-school Education) project Technical Paper 8b.* London: Institute of Education

Fleer, M. (2002) 'Sociocultural assessment in early years education: Myth or reality?', *International Journal of Early Years Education,* **10,** (2), 105–120

Johnston, J.S. (2009) 'How does the Skill of Observation Develop in Young Children?', *International Journal of Science Education*, **31,** (18), 2511–2525

Johnston, J. (2010) 'What Emergent Science is telling us about Scientific Development', *Primary Science,* 111, Jan/Feb 2010, 9–11

Kallery, M., Psillos, D. & Tselfes, V. (2009) 'Typical Didactical Activities in the Greek Early Years Science Classroom: Do they promote science learning?', *International Journal of Science Education*, **31,** (9), 1187–1204

Mercer, N. (2000) *Words and Minds: how we use language to think together.* London: Routledge

National Research Council of the National Academies (2007) *Taking Science to School*. Washington, D.C.: The National Academies Press

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

Piaget, J. (1976) 'Mastery Play' and 'Symbolic Play', in Bruner, J., Jolly, A. & Sylva, K. in *Play – Its role in Development and Evolution.* Middlesex: Penguin

Robbins, J. (2005) '"Brown paper packages?" A sociocultural perspective on young children's ideas in science', *Research in Science Education*, **35,** (2), 151–172

Return to Front

ISSN 2046-4754

Rogoff, B. (1995) 'Observing sociocultural activity on three planes: Participatory appropriation, guided participation, and apprenticeship', In Wertsch, J.V., Del Rio, P. & Alvarex, A. (Eds.), *Sociocultural studies of mind* (pp. 139–164). Cambridge, UK: Cambridge University Press

Shayer, M. & Adey, P. (2002) (Eds.) *Learning intelligence. Cognitive acceleration across the curriculum from 5 to 15 Years.* Buckingham: Open University Press

Siraj-Blatchford, I., Sylva, K., Muttock, S., Gilden, R. & Bell, D. (2002) *Researching Effective Pedagogy in the Early Years.* London: DfES

Siraj-Blatchford, I. (2009) 'Conceptualising progression in the pedagogy of play and sustained shared thinking in early childhood education: A Vygotskian perspective', *Educational & Child Psychology,* **26,** (2), 77–89

Stone, C.A. (1993) 'What is Missing in the Metaphor of Scaffolding?', in Forman, E.A., Minick, N. & Stone, C.A. (1993) *Contexts for Learning; Sociocultural Dynamics in Children's Development.* New York: Oxford University Press: 169–183

Tizard, B. & Hughes, M. (1984) *Young Children Learning.* London: Fontana Press

Tunnicliffe, S.D. (2007) 'No time to teach life saving skills? Essential first aid within biology lessons', *Journal of Biological Education*, **42,** (1), 3–4

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

Wells, G. (1987) *The Meaning Makers.* London: Hodder and Stoughton

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Return to Front

ISSN 2046-4754

Pre-school science education in Portugal: teacher education and innovative practices

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Assuming that science education in the early years is the stepping stone for the development of scientific and technological literacy, a teacher training programme was developed with six kindergarten teachers in Portugal. Its aim was to promote the (re)construction of their subject content and pedagogical knowledge leading to innovative practices, based on the characterisation of their profile, shortcomings and practices.

Learning through practice was considered the most effective means to promote change in kindergarten teachers' curricular approaches to science, hence the development of practical activities focusing on children's understanding and requiring their scientific knowledge and enquiry processes. These include a teacher's guide (presenting its objectives, concepts and teaching, learning and assessment strategies), a theoretical framework (presenting the concepts, known misconceptions and research references) and also the necessary didactic resources.

This article details the results of the developed teacher training programme.

Keywords: science education; pre-school; teacher education

1.0 Theoretical framework

Today, scientific and technological literacy is assumed by the research community to be a vital component of the early years teaching curriculum (Osborne & Dillon, 2008). Science and technology should take place in the early years classroom, in a child-centred approach and in a socio-constructivist environment, which will allow children to progress from a description to an explanation of the natural phenomena they observe in their daily lives. In turn, children will also become more competent in constructing shared and 'big' ideas, evolving from personal and 'small' ones (Harlen & Qualter, 2004).

It is no longer debatable that science education does undoubtedly contribute to scientific literacy. A vast number of researchers (such as Harlen, 2006; Eshach, 2006; Van Hook & Husiak-Clark, 2008; Hadzigeorgiou *et al*, 2009; Keogh & Naylor, 1999; Charpack, 1996; Martins *et al*, 2007; Martins *et al*, 2009), have presented the reasons for early science teaching, which should be regarded as a right for every student (Fumagalli, 1998), along with the right for education (UNESCO & ICSU, 1999).

The challenges facing 21st Century society are more efficiently met when the science curriculum is developed within a science-technology-society focus, as far as scientific literacy is concerned (Acevedo-Diaz *et al*, 2003; Aikenhead, 2002; Membiela, 2001). School science is more relevant and appealing to students when it is taught embedded in social contexts that are meaningful to them, with a displaced focus from the teaching of concepts. Children should be able to construct an authentic image about science and technology and about the way scientists work. They should form an elementary idea about the role that science and technology play in their lives and in the evolution of humanity and its relation to the planet in which we all live. School science should contribute to preparing future citizens to critically interact with their world, with its increasing complexity, considering social and ethical values when deciding and acting upon its problems and demands. It is vital that, at an early age, students should develop positive attitudes towards science and science teaching, where the science-technology-society strand of the curriculum will help promote students' motivation both for science and school science (Caamaño & Martins, 2005).

Return to Front

Recent studies on scientific literacy (PISA, 2006; EUROSTAT, 2003) show that Portuguese students ranked poorly compared to most European countries, with results close to those of Italy, Israel and Greece. These are results below OECD average, showing an impact of socio-economic and cultural background above OECD average (Pinto-Ferreira *et al*, 2007). These are facts that reinforce the need for new and innovative ways to teach science, beginning in the early years.

2.0 Pre-school education in Portugal

In Portugal, kindergarten, or pre-school, is non-compulsory, aimed at children between three and six years old. It is provided both in private and public (state) schools, with the latter provision having been established from 1974.

In 1997, the Ministry of Education published the *Curricular Guidelines for Pre-School Education*, presented as guidelines for kindergarten teachers and unlike a curriculum. Its goals are to raise the social value of pre-school education, to improve and rationalise teaching practices nationwide and to promote articulation with elementary schools. These guidelines present three main content areas, which are regarded as fields of knowledge, and include different scopes of learning, considering attitudes and know-how as well as knowledge itself.
The three content areas are:

- *Personal and Social Development*
- *Expression and Communication* (including the following domains: physical, drama, plastic and musical expression; oral expression and writing approach and mathematic expression)
- *Knowledge of the World* (regarded as a first approach to science, experimental and social sciences and to scientific thinking).

3.0 Changes in science education

Facing the current situation, considering science education at the kindergarten level and, in particular, science education in the Portuguese context, government authorities have shown an interest in investing in science education in the early years. In the more recent years, some steps have been taken to contribute to the improvement of the Portuguese early years provision.

The *Program of Primary School Teacher's Education in Experimental Science Teaching* has been developed for four years in Portugal and is seeing an increasing number of elementary teachers enrolling each year (from 986 teachers in 2006/2007, to 2940 in 2008/2009). It is sanctioned and financed by the Ministry of Education, with a workload of 126 hours per year, and consists of a variety of types of sessions aimed at teachers with qualifications at Master's or PhD level. Teachers interested in attending a second year have a whole set of new content available. All the publications relating to this programme are presented in the form of thematic booklets available on the Internet at **www.dgidc.min-edu.pt/experimentais/Paginas/Recursos_Didacticos.aspx**

In January 2009, the Ministry of Education published a booklet entitled *Despertar para a Ciência – Actividades dos 3 aos 6* (*Wake up to science – activities for 3-6 year-olds*), which provides teachers with a theoretical framework supporting science education in kindergarten, as well as 20 practical activities and references to support innovative practices in science. This booklet is available online at **//sitio.dgidc.min-edu.pt/recursos/Lists/Repositrio%20Recursos2/Attachments/805/pre_ciencias_1.pdf** and was delivered to the administrative services of every school in the country. At the same time, a nationwide training programme was implemented, intended to allow kindergarten teachers to learn, reflect and discuss the actual guidelines regarding science teaching in kindergarten, as well as experiment with and access the practical activities presented in the booklet.

In 2007, the same Ministry issued *Regulation nº17/DSDC/DEPEB/2007,* which presented kindergarten teachers with guidelines to support the construction of their classes' curriculum, clearly emphasising science education as an important part of this.

4.0 Promoting change

As well as the measures taken to invest in school science, changes in the education system, to be effective, should take into account the complementary influence of the three main axes of education in general, and of science education in kindergarten in particular: the *kindergarten teacher* (and his/her underlying education process); the *curriculum;* and the *resources* available to implement such a curriculum (Eurydice, 2006; Osborne & Dillon, 2008). It is therefore understood that this is an approach that should be considered in a multi-dimensional way, leading the authors to choose to work co-operatively, benefiting from the expertise drawn from each other's investigations. The teacher training programme, as presented, was developed by two teams of researchers, each researching different aspects related to science education in kindergarten: teacher training, and the science curriculum.

Return to Front

ISSN 2046-4754

5.0 Project presentations

Project A is entitled *Kindergarten Teacher Continuous Education – Contributions for the performance of experimental activities with kindergartners* and its aim is to design a teacher training programme that promotes the (re)construction of subject content and pedagogical knowledge, leading to innovative practices in science education in kindergarten. The developed programme was to be based on the characterisation of the kindergarten teachers' profiles, shortcomings and practices, in order to establish its objectives, contents, strategies and assessment.
To accomplish that purpose, a questionnaire was handed to all the teachers in public and private kindergartens in the Bragança district in northern Portugal in May 2008. Its main purpose was to collect essential data in order to better understand kindergarten teachers' characteristics and expectations, and so to establish and sustain the content of the teacher training programme to be developed. It was structured in three main sections:

- kindergarten teachers' personal characterisation;
- their professional experience and development; and
- aspects related to their practices, namely those regarding content from *Knowledge of the World,* (i.e. science teaching).

Achieving a response rate of 91.5%, it was possible to take into consideration 194 (out of 213) answers. Analysis of the questionnaires allows us to conclude that, compared to teachers in private kindergarten schools, teachers in public schools are, on average, older (45 years old), have longer periods of practice after their academic degrees (over 15 years) and a lower investment in continuing professional development, with 81 teachers out of those sampled having attended no teacher training programme at all and just 21 attending only one. The main reason given by the teachers to justify such a low attendance is the shortage of in-service teacher training programmes available, although they all emphasise the relevance of and need for such programmes to support their professional growth. Those teachers who did attend teacher training programmes show a higher score related to their didactical practices, showing a higher frequency of science-related activities.

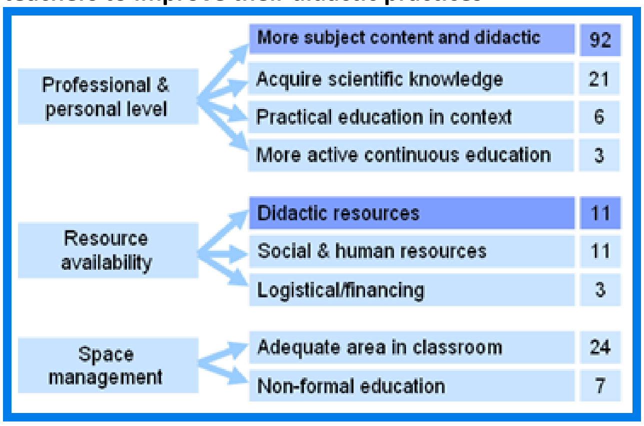
The majority of teachers stated that science should play an important role in their school curriculum, but were unable to elaborate on its aims, purposes and the possible strategies to implement it. The difficulties in conducting scientific activities outlined by kindergarten teachers are presented in Table 1 below, with most being attributed to a poor initial and in-service development.

Table 1 – Difficulties felt by kindergarten teachers in conducting scientific-related activities

Scale	**Response ratio %**					
1=very high, 2=high, 3=medium, 4=low, 5=non-existent	**1**	**2**	**3**	**4**	**5**	**N/A**
Scientific knowledge	2	7	66	17	2	7
Planning	1	9	56	25	4	6
Activity development with children	3	11	51	23	6	7
Content selection	1	11	51	25	5	7
Content adaptation to children's age	4	14	42	28	5	7
Resource acquisition	8	21	46	16	3	6
Connections with other content areas	2	13	41	28	6	9
Group management	2	18	37	26	10	8

Considering the responses given, the teachers suggested measures to improve their own didactic practices, as presented in Table 2.

Table 2 – Suggested measures by Kindergarten teachers to improve their didactic practices



Project B is entitled *Scientific Literacy in Kindergarten – a curriculum proposal* and its aim is to develop a kindergarten science curriculum with a science-technology-society (STS) focus, while establishing adequate science content, process skills and scientific attitudes. It encompasses also the development of a number of practical activities, presenting and detailing the concepts involved, as well as including the necessary educational resources (consisting of a teacher's guide and all the required materials to develop each practical activity).

Return to Front

The empirical validation process of these teaching strategies is to be developed by a number of kindergarten teachers who participate in a specific in-service training programme. Analysis of this process will lead to the definition of a science curriculum for kindergarten, presenting *what* to teach (a set of concepts), *why* teach science (the science process skills and scientific attitudes) and *how* to teach science to pre-schoolers (a set of teaching strategies). This is a process developed along the lines of Hodson (1996, 1998) and the American Association for the Advancement of Science, as presented in *Benchmarks for Science Literacy* (AAAS, 1993).

The overall purpose of this project is to present a science curriculum based on the assumption that kindergarten is a setting in which young children have to take an active part in learning situations that support both the investigative (skills and attitudes) and knowledge-based aspects (concepts) of science education.

From an initial analysis of the *Curricular Guidelines for Pre-School Education* (Ministério da Educação, 1997), some limitations in the document emerged. As a 14 year-old document, it shows itself as very generalistic, where the STS and Education for Sustainable Development (ESD) perspectives are omitted and with inexplicit content presentation and a lack of relevant concepts. It is inexplicit in its competence development presentation (regarding science knowledge, skills, values and attitudes), failing to present clear teaching and learning strategies (regarding types of activities, the framework, the resources…). Discussion about the elementary school curriculum is also absent, leaving kindergarten teachers unsupported in planning their own. These are some of the limitations of the Portuguese curricular document in a context in which, over the last decade, we have witnessed an increased awareness of the role of early science teaching as a consequence of the progressive preponderance of science and technology in modern-day society.

Data were gathered from the analysis of the Portuguese curricular guidelines, as well as of the curricula of the USA and other European countries. These, supported by international investigations in this domain (Saracho & Spodek, 2008; Van Hook & Husiak-Clark, 2008; Havu-Nuutinen, 2005; Hadzigeorgiou *et al,* 2009; Johnston, 1998), led to the development of ten teaching strategies. These practical activities were firstly validated in a real-life context by kindergarten teachers who attended the in-service teacher training programme developed by both projects, and as described below.

The same activities are to be developed again in a real context by kindergarten teachers who will not be attending the specific in-service teacher training programme. In the future, the assessment of kindergarten teachers' practices (in both cases) and of the activities' implementation process will serve to validate the proposed curriculum.

6.0 Links between projects

Project A is, in general terms, based on the assumption that kindergarten teachers must have the adequate subject content and pedagogical knowledge to support innovative science teaching. Project B assumes that a kindergarten curriculum must necessarily include a strong, consistent scientific dimension within a child-centred approach. These are crucial conditions to promote the development of children's scientific ideas in a constructivist learning environment that fosters scientific and technologic literacy. Learning activities should sustain and promote children's curiosity and enjoyment so that they develop a lasting interest in science. To accomplish such a task, it is necessary to teach teachers, developing adequate teacher training programmes and, on the other hand, teaching strategies should be available to kindergarten teachers, providing them with a curriculum to support their practices.

7.0 Teacher training programme presentation

The developed teacher training programme was entitled *S-T-S Education in Kindergarten – Importance of experimental work*, and its aims were to allow kindergarten teachers to:

- understand the relevance of and need for science education in the early years;
- (re)construct subject content and pedagogical knowledge;
- know international guidelines for science education – namely STS education; and
- promote the development of effective teaching strategies in kindergartens.

The teacher training programme was recognised by the Portuguese Teachers Continuous Education Council and was developed in Mirandela in the Bragança district, on a 3-hour/week-sessions basis, during the months of October and November 2009. It had a workload of 50 hours, of which 25 were of presentations/didactic teaching and 25 on an individual basis. Fourteen kindergarten teachers participated in this programme, with 6 participating further in the continuance of the current projects (A and B).

The programme's timetable is described in Table 3 overleaf.

Return to Front

Table 3 – Teacher training program chronogram

Contents	Duration	Session typology
- Chronogram construction - Program aims presentation	3h	Group sessions (TP) – 12h Promote group interaction, dialogue, discussion, analysis, reflection…
- VOSTS questionnaire - S-T-S science education - Kindergarten science education and the development of children's competences. - Scientific competences	3h	
- Kindergarten in science education – recent studies - Different science education perspectives - Teaching and learning strategies – experimental work - Experimental work planning	3h	
Objects and materials	3h	Small group sessions (TP) – 12h Practical activities development and discussion.
Light	3h	
Forces and movement	3h	
Living things	3h	
- Activities development in kindergartens	25h	Individual sessions/work – 25h Activities implementation in kindergartens.
- Results communication and discussion - Assessment	4h	Group session

The programme's practical activities were organised in 4 thematic blocks, leading to the exploration of some relative concepts:

- *Materials and objects* – thermal conductivity, materials & objects, technology in toys and material diversity;
- *Light* – shadows, colour mixing, mirrors and light propagation;
- *Force & motion* – results of forces in toys, kinetic energy, friction and viscosity; and
- *Living things* – bees, living & non-living, germination and silkworms.

These activities were all varied in their typology (exploratory, sorting, illustrative, fair test, etc.), in the educational resources they require (daily lives, laboratory, etc.), their duration (from 1 hour up to 2 months), and in the scientific competences they could develop in children. Here follows an example of one of the activities, entitled *Just let me sleep!*

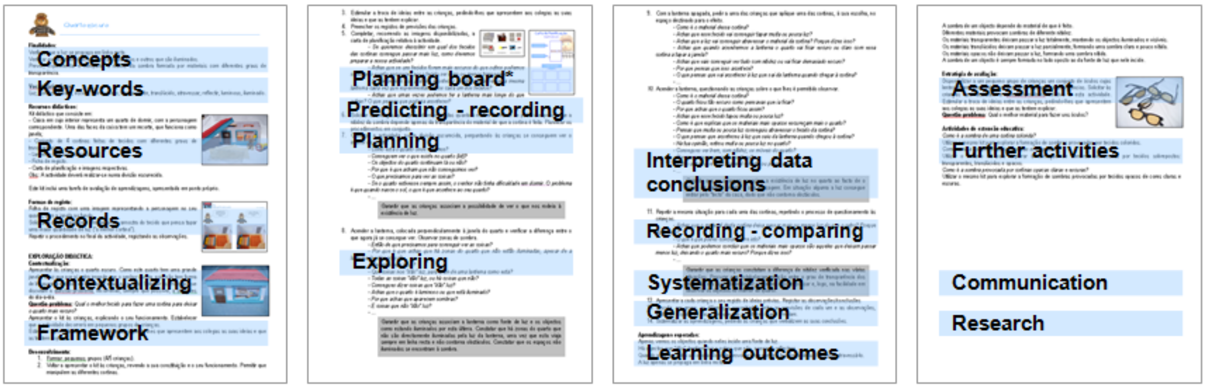
This activity is aimed at the development of a wide range of scientific competences, as described through the examples presented:

- *Content knowledge*: there are luminous and illuminated objects; we can only see when there is light; light can pass through an object/material or cause a shadow; different opacity of materials cause different shadows.
- *Science process skills*: such as comparing; identifying differences and similarities; inferring; interpreting information; and questioning.
- *Scientific attitudes*: such as showing interest in understanding the world; considering others' ideas and opinions; willingness to consider evidence and to change ideas; and perseverance.

The activity's framework is presented below in Figure 1, with the main aspects highlighted. The teacher's guide as presented to the teachers included all the aspects regarding this framework in the form of a consistent plan, which they could adapt to their own contexts. The different phases of the activity, as well as all the aspects regarding their development, are explained in detail.

Return to Front

Figure 1 – Teacher's guide



This activity, as with all those developed for the programme, points to a communication phase, in which children can communicate to others (colleagues, classes, parents) what they did and what they learned, as well as an enquiry phase, in which they can search for more information about the subject matter. All the teacher's guides present a set of questions for the children, aimed at helping the teacher to stimulate children's thoughts and helping them to progress in their ideas.

All the proposed activities are flexible as can be seen by their frameworks, allowing the teacher to adjust some aspects of the methodology to suit their own groups of children. At the implementation sessions that both researchers witnessed, it was evident that teachers adapted some of the phases to their own and specific contexts.

This activity also includes a pack of educational resources containing everything that the teacher will need to develop it with the children. The resource pack consists of a box, made up to portray a bedroom complete with wooden furniture and a big open window, and also includes a flashlight and a set of four curtains made of fabrics of different opacity. The window is the starting point of the activity, leading children to suggest solutions for the problem faced by the activity's little man: What can be done to allow him to sleep during the day as his room is too bright and he works on night shifts?

The record sheet included in the pack shows two images of the bedroom and, on one of them, the children are asked to glue over the window a sample of the fabric that they think is best to darken the room – using their *ideas*. On the second image, they are asked to glue a sample of the fabric that they now see as best for that purpose – the children's *observations*. Included in the resource pack is also a planning board (adapted from Goldsworthy & Feasey, 1997), with a set of cards that have the different variables involved in this experiment illustrated through images.

With the help of the teacher, children try to 'read' the images and, after understanding their meaning, proceed to fill out the planning board on the correct places.

The assessment strategy consists of a set of four spectacles whose lenses have been replaced with the same fabrics used in the curtains of the bedroom. Children are asked to explain which one they think allows better vision, applying what they observed and learned in the practical activity.

8.0 Results of the teacher training programme

We believe that the kindergarten teachers found the teacher training programme to be important and adequate for their needs, leading to positive results in their practice reconstruction, by presenting new and innovative ways of teaching science. It was considered an important practical education programme in context, making them realise the need to continue attending science education programmes, and they understood that they are at the start of a long process.

With regard to the developed activities, these have been shown to be adequate for science education at kindergarten level, after minor changes in some. The concepts were considered appropriate and relevant, and the science skills and attitudes they demand of children adequate. In short, they were considered to be adequate teaching strategies and educational resources for the kindergarten science curriculum.

All this leads us to consider the relevance of continuous professional education to improving and extending ways in which science is taught and, simultaneously, about children's functional understanding of some scientific inquiry processes and related science concepts.

Return to Front

9.0 Conclusions

To conclude, we should consider, as an input to the whole process, the *teacher training programme* on one hand, and the developed *practical activities* on the other. Both were based on the shortcomings present in the science education at kindergarten level, namely, kindergarten teachers' *lack of development* and *lack of resources*. These shortcomings are frequently referred to by the research community as the main reasons for the paradigm existing in schools all over the world, and were also referred to by the kindergarten teachers who answered the questionnaire that preceded the development of the teacher training programme. Analysis of the questionnaires allowed the researchers to establish a programme that would provide an adequate response to these shortcomings, as perceived by the teachers, prompting changes in their practices.

This led to the development of a *teacher training programme* and a *set of teaching strategies*, intended to serve as an articulate and complementary means to support kindergarten teachers' subject content and pedagogical knowledge.

As far as the teacher training programme is concerned, we were able to gather evidence regarding the kindergarten teachers' gained knowledge to support the developed activities, thus leading us to consider the relevance of knowledge in science education. During the development of the teaching strategies, teachers made reference to the nature of science, to the way scientific knowledge is constructed. They promoted children's questioning and adopted group work as the basis of science-related activities. Some inconsistencies regarding language and concepts were observed, but the teachers showed an awareness of these and a willingness to invest in overcoming them, understanding the need of continuous and autonomous learning processes.

While considering the developed educational resources as adequate for the kindergarten level, some were complemented by additional resources from the teacher. Some of the teacher's guides were also adapted, giving them more pertinence to certain educational contexts. In order to do so, they took into consideration both the activities' purposes and their own groups of children, showing conceptual and didactic knowledge to sustain such changes.

Some difficulties were nonetheless encountered. The exploration of the planning chart and the children's records were stated as somewhat difficult to accomplish, mainly due to the fact that they demand certain competencies that both teachers and children were uncomfortable with mobilising. Science education is still in its early stages in the kindergarten curriculum.

On the other hand, and with regard to the developed *teaching strategies*, we were able to gather evidence to believe them to be a means to achieve good practice, allowing us to consider the relevance of resources to science teaching. The implementation sessions were audio-recorded and photographed which, along with handwritten data, allowed for an accurate transcription of events. Analysis of the teaching strategies was based on the evidence that children gave, through their behaviour, performance and words, of mobilising a specific set of skills, attitudes and values. Knowledge was ascertained by considering their responses throughout the activity and, moreover, during the assessment strategy, focusing on children's choices and justifications.

Throughout the different activities, children gave evidence of mobilising a set of skills, attitudes and values, while constructing new and more complex knowledge, as they later revealed in the respective assessment activities. Knowledge from previous activities was transferred to new ones, where children based their arguments and predictions on previous observations.

Analysis of the whole process allows us to conclude that the development of the teacher training programme, with the teaching strategies, is a relevant means to the improvement of the science curriculum provided to young children in kindergartens.

Closing remarks

Emphasising the scientific and technological nature of modern-day society, the research community agrees about the need for science- and technology-literate citizens. Therefore, the educational system must provide an adequate response to this global challenge, investing at the teacher, curriculum and resources levels, contributing towards a more universal science and technological literacy for all.

There is undoubtedly a need for adequate teacher training programmes, as well as adequate teaching strategies, fully supported by a curriculum. In this context, it is possible to conclude that a teacher training programme, such as the one presented in this paper, can show positive results when developed through co-operative work among researchers in co-related areas, contributing to the improvement of science education at kindergarten level.

Return to Front

It proved to make a valid contribution to promoting change in science teaching in the kindergarten context, as it was based on the shortcomings as perceived by the teachers: lack of such in-service teacher training programmes and lack of specific teaching strategies to support innovative practices.

It also provides a clear example of how two of the recommendations made by Osborne & Dillon (2008) in their report to the Nuffield Foundation can be addressed. Science education must be sustained, on one hand, by good-quality teachers, with up-to-date knowledge and skills, as the foundation of any formal science education system and, on the other hand, by innovative curricula and ways of organising the teaching of science that are required to improve the science and technology literacy levels of the next generations.

References

American Association for the Advancement of Science (1993) *Benchmarks for Science Literacy.* Washington, D.C.: Autor

Acevedo-Díaz, J.A., Vasquez, A. & Manassero Mas, M.A. (2003) 'Papel de la educación CTS en una alfabetización científica y tecnológica para todas las personas', *Revista Electrónica de Enseñanza de las Ciências,* **2,** (2), 80–111

Aikenhead, G. (2002) 'STS Education: A rose by any other name'. In R. Cross (Ed.), *Crusader for Science Education: Celebrating and critiquing the vision of Peter J. Fesham*. New York: Routledge

Caamaño, A. & Martins, I.P. (2005) 'Repensar los modelos de innovación curricular, investigación didáctica y formación del profesorado para mejorar la enseñanza de las ciencias en las aulas desde una perspectiva CTS'. In P. Membiela y Y. Padilla (Eds), *Retos y perspectivas de la enseñanza de las ciencias y el enfoque Ciencia-Tecnología-Sciedad en los inicios del siglo XXI.* Spain: Educación Editora

Charpak, G. (1996*) La Main a la Pâte. Les Sciences a L'École Primaire*. Paris: Flammarion

Eshach, H. (2006) *Science literacy in primary schools and pre-schools*. Netherlands: Springer

Eurydice (2006) *Science Teaching in Schools in Europe.* Brussels: Eurydice

Fumagalli, L. (1998) 'O Ensino das Ciências Naturais ao nível fundamental da educação formal: argumentos a seu favor'. Em H. Weissman (org.) *Didáctica das Ciências Naturais. Contribuições e reflexões*, pp.13–29, Porto Alegre: ARTMED

Goldsworthy, A. & Feasey, R. (1997) *Making sense of primary science investigations*. Hatfield: The Association for Science Education

Hadzigeorgiou, Y., Anastasiou, L., Konsolas, M. & Prevezanou, B. (2009) 'A Study of The Effect of Preschool Children's Participation in Sensorimotor Activities on Their Understanding of the Mechanical Equilibrium of a Balance Beam', *Research in Science Education*, **39,** 39–55

Harlen, W. & Qualter, A. (2004) *The Teaching of Science in Primary Schools*. London: David Fulton Publishers

Harlen, W. (2006) *Teaching, Learning & Assessing Science 5-12.* London: SAGE Publications

Havu-Nuutinen, S. (2005) 'Young Children's Conceptions of Temperature and Thermometer', *The International Journal of Learning*, **14,** (9), 93–102

Hodson, D. (1996) 'Laboratory work as scientific method: three decades of confusion and distortion', *Journal of Curriculum Studies*, **28,** (2), 115–135

Hodson, D. (1998) 'Science Fiction: the continuing misrepresentation of science in the school curriculum', *Curriculum Studies*, **6,** (2), 191–216

Johnston, J. (1998) *Learning Science in the Early Years*. Hatfield: Association for Science Education

Keogh, B. & Naylor, S. (1998) 'Concept Cartoons', *Primary Science Review*, (51), 14–16

Martins, I., Veiga, M.L., Teixeira, F., Tenreiro-Vieira, C., Vieira, R.M., Rodrigues, A.V. & Couceiro, F. (2007) *Educação em Ciências e Ensino experimental - Formação de Professores.* Lisboa: Ministério da Educação – Direcção-Geral de Inovação e Desenvolvimento Curricular

Martins, I., Veiga, M.L., Teixeira, F., Tenreiro-Vieira, C., Vieira, R.M., Rodrigues, A.V., Couceiro, F. & Pereira, S. (2009) *Despertar para a ciência – actividades dos 3 aos 6*. Lisboa: Ministério da Educação – Direcção-Geral de Inovação e Desenvolvimento Curricular

Membiela, P. (2001) 'Una revisión del movimiento CTS en la enseñanza de las ciencias'. In P. Membiela (Ed.), *Ensenãnza de las ciencias desde la perspectiva ciência-tecnologia sociedad - Formación científica para la ciudadanía*, pp. 91–106. Madrid: Narcea Ediciones

Return to Front

Ministério da Educação (1997) *Orientações Curriculares para a Educação Pré-Escolar.* Lisboa: Ministério da Educação – Departamento de Educação Básica. Available at: http://www.min-edu.pt/data/Orientacoes_curriculares_preescolar.pdf

Organisation for Economic Co-operation and Development – OECD (2004) *Eurostat 2003 inquiry on national collection of services producer prices*. OECD: Statistics Directorate

Organisation for Economic Co-operation and Development – OECD (2007) *PISA 2006 – Science Competencies for Tomorrow's World: Volume 1: Analysis.* OECD

Osborne, J. & Dillon, J. (2008) *Science Education in Europe: Critical Reflection.* A Report to the Nuffield Foundation. London: King's College London

Pinto-Ferreira, C., Serrão, A. & Padinha, L. (2007) *PISA 2006 – Competências científicas dos alunos portugueses*. Lisboa: Ministério da Educação – Gabinete de Avaliação Educacional

Saracho, O. & Spodek, B. (2008) *Contemporary Perspectives on Science and Technology in Early Childhood Education.* USA: Author's edition

UNESCO (2000) *Science for the Twenty-first Century – A New Commitment. Declaration on science and the use of scientific knowledge*. Paris: UNESCO

Van Hook, S. & Husiak-Clark, T. (2008) 'Lift, Squeeze, Stretch, and Twist: Research-based Inquiry Physics Experiences (RIPE) of Energy for Kindergartners', *Journal of Elementary Science Education*, **20,** (3), 1–16

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Return to Front

ISSN 2046-4754

X is for x-ray: teaching young children about the skeletal system

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This article outlines a case study of a pre-service elementary teacher's first experience teaching science to young children. The study was situated in a US kindergarten classroom (5-6 year-olds) during the same semester in which Amy, the pre-service teacher, was enrolled in her college science methods class. Her challenge was to find ways to incorporate the inquiry-based methods of teaching science advocated in her college science methods class in an actual classroom, where literacy, not science, was the main focus of instruction. Data sources included lesson plans, classroom observation, videotapes, a reflective journal, and informal interviews. A description of this teaching experience from Amy's perspective will be shared.

Keywords: scientific inquiry, literacy, reflective journal, pre-service development, skeleton

1.0 Introduction

In many elementary classrooms throughout the United States, science is one of the subjects being crowded out of the curriculum in favour of literacy instruction. In the current educational climate of standards-based instruction and high-stakes testing resulting from the *No Child Left Behind* (NCLB) Act of 2001, time for science instruction in US elementary schools has been greatly reduced, or is non-existent (Buxton, 2006; Committee on Education, 2004; Goldston, 2005; Griffith & Scharmann, 2008; Spillane *et al,* 2001). This is despite a growing body of research that suggests the essential nature of science education for young children in developing not only the knowledge, skills and attitudes that benefit science, but that also enhance language development and other literacy skills (Eshach & Fried, 2005; Gelman & Brenneman, 2005; Innan, Trundle, & Kantor, 2010). Some elementary teachers are willing to let science slip from the curriculum because they are more comfortable teaching literacy skills than science, due to inadequate science content preparation, lack of self-confidence, anxiety, attitude, and professional identity toward teaching science (Lee & Houseal, 2003). Even teachers who do see the importance of science as an essential subject in the early grades are often under pressure from administrators to focus on literacy skills and are unable to allocate enough time to properly do justice to school science (Froschauer, 2006).

It is not only practicing teachers who are faced with this dilemma, but also university pre-service teachers who are assigned to elementary classrooms to implement the student-centred, inquiry-based science lessons that they hear so much about in their science methods classes. If science is not being taught in their assigned elementary classrooms, they are deprived of the opportunity to apply these teaching strategies. This disturbing scenario has the potential to create a whole generation of new teachers who simply have not had the opportunity to practice implementing meaningful science experiences in classroom settings. However, this does not always have to be the case and innovative ideas can emerge when aspiring teachers realise that there are ways to meet the requirements of both literacy instruction and science. That is what happened when Amy, an early childhood education pre-service teacher and science enthusiast, was assigned to teach a lesson on the letter 'X' to her kindergarten students.

2.0 The curriculum

Literacy

Teaching the letters of the alphabet is a common activity in kindergarten and undoubtedly an important step in providing foundational knowledge for reading. The National Early Literacy Panel Report (2009) lists alphabet knowledge, the knowledge of names and sounds associated with printed letters, as an important predictor of future literacy skills. In the US, children in kindergarten commonly work their way through the alphabet, letter by letter, and this was the case in the classroom where this study took place. The pre-service teacher in this study was assigned two tasks that initially seemed incongruent to her. Her co-operating teacher wanted her to teach a lesson on the letter 'X' and her science methods instructor wanted her to teach a science lesson. As it turned out, the letter 'X' became the perfect letter to illustrate how literacy and science instruction can be linked in a way that serves the requirements of both disciplines. The letter 'X' does not have many word choices with which it can be linked, other than the word 'x-ray'. X-rays can be pictures of bones and bones, of course, are part of the skeletal system of vertebrates. With these beginning ideas and the support of her co-operating teacher and science methods instructor, a meaningful literacy/science lesson emerged.

Return to Front

Science

Although all states in the US have now developed their own individual standards for teaching science, these rely heavily on two documents, *The National Science Education Standards* (NRC, 1996) and/or *Benchmarks for Science Literacy* (AAAS, 1993). Where kindergarten is concerned, there is no direct mention of the skeletal system as a possible topic, but both documents do suggest that it is appropriate for young children to begin learning about characteristics of organisms, specifically how living things have certain structures that serve different functions. Current research on the education of young children indicates that their thinking is surprising sophisticated, which is in contrast to the outmoded view that young children are concrete and simplistic thinkers (Duschl, Schweingruber & Shouse, 2007, p. 53). Children enter school with a great deal of knowledge about the natural world, which can form a foundation for the teaching and learning of scientific concepts. Anatomy is usually a topic dealt with in upper grades, but even young children come to school with knowledge of skeletons from cartoons, the Halloween holiday, museums and even from having broken bones. A significant body of research has investigated young children's understandings of the internal structure of animals. This research indicates that student understanding seems to increase with age and children tend to know more about the human body than other vertebrate animals (Prokop, Prokop, Tunnicliffe & Diran, 2007; Reiss & Tunnicliffe, 1999; Tunnicliffe & Reiss, 1999; Reiss & Tunnicliffe, 2001). This body of work suggests that more attention be spent on teaching children about animal skeletal systems (Prokop *et al,* 2007; Reiss & Tunnicliffe, 2001).

3.0 Research context

Study methods

This interpretive case study is an examination of a pre-service teacher's first experience teaching science. It is bound by time and place, and specific to one student, and one teaching experience. Multiple sources of information were used to gain an understanding of this experience, including the lesson planning process, ongoing informal interviews and discussion, observation of the actual lesson, and a reflective journal – a written reflection of the lesson after implementing it. The lesson was also videotaped, providing the opportunity for Amy to view the experience as not only as the person enacting the lesson but also as an observer seeing it from a different perspective. Data sources reflect the findings of this case study. The study was an attempt to understand human action within an authentic, realistic setting, making it meet the criteria of an interpretive case study (Creswell, 1998; Yin, 1994).

Setting

This study was conducted in a kindergarten classroom in a K-5 private elementary school in a mid-size city in the mid-western part of the US. Approximately 288 students attended the school and there were two classes per grade level, allowing for relatively small class sizes. Although the school is not required to administer the standardised tests that are mandated for public schools in the US, they choose to do so anyway in order to demonstrate to parents that they are a high-achieving school. Students in this school do quite well on standardised tests and the scores of all community schools are reported in the local newspaper. This tends to put a bit of pressure on teachers and administrators for students to do well, because the public tends to make comparison on school quality based on these scores. Private schools like this one are often under even more pressure to excel, because parents pay for tuition, unlike the case with tuition-free public schools. This leads to a focus on literacy and maths, the subjects that are tested. It is interesting to note that this particular school does view science as important and is part of the Green Vision Schools network. One school goal is to teach students to be environmentally responsible citizens. Parents have been very much involved in this initiative and an outdoor classroom for the teaching of science is currently being established. Even though science is viewed as an important subject at this school, it is taught mainly in grades 3-5 and limited to 30 minutes per day. Previously, science in the upper grades was allotted 45 minutes, but this year the time was reduced so more class time could be spent on literacy and maths. In the lower grades, science was not a priority and whether it was taught and how it was taught depended mainly on the individual teacher. In many situations, it is textbook-driven.

Amy spent three hours per week for 10 weeks in a kindergarten (age 5-6) classroom as part of a required practicum in her education programme. At the same time, she was also enrolled in a science methods class for elementary teachers where the focus was on inquiry-based science teaching and the many different ways this could look in an elementary classroom.

4.0 Findings

Amy reflects on her lesson

"I must admit that I was a little intimidated at first about teaching a science lesson In kindergarten, even though I am an early childhood major and very comfortable teaching students in this age group. When my co-operating teacher told me that she wanted me to introduce the letter 'X' in the lesson, I wondered how in the world I was going to combine a *science* lesson required for my college science methods class and the literacy lesson that my co-operating teacher wanted.

Return to Front

After talking with my co-operating teacher and my science methods instructor, I began to see how one lesson could do justice to both subjects. My lesson plan consisted of assessing the children's prior knowledge with a class discussion, providing specific information on x-rays, including visual aids (actual human x-rays), incorporating additional literature with an age-appropriate book, a hands-on matching game, and assessing the knowledge gained by having the class assemble their own skeletons.

Where to start: using prior knowledge

"A concept that I learned in my science methods class was that, in an inquiry-based classroom, it is important to begin with what children already know and link new learning with prior knowledge. To begin this lesson, I asked students if they knew any words that started with the letter 'X'. I was genuinely surprised at the amount of prior knowledge students had as the first part of the lesson played out. Of course, you hear this and read about it in your college classes, but it really is true. Five-year olds are so willing to participate, and their responses included words that had the beginning sound, but not the letter, such as 'exercise', 'escalator' and 'exact'. I validated their thinking by writing these words on the board and explaining that, although they didn't begin with the actual letter 'X', they certainly did have that beginning sound. As I had anticipated (and hoped), one of the words brought up was 'x-ray'. I asked if they knew what an x-ray was and received some great answers that I honestly wasn't expecting: *'a picture of when you get hurt'* and *'a picture of bones, so you can see what is wrong with the person'.* At that point, I knew that an x-ray was something with which many of the children were already familiar. This became even more evident when I asked if any of them had experienced getting an x-ray. This question was a hit! Several of the children relayed their personal x-ray experiences along with those of family members and friends. The x-ray experiences included a broken arm, a finger, and organs such as the lungs and gallbladder.

X-rays

"After the stories and the discussion about the experiences with x-rays, I showed children some x-rays that I had borrowed from a local hospital. I had x-rays of the lower spine, a fractured wrist, the knee, and the rib cage. This part of the lesson was quite engaging for the students, and they were simply fascinated to be able to see actual pictures of the skeletal system! Although they knew about x-rays, being able to actually see and touch them added a new layer of understanding to what these pictures were representing. We then played a game of guess the x-ray. I took out an x-ray and the children told me what they thought it was. They were able to identify the knee, wrist, and spine. After they identified the x-ray, I showed them on me where this was located and then they found that bone on their own body. When we looked at the lower spine x-ray, I had a volunteer turn to her side. I placed the x-ray over her so that the children could see exactly where this was located in the body. This was, by far, their favourite exercise! As they looked at the x-rays, I noticed the children actually touched their kneecaps, wrists, and spine to feel the bones they were seeing on film.

What is inside other animals?

"After what turned out to be a very long and engaging discussion about what was inside us, I introduced some other skeletons to the class using the book, *Rainforest Animal Adventure,* by Sarah Fabiny. This book featured all sorts of different animals, including a jaguar, a frog and a bat. I thought it important for children to move beyond humans so that they would understand that other vertebrates have skeletons, and that the general purpose of the skeletal system is the same. This book is a pull-tab book, and the animals are presented first in their skeletal forms so that the children can only see the bones. When you pull the tab, a picture of the actual animal is revealed. I went through the whole book, page by page, and the children were excited to predict which kind of animal matched each skeleton. I didn't really plan on going through the entire book, but the interest level was so high and the students pleaded to see the next animal. It was at this point that I believe the students were beginning to grasp the concept that the skeletal system is the framework for the body, and they continued to get better at predicting which animal matched the skeleton. I was not explicitly 'telling' them the function of the skeletal system, but I could see that they were beginning to comprehend that the skeleton was what supported the animal's body.

"After reading the book, students played a matching game in pairs, in which they matched an animal's skeleton with its exterior appearance. With the help of my co-operating teacher, I was able to make copies of both the skeletons and the animals to create this game. This actually required a bit of thought on the part of students and their conversations gave insight into their thought processes. They carefully looked for skeletons that formed the framework for what the animal looked like on the outside. Some students were able to do this more easily than others, but it was clear that they were building an understanding of how skeletons function.

Assessment

"To end the lesson and assess student comprehension, I asked students to create their own skeleton from sheets of paper, with arms, legs, a rib cage, and a head. I modelled the directions for this culminating activity by asking the question, *'Does it go here?'* It was obvious that the students knew exactly what to do and happily got to work assembling the human skeleton and glueing the bones onto a piece of black construction paper. The students constructed a final product that had the appearance of a full body x-ray.

Return to Front

The majority of the twenty-two students were able to assemble the basic skeletal parts (arms, legs, head, and torso) with minimal assistance. They then drew the body around the bones. Even before this activity, I was relatively confident that the students had grasped the concept of a skeleton, but this exercise provided additional evidence that they did indeed learn what I hoped they would. Beyond the knowledge acquired by the class, the general feedback from the children and their overall enthusiasm about their lesson was extremely positive.

A question of time

"When I looked at the time, I was shocked! A lesson that was supposed to be no longer than 20 minutes had lasted over twice that long. My co-operating teacher said that the children (and I) were so engaged in what was happening that she allowed the lesson to continue beyond my allotted time. She was satisfied that justice had been done to the letter 'X' and was very pleased that, in the process, the children had learned so much more. I personally feel that the time spent on this lesson was worthwhile as far as learning was concerned. The students were certainly interested and engaged, and multiple experiences are needed for students to build understanding. I could see that, throughout the lesson, students were building their own understanding of the skeletal system and its purpose."

5.0 Discussion

Amy, as a novice teacher, was faced with the challenge of incorporating science into a classroom where literacy was the main focus. She took her knowledge of content and pedagogy and constructed a lesson that integrated what she knew as best practice in science and in literacy. This was a complex process, which required a great deal of thought, review of resources and support from both her co-operating teacher and her science methods instructor. Like the children who spent a great deal of time on the final lesson, Amy also spent time and often felt uncertainty as she considered how to teach this initial science lesson. As a pre-service teacher, Amy 'knew' what science teaching and literacy instruction should look like, and the process of struggling with ways to put this knowledge into practice was a critical part of her development as a teacher. This school was typical of schools in the US, where school science takes a secondary role to literacy instruction (Buxton, 2006; Committee on Education, 2004; Goldston, 2005; Griffith & Scharmann, 2008; Spillane *et al,* 2001). This was the reality of the school culture. As Cochran-Smith (1995) has suggested, it is important for pre-service teachers to situate teaching within the culture of the school and think critically about students' learning opportunities. That is what Amy did. She dealt with the existing situation pragmatically and was able to work effectively in this system to create a meaningful lesson for her students.

In this lesson, students were fully engaged in literacy practices as they listened, spoke with each other and their teacher and learned the letter 'X' and words that began with this letter sound. These literacy practices were embedded in a rich and engaging context that made learning the letter meaningful, supporting existing research on the complementary nature of school science and literacy instruction (Eshach & Fried, 2005; Gelman & Brenneman, 2005; Innan, Trundle, & Kantor, 2010). This lesson began with knowledge that children brought with them from their previous experiences. Even though Amy 'knew' that students came to school with prior knowledge (Duschl, Schweingruber & Shouse, 2007), as she had learned in her college classes, she was surprised at the extent of knowledge that children as young as these brought to school.

Most students already knew about x-rays and the instruction provided at school built upon that knowledge. Not only did students see real pictures of what the skeletal system looks like, but they also built upon that initial knowledge to construct a simple theory of what the skeletal system does. In this case, children were not explicitly 'told' that the skeletal system is the framework for the outside of the body, but they created this understanding for themselves through interaction with each other in the activities provided by the teacher.

Where literacy was concerned, students certainly learned about the letter 'X' and about finding information in books. Each time Amy came to their classroom throughout the rest of the semester, at least one child would say, ***'Remember when you taught us about the letter "X" and x-rays?'*** This opportunity to integrate science and literacy gave Amy a great deal of confidence and the knowledge that when the two subjects are integrated, the learning that takes place is doubled. The focus on literacy in today's elementary classrooms can actually be a benefit for science if the two disciplines are seen as supporting each other, rather than creating a situation where a teacher has to choose one over the other.

6.0 Implications

This case study has several implications for teaching and learning science:

- Children bring a great deal more prior knowledge to the classroom than is often acknowledged. This prior knowledge can serve as a foundation for future learning. Meaningful science instruction begins with what students already bring to the school setting.

Return to Front

- Time is required for students to construct understanding of science concepts. This is time well spent, because it results in meaningful understanding rather than superficial knowledge that is soon forgotten. When students are engaged in the learning process, time passes quickly. In scheduling time in the school timetable for science, this is an important consideration.
- Science is an essential subject in the early grades and can often serve as a rich and meaningful context in which students can apply literacy skills. Rather than taking time away from the literacy skills of reading, writing, listening and speaking, school science can actually enhance the learning of these skills.
- Pre-service teachers need the opportunity to apply what they are learning in their college classes and to face the realities that practicing teachers face every day. When pre-service teachers see first-hand the learning that can take place in school science, without sacrificing other subjects, they are more likely to do all that they can to incorporate meaningful science instruction into their own future classes and not be one of those teachers who is willing to let science slip out of the curriculum.

References

American Association for the Advancement of Science (AAAS) (1993) *Benchmarks for science literacy*. New York: Oxford University Press

Buxton, C. (2006) 'Creating contextually authentic science in a "low-performing" urban elementary school', *Journal of Research in Science Teaching,* (43), 695–721

Cochran-Smith, M. (1995) 'Colorblindness and basket making are not the answers: Confronting the dilemmas of race, culture and language diversity in teacher education', *American Educational Research Journal,* (32), 493–522

Committee on Education (2004) *Lost in space: Science education in New York City public schools*. New York City: The council of the city of New York

Creswell, J.W. (1998) *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, CA: SAGE Publications

Duschel, R.A., Schweingruber, H.A. & Shouse, A.W. (Eds.) (2007) *Taking science to school. Learning and teaching science in grades K-8*. Washington, D.C.: The National Academies Press

Eshach, H. & Fried, M.N. (2005) 'Should science be taught in early childhood?' (Electronic version), *Journal of Science Education and Technology,* **14,** (3), 315–336

Eunice Kennedy Shriver National Institute of Child Health and Human Development, NIH, DHHS (2010) *Developing Early Literacy: Report of the National Early Literacy Panel.* Washington, D.C.: US Government Printing Office

Fabiny, S. (2003) *Rainforest animal adventure*. London: Pinwheel Publishing Company

Froschauer, L. (2006, September 8). 'Should science be included in adequate yearly progress?', *NSTA Reports.* Retrieved May 13, 2008, from www.nsta.org/main/news/stories/nsta_story.php?news_story_ID=52550.

Gelman, R. & Brenneman, K. (2004) 'Science learning pathways for young children', (Electronic version), *Early Childhood Research Quarterly,* (19), 150–158

Goldston, D. (2005) 'Elementary science: Left behind?', *Journal of Science Teacher Education,* (16), p.185Griffith, G. & Scharmann, L. (2008) 'Initial impacts of no child left behind on elementary science education', *Journal of Elementary Science Education*, **20**, (3), 35-48

Innan, H.Z., Trundle, K.C. & Kantor, R. (2010) 'Understanding natural science education in a Reggio Emilia-inspired preschool', *Journal of Research in Science Teaching,* **47,** (10), 1186–1208

Lee, C.A. & Houseal, A. (2003) 'Self-efficacy, standards and benchmarks as factors in teaching elementary school science', *Journal of Elementary Science Education,* **15,** (1), 37–55

No Child Left Behind Act (2002) Public Law No.107–110, 115 Stat 1425

National Research Council (NSES) (1996) *National science education standards*. Washington, D.C.: National Academies Press

Prokop, P., Prokop, M., Tunnicliffe, S.D. & Diran, C. (2007) 'Children's ideas of animal's internal structures', *Journal of Biological Education,* **41,** (2), 62–67

Reiss, M.J. & Tunnicliffe, S.D. (1999) 'Learning about skeleton and other organ systems of vertebrate animals', *Science Education International,* **10,** (1), 29–33

Reiss, M.J. & Tunnicliffe, S.D. (2001) 'Students' understanding of human organs and organ systems', *Research in Science Education,* (31), 383–399

Spillane, J.P., Diamond, J.B., Walker, L.J., Halverson, R. & Jita, l. (2001) 'Urban school leadership for elementary science instruction. Identifying and activating resources in an undervalued school subject', *Journal of Research in Science Teaching,* (38), 918–941

Return to Front

Tunnicliffe, S.D. & Reiss, M.J. (1999) 'Students' understanding about animal skeletons', *International Journal of Science Education,* **21,** (11), 1187–1200

Yin, R.K. (1994) *Case study research: Design and methods.* Thousand Oaks, CA: Sage Publications

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Return to Front

ISSN 2046-4754

News & Notes

The Emergent Science Network

The Emergent Science Network was established in 2007 to:

- facilitate communication between people interested in emergent science;
- develop understanding of young children's scientific development;
- support professional working with young children; and
- evaluate the impact of emergent science research on early years pedagogical practice.

The network provides an important communication link between professionals, academics and others interested in early years science from across the world. Members receive three newsletters a year, collaborate on research, presentations and publications, and communicate ideas and support each other. The latest Emergent Science Newsletter can be found through the following link **http://www.bishopg.ac.uk/docs/Emergent%20Science/ESAutumnNewsletter.pdf**

If you wish to join the network (there is no cost involved), please contact Jane Johnston at **j.s.johnston@bishopg.ac.uk**

IOSTE Mini-symposium, Reading, UK – Contemporary Issues in Science and Technology Education
20th – 21st June 2011 (Welcome Reception on 19th June)

The symposium is open to all those working in the field of science and technology education, including established researchers, Master's and Doctoral students, and practising teachers in schools.

For more information about IOSTE, please visit **www.ioste.org**
For more information about the symposium, please go to **www.ioste-NWE**

ESERA 2011

Early years science education is a strand at the European Science Education Research Association (ESERA) Conference in Lyon, 5th – 9th September 2011. The early years science education strand at the Conference focuses on emergent science, science pedagogy and learning in the early years, cognitive resources for science learning, early years science and technology curriculum, innovative teaching practices in the early years, children's learning, pre-school science and early years teacher education in science.

More information about ESERA membership can be found at **http://www.naturfagsenteret.no/esera/**
More information about the 9th ESERA Conference can be found at **http://www.esera2011.fr/**

Cambridge Primary Review Network

You can contribute to the new Cambridge Primary Review Network, which:

- aims to build reflectively and critically on the ideas, principles and proposals in the final report of the Cambridge Primary Review (CPR);
- is securely grounded in sustainable evidence, whether from the CPR or other sources;
- enhances professional and institutional capacity in the interests of replacing prescription, compliance and dependence by knowledgeable and accountable professional autonomy; and
- improves the quality of primary education experienced by all the nation's children, but especially those who have given the CPR particular grounds for concern: the disadvantaged, the vulnerable, the marginalised, and those who for whatever reason are unable to benefit from the best that primary education can offer.

More information about the Network, the regional centres and how you can contribute can be found on the CPR website: **http://www.primaryreview.org.uk/**

Return to Front

ISSN 2046-4754

News & Notes

Early Years Research Project

Coral Campbell from Deakin University, Australia, is drafting a proposal for an internationally collaborative research project to be undertaken by members of the new Early Childhood SIG of ESERA, to be reported back at ESERA 2011 (preliminary findings) & ESERA 2013:

International Early Childhood Science Education Research Proposal by Coral Campbell:
Currently, we have some understanding of how science education is 'taught' or included in pre-school centres in some countries around the world. From the research undertaken, it would seem that early childhood (EC) practitioners need opportunities for engaging in the content knowledge of science and in learning how to present material to children to stimulate their interest or to move them forward in their understandings.

My proposal is two-fold:

- To undertake a literature search (or, if time, actual research) around different practices in learning and teaching emergent science education in different countries. From this, we can draw on good practice to highlight what effective emergent science education practice looks like. The data may support the contention that professional development is required by EC practitioners in the area of science education. If not, the data may provide evidence about the best way to provide learning opportunities for EC educators. Either result would be of benefit to others attending ESERA. The results of the literature survey will provide the papers for the symposium at ESERA in 2011.
- Depending on the results of the research, the group will develop an intervention strategy in the form of extended professional learning that can be implemented and interrogated from a number of aspects during the delivery of the intervention strategy. This would need to be developed by the group participating in the research.

My suggestion for the intervention strategy would involve a one-day workshop around key ideas in one or two conceptual areas of science. The EC practitioners would be involved in hands-on/minds-on activities, which should help develop their pedagogical content knowledge. At the end of the first session, EC practitioners develop a plan/strategy for implementation of one of the key science areas over the following four weeks. During implementation, they keep a journal/log book, including digital images of what they have been doing. After 4 weeks, they return for another day, at which time they provide feedback on what they have been doing and are given further professional development related to another key area.

In terms of research, there are several aspects:

- Preliminary research into current understandings and practice. This can be as big or as small as is warranted by the researcher and the knowledge they have of previous work in this area in their country. Depending on circumstances, data may be in the form of a literature search, or field work based on questionnaires, surveys or interviews.
- The intervention strategy needs to meet the needs of the researcher – their time availability, funding, etc., and those of the EC practitioners. Again, the number of participants in the intervention strategy would be up to the researcher but, for the validity of international data, a group of no less than 6 should form the cohort participating in the professional development days.
- The data collected from the commencement of the intervention strategy to the end should be consistent across the group and be sufficient to address the question of whether the intervention strategy has improved the science understanding of the EC practitioners, and therefore enhanced the opportunities for children. Data could include researcher observations, pre-post science knowledge questionnaire, interviews with participants after the intervention, and document and artifact gathering. Some researchers may wish to collect data from children, but this is another aspect of the research that is not being included here.

The proposal should be sufficiently flexible to allow individual focuses by researchers, but should provide the baseline data as indicated above. The idea would be to present the preliminary results at ESERA 2011 in France and to publish collaboratively. The results from the research into an intervention strategy would form the basis of our contribution to ESERA 2013. In particular, if we were able to generate six papers from six countries, we could approach a journal for a special edition or possibly even produce a book on the status of science education in pre-schools around the world.

If you would like to take part in this research please contact Coral at **coral.campbell@deakin.edu.au**

Return to Front

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Resource Reviews

Knowledge and Understanding of the World

Early years are key in the education of children. This very readable book provides insights for readers into providing learning opportunities in developing knowledge and understanding of the world. This area is one of the strands of early years education in England in which there are four overarching themes: the development of each child (and each child is unique), health and wellbeing, respecting each other in positive relationships, and the context in which children experience the world (which needs to be an enabling one). All the learning experiences planned and followed by children fall into the six key areas of learning in the Early Years Foundation Stage:

- knowledge and understanding of the world
- personal, social and emotional development;
- communication, language and literacy;
- problem-solving, reasoning and numeracy;
- physical development; and
- creative development.

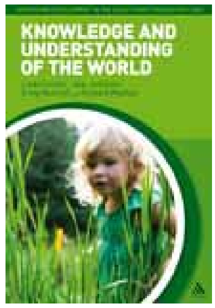
This book has six chapters following the series editors' preface introducing the Early Years stage. In this introduction, they discuss holistic play and how this book, one of a series, supports development of children in the Early Years Foundation Stage. The text seeks to promote an interdisciplinary approach in advocating the provision of rich learning experiences for children through teamwork with teachers and other personnel in a classroom. Meeting the many and different needs of a group of children who are at different stages in age and development is considered.

Each chapter has a very useful summary in a 'content box' at the beginning, which includes references. The chapters are: *Exploration and investigation; Designing and making; Information and communication technology; Time; Place;* and *Communities.* The book ends with conclusions and further reading suggestions, to allow readers to extend their own understanding of this area of education. The authors all provide a holistic view of the themes in a cross-curricular setting.

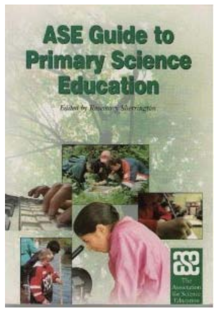
Students and practitioners alike will find the book extremely useful in their learning and reflections on current practice for early years in England, and the invaluable references provide starting points for further reading and research. Educators and those interested parties who work with other age groups will find that this book provides them with useful insights into this crucial stage of education upon which all subsequent learning is constructed.

Sue Dale Tunnicliffe

Return to Front



Knowledge and Understanding of the World
Authors: Linda Cooper, Jane Johnston, Emily Rotchell and Richard Woolley. Series Editors: Jane Johnston and Lindy Nahmad-Williams
Published 2010 by Continuum
Paperback, 135 pages
RRP: £16.99
ISBN: 978-1-4411-3762-**3**



ASE Guide to Primary Science Education
Editor: Wynne Harlen
Published 2011 by the Association for Science Education (ASE)
Paperback, 208 pages
RRP: £19 to ASE members and £25 non-members
ISBN: 978 0 86357 427 6

Be Safe! Health and Safety in School Science and Technology for Teachers of 3 to 12 year olds (4th edition)
Published 2011 by the Association for Science Education (ASE)
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Resource Reviews

ASE Guide to Primary Science Education

This is a new edition of the popular primary guide, with each chapter being written afresh by experts in the field and the whole book being carefully edited by Wynne Harlen. The book is one of a trio of books published by the ASE in 2011; the others are the new edition of the *ASE Guide to Secondary Science Education,* and a new ASE Guide to Research, which will be published later in the year.

This book is divided into four sections, focusing on:

- *Learning science at the primary level*
- *Teaching primary science*
- *Provision for science at the school level*
- *The national and international context*

Chapters include updates on recurrent themes, such as assessment, planning, early years; issues that professionals are tackling at the moment, such as creativity, ICT and the environment; and important issues for developing our teaching and children's learning in science, such as dialogic teaching, international perspectives on teaching and learning and how to smooth transition.

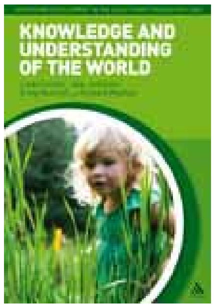
There is a great deal here for the early years science professional working with children up to 8 years of age. Each chapter is based on good practice in primary education and contains:

- discussion of ideas to assist reflective practice and help professionals to engage with the ideas and consider the tensions between theory and practice. For example, Chapter 11, *Formative feedback and self-assessment,* contains boxed research findings that professionals can consider in relation to their own experiences and practice;
- support for professionals in their practice with practical ideas that can be tried out in the classroom and evaluated. In some chapters, these are in the form of case studies; for example, a case study in Chapter 8, *Using IT in teaching and learning science,* focuses on how IT can be used during pond-dipping to maximise motivation and minimise the time spent in recording back in the classroom; and
- references that can be used for further reading in the area to deepen and widen understandings.

Overall, this book is a **must** for anyone serious about developing their own practice and supporting the scientific development of young children.

Jane Johnston

Return to Front



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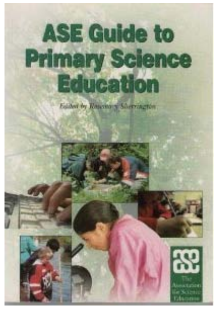

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Be Safe! Health and Safety in School Science and Technology for Teachers of 3 to 12 year olds (4th edition)

This is the fourth edition of this guide. It provides updated material on topics included in previous editions, as well as new materials to support the teaching of health issues and with new sections relevant to early years science teaching and learning. The guide covers a range of science topics that early years professionals would teach, such as *Ourselves and our Senses, Plants, Keeping Animals,* as well as looking at the use of magnets, electricity and making things, etc. There is a separate chapter on *Science for the Under-5s* and, whilst this is useful, it would have been even better to have a short section in each of the relevant chapters to discuss early years issues, as without this it can appear that the other chapters are not relevant to early years.

Within each chapter, the guide suggests materials, plants and animals that are safe to use in the classroom as well as those unsuitable. For example, in the section on *Making Things,* it gives valuable advice on use of tools and materials. Some of this is also covered in Chapter 4, *Science for the Under-5s,* but some distinction between the different stages of development would be really useful. Maybe the addition of an early years expert on the writing team would have been helpful, ensuring that the guide was well matched to professionals working from birth to 8 years of age.

Having said this, the guide is very useful and every teaching professional should have it as a resource to help them in their planning for science.

Jane Johnston

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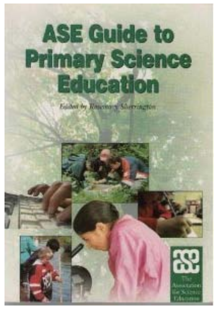

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