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Issue 6 Winter 2013

Contents

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For further details, please see page 43.

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Editorial

The last ten years have seen a huge paradigm shift in science education research and a rise in interest in early years science research. Ten years ago, at science educational research conferences, most research was more science-focused than educational-focused and was predominantly secondary or tertiary, rather than primary. Further, the concept of early years was unfathomable to many science educational researchers, who often commented that young children could not understand scientific concepts and were not capable of scientific skills. For the primary or early years researchers, papers were hidden amongst research on totally unrelated areas and so lost.

Since then, early years science has come of age and been recognised as an important foundation for the development of scientific skills, understandings and attitudes, and research into early years science has blossomed. Key milestones of this paradigm shift have been:

- The use of the term 'emergent science' in order to help the understanding of the beginnings of scientific development;
- An increase in early years science publications across the world, which support practitioners and the children they care for;
- Support for early years articles in ASE publications;
- The start of the Emergent Science Network, which linked early years practitioners across the world;
- The introduction of the Early Years SIG (Special Interest Group) at ESERA (European Science Education Research Association) and a significant increase in research papers submitted to conferences (see extended abstract in this issue by Amauri Bartoszeck from Brazil, which focuses on children's understanding of trees);
- An increase in early years research contributions and the impact of research on practice and provision. The early years extended abstracts from the ICASE World Science Education Conference are evidence of this. They include contributions from around the world: *The role of 3- dimensional mind maps in science teaching and learning of early childhood learners* by Mohun Cyparsade and Vimala Adiapen from Mauritius; *Next Generation Science Standards Stimulating Change in US Science Education* by Mike Padilla from the USA; and *Developing the Scientific Curiosity of 3 to 7 Year Olds* by Sue John, Rebecca Cullen, Delia Cole and Catherine Cooper, Ely and Caerau Children's Centre in Wales;
- The introduction of *JES* as the first science educational research journal dedicated to not only the early years, but also the impact of research on practice and provision, thus attempting to bridge the gap between research and practice; and
- An increase in research conducted by early years practitioners, such as the paper in this edition by Iteen Palmer *(Recognitions and naming of plants and animals by 4 year-olds from differing backgrounds in an English Foundation Stage learning area).*

We are optimistic that the next ten years of scientific educational research will see early years science research as even more firmly established and its importance recognised, and that you will feel able to share your research through *JES.*

Sue Dale Tunnicliffe and Jane Johnston
Editors, *JES*.

Contributing to the Journal of Emergent Science

Instructions for authors

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 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

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

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

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

Guidelines on written style

Contributions should be written in a clear, straightforward style, accessible to professionals and avoiding acronyms and technical jargon wherever possible and with no footnotes. The contributions should be presented as a Word document (not a pdf) in Times New Roman point 12 with double spacing and with 2cm margins.

- The first page should include the name(s) of author(s), postal and e-mail address for contact.
- Page 2 should comprise of a 150-word abstract and up to five keywords.
- Names and affiliations should not be included on any page other than page 1 to facilitate anonymous refereeing.
- Tables, figures and artwork should be included in the text but should be clearly captioned/ labelled/ numbered.
- Illustrations should be clear, high definition jpeg in format.
- UK and not USA spelling is used i.e. colour not color; behaviour not behavior; programme not program; centre not center; analyse not analyze, etc.
- Single 'quotes' are used for quotations.
- Abbreviations and acronyms should be avoided. Where acronyms are used they should be spelled out the first time they are introduced in text or references. Thereafter the acronym can be used if appropriate.
- Children's ages should be used and not only grades or years of schooling to promote international understanding.

- References should be cited in the text first alphabetically, then by date, thus: (Vygotsky, 1962) and listed in alphabetical order in the reference section at the end of the paper. Authors should follow APA style (Author-date). If there are three, four or five authors, the first name and et al can be used. In the reference list all references should be set out in alphabetical order

Guidance on referencing:

Book

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

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

Chapter in book

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

Journal article

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

Reviewing process

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

Books for review

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

The effect of two pedagogical approaches on the scientific development of predictions and hypothesis in the early years

Jane Johnston

Abstract

In recent years there has been increased understanding of the pedagogies that support early scientific development and learning; that is, from birth to 8 years of age. This research looks at the impact on scientific development and learning of two pedagogical approaches: exploration and problem-solving to answer the research question 'what is the effect of the pedagogical approaches on the development of predictions and hypotheses in the early years?'

Evidence was collected during a day of ten science activities, with sixty children aged 6 years with five adults supporting, and using two pedagogical approaches (five exploratory activities and five problem-solving activities). The children's responses to prompt questions were recorded, by the adults working with each group of children, on prompt sheets with each activity, and the responses were categorised into those that contained no links to reasoning, experiential links, tacit or weak links and scientific causal links.

The findings indicated that children provided slightly more responses with explanations (152 – 56%) than without (120 – 44%) and these responses had links equally based on experience and science. There was also evidence that the problem-solving activities generated significantly more responses with scientific causal links (55) as compared to the exploratory activities (5). Problem-solving activities appeared to lead to the generation of more scientific causal links as the children's thinking became more relational-based. It appeared that the activity and prompt questions were important factors in encouraging and supporting explanations for the responses (both predictions and hypotheses). Both the type of activity, and the interaction with adults, supported children in making the links between their observations, prior knowledge and subsequently developing their ideas, process and thinking skills. This has implications for planning science experiences and interacting with children during these experiences.

Keywords:
Early years, pedagogy, prediction, hypothesis

Introduction

In recent years, there has been increased understanding of the pedagogies that support early scientific development and learning; that is, from birth to 8 years of age (e.g. BERA, 2003; National Research Council of the National Academies, 2007; Fleer, 2007; CLS, 2013). This research looks at the impact on scientific development and learning of two pedagogical approaches: exploration and problem-solving, to see how the different approaches encourage predictions and hypotheses.

Background

Predictions and hypothesis

Predictions are statements made about future events, usually based on prior knowledge (Klentschy, 2008). Hypotheses are explanations or sets of possible explanations for observed scientific phenomena or events (Fisher *et al*, 1983; Wenham, 1993), with recognition of relationships in an event (Quinn & George, 1975). Their place in science is recognised, with the nature of science being a body of theories or longstanding hypotheses that can be subject to modification or review (McComas, 1998). The link between hypotheses and predictions is made by McComas (1998) in that hypotheses should lead to predictions, which can be tested, and so support the hypotheses.

Both predictions and hypotheses are sometimes misunderstood by early years and primary teachers. In particular, a hypothesis is often seen as synonymous with prediction and considered a sensible guess, without identification of '*the connections that might obtain between the phenomena under study, at uniformities and patterns that might underlie their occurrence*' (Hempel, 1966: 15). A hypothesis looks back as well as forward and explains data or events that have occurred in the past (Klentschy, 2008), as well as explaining what might happen in the future. A prediction will always look forward, indicating what will occur in the future and is based on prior knowledge (Klentschy, 2008).

Generating both predictions and hypotheses involve observation and use of prior knowledge. Park (2006) identifies that the process of generating a new explanatory hypothesis has three parts:

1. making observation;
2. asking causal questions; and
3. searching for a hypothesis.

Although Park (2006) was working with older students, the process of generating a hypothesis is likely to be the same. Children will recall their prior knowledge during observation, make connections between what they see, have done and what they are currently focusing on and suggest a new explanatory hypothesis. In Park's (2006) research, background knowledge was found to play a role in the development of new hypotheses, with children using 'similarity-based reasoning' in connecting the background knowledge and the conflicting phenomena to be explained. Even when children are very young and do not have a depth of background knowledge, they can generate new experimental hypotheses if they can see the evidence is not there to support their previous ideas. As Park (2006) suggests, the generalisation of new hypotheses can be an effective strategy for conceptual change.

Understanding of the skills involved in making predictions and hypotheses in early years children is hampered by the difficulty of measuring their development (Dixon, 2005). There appears to be some evidence that the development of young children's thinking is initially object-based and moves, as they develop, to more relational-based (Gentner & Medina, 1998; Rattermann & Gentner, 1998), as they make the links between their observations and prior knowledge and discuss these with peers and informed adults (Vygotsky, 1978) in the co-construction of ideas (Siraj-Blatchford *et al*, 2002).

The importance of predictions and hypotheses in scientific inquiry

Predictions and hypotheses are important parts of the scientific process, supporting children in developing their scientific thinking (White, 2004), a primary aim of science education (Li & Klahr, 2006). Predictions and hypotheses also help children to make links between their knowledge and theories (Gentner & Medina, 1998; Rattermann & Gentner, 1998; Howard-Jones *et al*, 2006). However, for young children, scientific inquiry is likely to be more about exploration than investigation, more about observing and making sense of observations in an unsystematic way. The National Research Council of the National Academies (2007: 135) identifies that children can take either 'prediction-oriented' or 'hypothesis-oriented' approaches to inquiry. Prediction-oriented approaches are undertaken by children who are theory-driven, generating hypotheses and then testing the prediction of these through inquiry. Hypothesis-oriented approaches involve children in finding hypotheses that best fit the evidence from their inquiry. In both approaches, there is a need for explanations of why something happens (McComas, 1998) and links between theories and hypotheses; that is, focusing on the larger picture rather than just its component parts (Kosso, 2009). This is a complex process and one that younger children are unlikely to perfect without practice and support.

Primary science specialists tend to emphasise the process of predicting and hypothesising, rather than the production of scientifically accurate predictions and hypotheses (Davis & Coskie, 2009). The process is thought to support conceptual development, especially where there is cognitive conflict between the ideas held by the children, the ideas of others and the scientifically accepted idea (Park, 2006). This is particularly the case where children have the opportunity to reflect and modify their ideas, as a combination of cognitive conflict, metacognition and social construction works best in conceptual development (Shayer & Adey, 2002).

Pedagogies to support scientific skills

The importance of play as a pedagogy is assured through the work of many theorists (Froebel, 1826; Rousseau, 1911; Piaget, 1976) developing interest and having relevance to the child as well as supporting generic and science-specific skills and understandings. Exploratory play that encourages children to explore scientific phenomena is more likely to support the development of scientific skills such as observation, an important generic and specific skill (Pestalozzi, 1894; Piaget, 1929). Explorations and investigations also support skills such as predicting, hypothesising and interpreting, supporting children in their scientific thinking (Gentner & Medina, 1998; Rattermann & Gentner, 1998; Howard-Jones *et al*, 2006; National Academies, 2007). Professionals working with young children need to support them in making links between their observation and hypotheses and theories of science (Kosso, 2009), although these links may not always be apparent to the child, let alone the teacher. Stefanova and Minevska (2009) feel that there is often a one-sidedness in the teacher-pupil relationship, with the teacher explaining a phenomenon to the child, and that this does not result in the child being able to making these links. Support can come through a range of approaches, such as cognitive acceleration techniques (Shayer & Adey, 2002), dialogic teaching (Alexander, 2008), scaffolding (Vygotsky, 1978) and co-construction of ideas (Siraj-Blatchford *et al*, 2002).

Pedagogies to support cognitive and language development

The importance of language for cognitive development (Vygotsky, 1962; Bruner, 1991) 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.

Creative approaches

Creative approaches, such as inquiry-based science education (IBSE), also originate from theorists (Froebel, 1826; Pestalozzi, 1894; Dewey, 1910; Rousseau, 1911). Creative approaches involve innovation, originality, ownership and control (Woods & Jeffrey, 1996; Jeffrey & Woods, 2003), as well as curiosity, connection-making and risk-taking, whilst ISBE also emphasises the role of the teacher. Creative approaches can be used as pedagogical tools for knowledge construction and the development of positive attitudes.

Design and procedure

Research questions and activities

The research looked at how exploratory and problem-solving pedagogical approaches supported scientific development, specifically the scientific skills of prediction and hypotheses with related causal links. Evidence to answer the research question was collected during a day of science activities with sixty 6 year-old children. There were ten activities (five that involved exploration or exploratory play and five that were problem-solving activities) and each one provided opportunities for the scientific skills of prediction and hypotheses with related causal links. Exploratory activities are ones that provide opportunities for children to explore scientific phenomena in their own way, using and developing scientific skills and understandings as they follow their own lines of inquiry. In this research, the exploratory activities were structured by the resources set out on each table, but the direction of exploration was entirely left to the children. Problem-solving activities are ones that pose an initial problem and so structure the lines of inquiry to solve the problem. In this research, the problem-solving activities were structured by an initial question and so were teacher-initiated.

Exploratory activities and prompt questions to promote prediction and hypotheses

1. Ice balloon exploration:
   What do you think will happen when you…put salt on the ice balloon/ put the ice balloon in water?
2. What clothes does Teddy need for his holidays?
   Why does Teddy need these clothes for his holiday?
3. Seasonal playdough exploration:
   What do you think will happen when you…mix the playdough/ add the stars?
4. Exploring materials and mixing materials:
   What do you think will happen when you…touch/ squeeze/ add water to the materials?
5. Seasonal water play:
   What do you think will happen when you…put this in the water/ stir the water?
   Why do you think that has happened?

Problem-solving activities and prompt questions to promote prediction and hypotheses

6. Which gloves will keep the ice hands cold?
   What will happen if you put the different gloves on the ice hands?
7. What wrapping paper is strongest?
   Which paper do you think will be the strongest? Why?
8. Make a box to protect a delicate present:
   What do you think will make a good box? Why?
9. How can we stop Santa's sledge sliding off the roof?
   Which sledge do you think will stay on the roof? Why? Why is this sledge the best?
10. How can we free the bears/ minibeasts from the ice?
    How do you think we can free the bears/ minibeasts?

Sample

The research was carried out with two classes of 6 year-old children. There were sixty mixed-ability children in total, twenty-five per cent of whom had statemented special educational needs. The researcher, two class teachers and two teaching assistants supported the activities and the data collection, moving around the groups and children and activities, so each activity and group of children had similar adult interaction. Permissions for the research were obtained from the school, parents and children.

Procedure

The children started on one activity and could move around the activities freely (although no more than 6 children were allowed at any one table) and each child visited each activity during the course of the day, spending more time on activities that captured their interest. This meant that every activity was equally visited during the day, although some children did spend more time at some activities; this however varied, so that different children chose to spend more time on different activities. The results did not appear to have been affected by the order in which children went to each activity and the enthusiasm for and engagement with the activities lasted throughout the day.

The adult role was to interact with the children, moving around the activities, interacting with the children and recording spontaneous comments and answers to prompt questions. The adults used the prompt questions when the children's own lines of inquiry were flagging and to encourage them to articulate their predictions and hypotheses. The children's responses to the prompt questions and other comments were recorded by the adults working with each group of children on prompt sheets with each activity; the part played by the adult interaction was not part of this study and, whilst this will have an impact on results, this will be minimised by the adults interacting equally with each group. The adults also played a part in the analysis of the responses, using cues from the interaction to identify if responses were predictions or hypotheses. The responses were categorised into those that contained no links to reasoning, experiential links, tacit or weak links and scientific causal links.

Findings

Table: Showing pedagogical approach and the number of responses from children with 1) no links to reasoning, 2) experiential links, 3) tacit or weak links and 4) scientific causal links

Activity	No link	Experiential link	Tacit or weak links	Scientific causal links
Ice balloon exploration	**24 predictions** Turn soft Melt	**1 prediction** It will go harder (because I've done it before)	**3 hypotheses** The water makes the ice smooth and melty Ice gets bigger when salt is added	**1 hypothesis** Melted because the water is HOT!
What clothes does Teddy need for his holidays?	**7 predictions** (mainly lists of clothes needed with no explanation)	**6 predictions** (based on holidays in Spain and experiences) Welly boots (so it's raining)		**2 hypotheses** Needs a coat (for North Pole) Because it's cold Jumper and gloves to keep hands warm
Seasonal playdough exploration	**25 predictions**		**1 hypothesis** Adding stars will make the dough turn gold	
Exploring materials and mixing materials	**28 predictions** (lists of different types of materials)			
Seasonal water play	**12 predictions** The water will change colour The object will sink	**15 predictions and hypotheses** Because the object was too heavy and bubbles float	**8 predictions and hypotheses** Because it is like soap	**2 hypotheses** It will dissolve
Which gloves will keep the ice hands cold?	**2 predictions** Purple glove, not sure why	**17 predictions and hypotheses** Purple woolly glove because the glove is warm	**5 predictions and hypotheses** Thick rubber glove, it's big Because it is already in it	**7 predictions and hypotheses** Because of the properties of the gloves Because it is woolly Because it is rubber
What wrapping paper is strongest?	**9 predictions**	**5 predictions and hypotheses** It feels like it's really strong Because it's soft	**3 predictions** Because it's long You can screw it up	**16 predictions and hypotheses (based on the properties of the paper)** Tin foil because it's like metal Because if you compare it's the heavy one
Make a box to protect a delicate present (we used an egg and this affected the responses)		**3 predictions leading to hypotheses** Bubble wrap because it stops things smashing Make it look like a castle because egg boxes look like castles	**7 predictions and hypotheses** It needs a nest to keep it warm	**6 predictions and hypotheses** Boxes are hard so they're better to protect
How can we stop Santa's sledge sliding off the roof?	**7 predictions** This one – I don't know	**9 predictions** Turn the ramp the other way round Let's do it really high up so it will go down	**1 prediction** It will go easier	**19 predictions and hypotheses** The rough sledge was slowest because it was still Because it has a smooth surface
How can we free the bears/ minibeasts from the ice?	**6 predictions** Put them in a warm place	**8 mainly predictions** Get cup and hold hairdryer underneath to melt ice		**7 predictions and hypotheses** Wait until the ice turns to water The heat from the hairdryer is melting it
Total for Exploratory Activities	96	22	12	5
Total for Problem-Solving Activities	24	42	16	55
Total	120 (44%)	64 (24%)	28 (10%)	60 (22%)

Key:

1. No links to reasoning: children gave no indication of any reasoning underpinning their response
2. Experiential links: links given by children were based on prior experiences in school or at home
3. Tacit or weak links: responses given by children indicated some implied link or weak scientific link
4. Scientific causal links: responses given by children were based on some scientific understanding

Discussion of findings and implications

This analysis indicated that these children provided slightly more responses with explanations (152 – 56%) than without (120 – 44%) and that these responses had links equally based on experience and science. There was also evidence that the problem-solving activities and prompt questions generated significantly more responses with scientific causal links (55) as compared to the explorations and exploratory play (5).

The children's responses were often unsophisticated and object-based and did not have explanations/links. Indeed, many of the responses were simply single word predictions, with no evidence that they were based on any prior knowledge, so more akin to the definition of a prediction as a sensible guess, without identification of '*the connections that might obtain between the phenomena under study, at uniformities and patterns that might underlie their occurrence*' (Hempel, 1966: 15), as opposed to Klentschy's (2008) identification that predictions are based on prior knowledge. This is probably a result of limited experience in children this young and so unsurprising. A few responses (56% of the total) included explanations/links and 40% of these (60 out of 152) were scientific causal links, with a similar number (64 out of 152) based on experience (Park, 2006).

Problem-solving activities appeared to lead to the generation of more scientific causal links as the children's thinking became more relational-based (Gentner & Medina, 1998; Rattermann & Gentner, 1998). It thus appeared that the activity and prompt question were important factors in encouraging and supporting explanations for the responses. It endorses the view that it is important to support children in making the links between their observations, prior knowledge and in developing their ideas through discussion with peers and informed adults (Vygotsky, 1978). This support should not impart knowledge in young learners, but scaffold their development through the co-construction of ideas (Siraj-Blatchford *et al*, 2002). It also involves teachers in knowing when to intervene or interact with children and this is a pedagogical skill that is a characteristic of creative teaching, but not fully utilised in practice (CLS, 2013). In this way, scientific exploration that allows children to follow their own avenues of inquiry, and where teachers allow children 'too much' freedom and do not support them as they learn, is less productive, as is exploration that is so structured that the inquiry is teacher-initiated and teacher-led. In this research, it may be that the problem-solving activities were more successful than the exploratory activities in:

- encouraging the children to focus on the initial observation, so that they move from their initial observation to a slightly more focused observation;
- encouraging observation and thinking skills linked to scientific phenomena, through prompt questions; and
- co-constructing ideas and providing a context in which scientific explanations for their findings build on observations and prior scientific knowledge.

This does not indicate that exploratory activities are without merit, but more that teacher interaction, scaffolding and dialogue are important in all pedagogical approaches (Vygotsky, 1962; Alexander, 2008) and that the nature of the teacher interaction should differ because of the approach and individual child. Further research would be necessary to both explore the effect of different approaches and different teacher interaction, but even this limited research adds to the research body (e.g. CLS, 2013) and indicates some implications for curriculum design, planning science experiences, interacting with children during these experiences and teacher training. A curriculum that is overly prescriptive and proscriptive, content-driven and lacking in relevance to the children is unlikely to support conceptual development. Further, teachers whose pedagogical and content knowledge is insecure are unlikely to be able to fully engage with and support children in their inquiry (Kosso, 2009) and co-construct ideas (Siraj-Blatchford *et al*, 2002).

In addition, teachers need to understand child development; the way children develop scientifically and what the early skills of prediction and hypothesis look like. This research indicates that young children can predict and make scientific-based hypotheses. We need to be careful not to underestimate the ability of early years children to understand how their early experiences, both informal (experiential) and formal (educational), can support the development of their skills in making both predictions and hypotheses. There are, again, implications here for curriculum planning and teacher training, so that teachers can develop skills that enable them to engage in the complex process of teaching (Kosso, 2009).

Although in recent years early years scientific research is more evident, there is still a need for more research focusing on the scientific process in young children and especially to consider the link between skill and conceptual development.

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The recognition and naming of plants and animals by 4 year-olds from differing backgrounds in an English Foundation Stage learning area

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Abstract

The research reported here sought to answer the question of whether the names of plants and animals in our English natural environment are similar to those used in other countries and how this hinders or helps science understanding within the English early years setting.

This work used a case study approach to explore the knowledge and ability of four 4 year-old children from differing non-English backgrounds to recognise and name 'everyday' plants and animals and to suggest the appropriate habitat for each. The source of their knowledge was explored, as well as the name and category they gave to each plant or animal. The children were questioned using a pre-designed protocol, then shown small coloured photographs of each organism and questioned again. The findings show that the children had significant knowledge of plants and animals using their first language. They knew a number of invertebrates, mostly arthropods. Mammals and birds were the most reported vertebrates and the most often seen. Children knew more monocotyledons than dicotyledons. The children were able to use both their home language and the school language to identify organisms.

Keywords

Early years, plants, animals, home language

Introduction

Science in the Early Years is a key part of learning in the Foundation Stage curriculum, known as 'Understanding of the World' (DfE, 2012). This gives clear guidance on providing rich opportunities for children to explore the world around them, using all their senses and oral language skills. Enabling children to begin to learn about their world through exploration and discussion allows them to develop a range of skills and positive attitudes that enhances their learning across the curriculum. Dialogic talk has been found to be most beneficial in this process (Alexander, 2008). Communication is of utmost importance to the Early Years Foundation Stage (EYFS) classroom because, as children are given opportunities to be actively engaged in the dialogic aspects of these science sessions, they have more 'ownership' of their own learning (Johnston, 2005). The environment inside and outside plays a key role in supporting and extending children's development and learning (DfE, 2012) and, although children learn from everything they do, their development depends, in part, on the quality and range of experiences they have received both in the environment of their setting and at home (Sylva *et al*, 2004).

This study attempts to explore the reasoning behind young children's identification of plants and animals, including knowledge of their natural habitat. The quality of home learning plays a key part in the development of a child's development, particularly so when quality support is available for children whose first language is not English (Sylva *et al*, 2004). Young children frequently cite home rather than school as the place where they find out most things. Gatt *et al* (2007) comment that, in a study with Maltese children, they found a restricted understanding of the term 'plant', meaning something small, with a thin stalk, leaves and a flower. Trees, cacti and nettles were not classified by these children as plants. This study identified parents as the main source of knowledge, and schools were rarely mentioned by the children. These findings were similar to an earlier study in New Zealand by Bell (1981), which found that primary-aged pupils from different cultural backgrounds have similar limited ideas about plants, and who name all non-flowering plants as 'grass'. Researchers such as Rosch and Mervis (1975) have recognised for some time that children also identify an organism using the everyday name common to their own culture, and their past experiences of plants and animals help such understanding.

It is important to find out about a young child's understanding and thinking. Using their home language when they first come to a setting is a valuable approach, which avoids confusion if English is at an early stage of acquisition. Only by understanding a child's current attainment and understanding can a teacher help to build on this in a formative way (Harrison & Howard, 2009). It is thought that this can be achieved by creating a rich and varied environment that supports the learning and development of young children. In this way, they are given the confidence to explore and learn in secure and safe, yet challenging, indoor and outdoor spaces (Johnston, 2005).

Early years science is best learned by looking, doing and talking about it in the years from birth to age eight (Johnston, 2011). Hence the learning environment should provide a choice of activities through play that positively reflect the cultural and linguistic identity and experiences of a child. Most importantly, an effective learning environment should provide opportunities to play outside, because most children tend to benefit more from this as they are less inhibited in their use of language in an outdoor environment compared to an indoor one (Riley, 2007).

Attitudes and actions of young children appear to suggest that they engage in scientific thinking and actions long before entering a formal classroom setting. There are some suggestions for fostering scientific vocabulary with bilingual children alongside their engagement with science experiences (Zeece, 1999; Wells, 1985; Harlen, 2011). In many regions of the world, it is commonplace for children to hear two languages from birth (Baker, 2006). In recent years, the rate of multilingualism has steadily increased in Britain, due in part to the establishment of the European Union, ease of mobility between countries and immigration (Baker, 2006). Recent official figures state that the number of pupils in schools in England with English as an additional language is about 10%, or around 650,000 pupils, with almost 300 languages (Kinberg, 2009). Therefore, there are increasing numbers of pupils entering EYFS settings for whom English is not their first language in the home, and who belong to a different culture where their concept of 'plant' and 'animal' might be significantly different from that held by native English children who have always lived in England (Boulter *et al*, 2003).

Three of the children in this study came from a cultural background where English was not their first language, the fourth child spoke English but was from a non-English cultural background (Sri Lankan). Villalbi and Lucas (1991) point out that different languages have different ways of naming plants and animals. For example, 'animal' is used in English everyday language to only refer to mammals, which is biologically inaccurate as an ant is technically an animal as well as an insect, whereas in Spanish this difficulty with semantics does not arise (Johnston, 2005). Personal observations as part of this study showed that the majority of the English second language children struggled with the English label of plants and animals in English, which acknowledges that there was merely a labelling problem with naming plants and animals, as pointed out by Villalbi and Lucas (1991).

Observation is a universal activity through which to learn about the world, unconfined to science. Observations are carried out in a range of contexts and across the areas of learning and development both indoors and outdoors (DfE, 2008). However, observations in science are an important aspect of learning; observing specimens in a focused way can lead to identifying and classifying through pattern seeking. This skill in observation is also helped by observing organisms over time (Turner, 2012). In order to identify an organism, children use the everyday name of the culture in which they are living (Rosch & Mervis, 1975). Moreover, children develop scientific ideas from an early age through the exploration of their immediate environment (Driver *et al*, 1985) inside and outside their home, with the help of their parent or other family member who tends to be their first facilitator in language and information, well before entering an early years setting.

Baker (2006) argues that, in order for multilingual children to develop scientific language, they need to begin with concrete 'hands-on' experiences that the teacher links to the language of science. Listening to what children say is important but, equally, the teacher should 'listen' to what children do not say (Feasey, 2000) and watch (Siraj-Blatchford, 2000). A 'silent period' at the early stages of learning an additional language is natural and normal and is not a sign that something is wrong (Hall, 1995). The use of language does not always have to be oral; for example, watching body language as children engage in a silent activity is an essential part of teaching science and an approach all EYFS practitioners should cultivate, especially with young bilingual children (Siraj-Blatchford, 2000).

Sometimes pupils only use words that are not within their linguistic range, even if given other words by a teacher, as they do not see the reason to use other words (Feasey, 2000). We need to help these children to improve their understanding and English language acquisition by providing opportunities for their speaking and listening to be 'scaffolded' by a more knowledgeable other, which is usually the adult (Vygotsky, 1962; Bruner, 1983). This can be achieved by using an everyday equivalent, in English, alongside a scientific one in their first language, about the world around them. The project sought to find out how three and four year-olds discover information about their environment and how these personal experiences influence their understanding about the plants and animals in the natural world. It also looked at specific terminology that children have acquired in relation to these organisms.

The research questions were:

- Can children of 4 years of age name the animals and plants that they notice in the everyday environment?
- From what source do these children say that they learnt these names?
- What knowledge do the children have of organisms and habitats?
- Is there an effect of their mother tongue on their vocabulary when they learn in English at school?

Methodology

The study took place in a multicultural, inner city state primary school situated in a London borough in England. Two thirds of the school's population came from black and minority ethnic communities. Over two thirds (82%) of the 480 pupils were from a range of minority ethnic groups (Ofsted, 2009). Twenty two percent (22%) were Asian; 16% were black African and Caribbean; 8% were from refugee or asylum seeking backgrounds; and 28% were at the early stages of learning English. There were a high proportion of pupils who were eligible for free school meals.

The research was carried out as part of the usual activities planned for the children. Practitioners would match their observations to the expectations of the EYFS development matters, which include independent activities, practitioner-led activities and activities set up by the adults but where children are expected to work independently (DfE, 2012). This is a frequently used form of first-hand evidence collection made by early years researchers (Maynard & Thomas, 2009). It is also a standardised way of assessing how children are learning and enables practitioners to identify the next step.

The four 3-4 year-old pupils were selected by the class teacher, using the Attainment on Entry (AE) criteria (DfE, 2008), from a group of ten participants across the EYFS who were learning English as an additional language. The focus of the study was on identifying any differences in vocabulary and semantics in naming plants and animals with bilingual children. These children knew more in their first language; however, sometimes definitions and categorisation were different in one culture setting compared to another. The duration of the project was for ten weeks during the months of January to April 2011, in two twenty-five minute sessions on two sequential days each week. The children were from the following countries: Mauritius, India, Kenya and England/Sri Lanka (the English child is bilingual as she is from a background in which English is only spoken at school and by an older sibling at home, as both parents only speak Tamil). It was anticipated that the use of participants from a broad range of home languages would enable the identification of any common factors within the group. Between them, the children spoke Tamil, Gujarati, Hindi, French and English as their home languages. All four participants were at the 30-50 months' level of learning in the EYFS Development Matters Scale of Learning (DfES, 2007).

The ethics of the project were according to those laid out by the British Education Research Association (BERA, 2004), as the main focus was informing and protecting the children who are classified as vulnerable because of their young age .The school obtained parental consent from ten parents. It was also important that the children understood their role in the project and for them to agree to participate in the programme. They were assured that the research would be anonymous and they were informed that they could withdraw from the study at any time. This study occurred as part of the children's EYFS curriculum through one of the strands, 'Understanding of the World' (in science) (EYFS, 2012). It was not specifically designed for the research.

The questions were conducted in the classroom, in a corner of the room. The research was in two parts; firstly, the children were interviewed individually following a prescribed protocol for each child, exploring plants and animals separately from each other. The first activity asked the children to name as many animals as they could in one minute and asked where they had found out about them. Secondly, the children were shown coloured photographs, reduced life-size, of a variety of organisms. The plants subjects were: an apple tree, a rose, a tulip, a sunflower plant, a palm tree, a daisy, lettuce, grass and an orange tree. The animals included a squirrel, a mouse, a pigeon, a crow, an ostrich, a Dalmatian dog, a spider, an elephant, a grass snake and a ladybird. The children were asked to name each organism.

The study was conducted whilst the children were learning about jungle animals and their habitats and explains the inclusion of a palm tree, ostrich and elephant. Each child was asked to name an animal or plant based on its characteristics; for example, 'lives in the jungle' or 'does not live in the jungle', or habitat, to see if they would be able to make the connections with the lesson topic. Then they were asked to say where they had seen/found out about the animals.

Analysis

The taped conversations were transcribed and the different names given were counted manually. These names were then allocated to super-ordinate categories, such as ladybird into 'insects' and spider into 'arachnids', in turn subsumed in a higher category of 'arthropods'. Excel was used as a means of interrogating the data efficiently (see Table 5).

The responses to the first questions were grouped accordingly in the following categories: *Exotic (to this country), Endemic wild, Domesticated for pleasure/food* and *Farmed* (see Table 1). Additionally, plants and animals that were named were divided by using a scientific name and were placed into scientific classifications, such as *gymnosperms* (plants with seeds but no flowers), and flowering plants, which were subdivided into *monocotyledons* and *dicotyledons* (see Table 2). The animals were divided into *Mammals, Birds, Reptiles, Fish, Arthropods, Amphibians, Molluscs, Annelids* and Arachnids. The children's responses to where these plants and animals were seen were categorised into the following groups: woodland/forest, zoo, media, pet shop (plant shop/local shop), school outdoors, home/garden/yard/park/playing field (see Tables 1 and 4).

The points for the data were counted separately. The responses to being asked where the animals /plants had been seen/found out about were analysed using a numbering code, using the following coding: (3) home, (1) school, (2) visit to natural area, (2) media. None of the answers would have a count of more than 4 respondents, due to the number of pupils interviewed. However, when they were asked where they saw the organism, they may have answered using multiple sites such as *'Tesco', 'my nana's front garden'* and *'at home'*; therefore, an answer for where the children saw the organism could have a total of more than four. If a child answered *'I do not remember'*, the answer was not coded and no data gathered on the frequency of this response.

The data presented here exemplify the overall findings and some indication of the different cultural influences on the knowledge of plants and animals of these four pupils.

Results: Plants

Table 1: The total number of plants that pupils named in one minute and where they saw them.

Category of plants named by children	**Child 1 Mauritius**	**Child 2 India**	**Child 3 England/Sri Lanka**	**Child 4 Kenya**	**Total**
Age of students	48 months	49.5 months	44 months	50 months	
Exotic to this country	2	2	1	1	6
Endemic wild	1	1	1	2	5
Domesticated for pleasure/food	2	1	1	2	6
Farmed	1	1	2	1	5
Total	**6**	**5**	**5**	**6**	**22**
Where plants were seen					
Visit to natural area: parks/woodland/forest	1	1	0	0	2
Home/garden/yard/ park/playing field	4	3	2	3	12
School outdoors	1	1	1	1	4
Media	0	0	2	1	3
Zoo	0	0	0	0	0
Pet shops/plant shop/ local shop	0	0	0	0	0

All children identified home/garden/yard as where they saw plants most often. Plant shop/store and zoo were not named as a place in which to see plants. The habitat proved a bit difficult for Child 4 who was is in the early stages of learning English and did not have a wide English vocabulary. Child 1, Child 2 and Child 3 were able to name plants when provided with habitat clues.

Table 2: Total number of plants named in one minute placed into a scientific classification.

Scientific classification	**Child 1 Mauritius**	**Child 2 India**	**Child 3 England/Sri Lanka**	**Child 4 Kenya**	**Total**
Age of students	48 months	49.5 months	44 months	50 months	
Monocotyledons One seed leaf and parallel venation on leaves	2	1	1	1	5
Dicotyledons 2 seed leaves and have branched venation	1	1	1	0	3
Gymnosperm Produce seeds but do not make flowers	0	1	1	1	3
Total	**3**	**3**	**3**	**2**	**11**

Table 3: Plants named when pupils were asked for specific plants and where they were seen.

Description of places in which plants found	Child 1 Mauritius	Child 2 India	Child 3 England/Sri Lanka	Child 4 Kenya	Total
Age of students	48 months	49.5 months	44 months	50 months	
In the garden /yard	1	1	0	1	3
Inside child's house	1	1	1	0	3
Outside child's house	0	0	1	1	2
Lives in wet places	0	0	0	0	0
Lives in water	1	0	1	2	3
Lives on the ground	1	1	1	1	4
Where plants were seen					
Visit to natural area: parks/woodland/forest	1	1	0	0	2
Home/garden/yard/ park/playing field	3	3	2	3	11
School	1	1	1	1	4
Media	0	0	2	1	3
Zoo	0	0	0	0	0
Pet shops/plant shop/ local shop	0	1	0	0	1
Outdoors	0	0	0	0	0

The home/garden/yard remained as the most often cited location in which they had seen the plant.

Results: Animals

Table 4: Total number of animals named in one minute and where they were seen.

Description of places in which plants found	Child 1 Mauritius	Child 2 India	Child 3 England/Sri Lanka	Child 4 Kenya	Total
Age of students	48 months	49.5 months	44 months	50 months	
Exotic to this country	4	3	0	3	10
Endemic wild	0	0	5	0	5
Domesticated for pleasure/food	1	1	0	1	3
Farmed	1	1	0	0	2
Total	**6**	**5**	**5**	**4**	**20**
Where animals were seen					
Visit to natural area: parks/woodland/forest	1	1	1	3	6
Home/garden/yard /park/playing field	3	3	2	0	8
School	1	1	1	1	4
Media	1	1	2	0	4
Zoo	0	0	0	0	0
Pet shops/plant shop/ local shop	0	0	0	0	0
Outdoors	0	0	0	0	0

The results for 'animals' show that Children 1, 2 and 4 name more exotic animals (10), while Child 3 named endemic animals (5) (Table 4). Child 1 (Mauritius) named more animals than any other child (6). The frequency of pets/domesticated animals Child 1 (1), Child 2 (1), Child 3 (0) and Child 4 (1) were similar in these countries. Additionally, the children named farm animals the least, with Child 1 (1), Child 2 (1), Child 3 (0) and Child 4 (0). The animals were seen in the media, in the home/garden, on a visit to natural areas and at school. None of the animals were seen at the zoo, pet shops or outdoors.

Table 5: Showing the number of animals named in one minute using science classifications.

Scientific classification	Child 1 Mauritius	Child 2 India	Child 3 England/Sri Lanka	Child 4 Kenya	Total
Age of students	48 months	49.5 months	44 months	50 months	
Mammals	5	5	4	3	17
Birds	5	3	5	3	16
Reptiles	5	4	1	0	10
Fish	5	3	1	1	10
Arthropods	5	4	0	0	9
Amphibians	5	3	1	1	10
Molluscs	5	0	1	0	6
Annelids	4	0	3	1	8
Arachnids (Spiders)	4	2	4	1	11

In Table 5, invertebrates were mentioned more than vertebrates. The scientific category named the most was mammals (17). The vertebrates encountered every day were birds. The children found it difficult to name a ground-dwelling invertebrate (1) (see Table 6); Child 2 did not name a domesticated animal, and Child 3 did not list animals that live on water. Child 1 came out on top in the scientific classification of animals.

All four children could list flying birds, small mammals, flying vertebrates, animals living in water and nocturnal animals, showing that pupils are quite knowledgeable about most habitats and used some scientific naming to describe animals (Tamer *et al*, 1991) very well.

However, in the scientific classification (Table 5), the following children did not name an animal in the various classifications: Child 2: Molluscs and Annelids; Child 3: Arthropods; and Child 4: Reptiles, Arthropods and Molluscs. Child 1 was able to name an animal in all categories, due to parental support and her understanding of the scientific vocabulary used in her everyday home language.

Table 6: Animals named when pupils were asked for specific animals and where they had seen them.

Description of animals	Child 1 Mauritius	Child 2 India	Child 3 England/Sri Lanka	Child 4 Kenya	Total
Age of students	48 months	49.5 months	44 months	50 months	
Flying birds	2	2	1	1	6
Small mammals	2	1	1	1	5
Domestic animals	1	0	1	1	3
Ground-dwelling invertebrates	1	0	0	0	1
Lives in water	1	1	1	1	4
Lives on water	1	1	0	1	3
Nocturnal animal	1	1	1	1	4
Flying Invertebrates	1	1	1	1	4
Where animals were seen					
Visit to natural area: parks/ woodland/forest/beach	1	1	0	0	2
Home/garden/yard /on way to school	3	3	2	3	11
School	1	1	1	1	4
Media	1	0	2	1	4
Zoo	0	0	0	0	0
Pet shops/plant shop/ local shop	0	1	0	0	1
Outdoors	0	0	0	0	0

The children's knowledge about plants was greater than that of animals. This finding supports Gardner's (1995) descriptions of young pupils as 'naturalists' as they were able to recognise more important distinctions in plants than animals. The data show that pupils' knowledge and understanding of plants came from their home environments. Tunnicliffe and Reiss (2000) explained that pupils' home learning of plants can be through the observation of the eradication of moss from the lawn, planting out flower beds or hanging baskets, or just admiring specimens seen on walks. The frequency of pets/ domesticated animals from Child 1 (1), Child 2 (1), Child 3 (0) and Child 4 (1) were similar in these countries, although the small sample means that results have to be tentative. Additionally, the children named farm animals the least: Child 1 (1), Child 2 (1), Child 3 (0) and Child 4 (0). The animals were seen in the media, at the home/garden, on a visit to natural areas and at school. None of the animals was seen at the zoo, pet shops or outdoors (see Table 4).

Invertebrates were mentioned more than vertebrates. The scientific category that was named the most was mammals (17). Birds were the vertebrates encountered every day. The children found it difficult to name a ground-dwelling invertebrate with only Child 1 able to name one (Table 5); only Child 2 did not name a domesticated animal (Table 6) and Child 3 did not list any animals that live on water. The bilingual pupils who were learning English were better able to identify organisms and their habitats than the English child. Child 1 knew the most about scientific classification of animals, according to her work.

Discussion of research questions

The research questions were as follows:

- From what sources have these children gained their knowledge about plants and animals?

  The findings (see above) indicate that the children's knowledge of plants was greater than their knowledge of animals. This knowledge and understanding of plants came mainly from their home experiences (Tunnicliffe & Reiss 2000), although was dependent on having opportunities as 'home gardeners'. Although the multilingual children were at the early stages of learning English, they were better able to identify organisms and their habitats than the English-speaking child.

  Wandersee and Schussler (2001) explained that young pupils have an innate interest in plants but, when they see an animal moving, they exhibit 'plant blindness' and ignore plants. However, the data from this small sample show that children do notice both plants and animals in their everyday environment.

- What knowledge do children have of habitats and their organisms?

  Children were able to identify plants more easily than animals when talking about their characteristics and when shown picture cues and during the interviews. It could be that pupils are quite knowledgeable on most habitats and understand biological nomenclature (Tamer *et al*, 1991), although this is not fully clear from this research.

  For example, Child 1 was able to name an animal in all categories, which might indicate parental support and her understanding of the scientific vocabulary used in her everyday home language. The data show that pupils' knowledge and understanding of plants came mainly from their home experiences. Therefore, greater effort should be made to help them engage with more opportunities in school. This is possible even in urban schools with very little or no obvious environmental or natural areas.

- Can children name the animals they notice in their everyday environment?

  Some of the animal identification might be the result of familiarity with representations of the organisms during experiences with early years toys and other items, as suggested by Gatt *et al* ((2007). Vygotsky (1978) postulates that children think and learn because they incorporate cultural aspects in their learning. It was interesting to learn of the different names of the animals and plants that the children used when they were relating how they encountered them in their real lives (see Tables 3 and 6). Such findings suggest that their connection between their everyday natural world and learning is not out of touch as is sometimes claimed (Louv, 2006).

  The findings from this short research study seem to indicate that these children have an innate interest in animals and plants, particularly flowers.

- Is there an effect of the mother tongue on their vocabulary when they learn in English at school?

  The language used by each of the children had developed over the ten weeks. They were delighted with the new scientific words they encountered, shown when they frequently repeated a new word, stretching out the sounds as if they enjoyed the words rolling off their tongues. The word 'mammal' became '*mmmmmmmal*', with the pupils learning the phonetic sounds of the letters. Most importantly, much of the new vocabulary was internalised and children were able to use the new words during independent conversations, without prompting. As an example, Child 1, when reading a book, spotted an owl and said to the researcher, '*here is a nocturnal animal. He sleeps all day and comes out at nights'.*

Conclusion

The aim of the project was to explore how four 4 year-olds recognised, identified and grouped plants and animals in the English language used in England and other countries. Children referenced the home and not the school. The children were able to recognise the animals and plants with which they came in contact, name their habitats and use their scientific names, and this scientific learning also improved their English language use. Plants were more readily identified by these children, which could be the result of cultural influences as many of the plants might have been encountered as a common food source or used in home remedies for medicinal use.

This small-scale study indicates the benefits of knowing about the home environment, cultural aspects and home language use in order to support the child's school learning in science.

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Extended Abstract: from the ESERA 2013 Conference

Introduction

ESERA 2013 was the 10th biannual conference of the European Science Education Research Association, and took place from September 2nd – 7th in Nicosia, Cyprus. There has been an early years Special Interest Group (SIG) since 2009 when it was established at the ESERA Conference in Istanbul, Turkey, building upon the work of the Emergent Science Network. The SIG mission statement is to:

- Develop understanding of young children's scientific development;
- Support professional working with young children; and
- Evaluate the impact of early years science research on early years pedagogical practice.

In 2013, the early years strand was very prominent and illustrated the paradigm shift discussed in the Editorial of this edition of *JES*. The research within the strand was wide-ranging, involving children throughout the early years age range (birth to 8 years of age) and a wide range of pertinent issues, such as children's understanding as in the research outlined by Bartoszeck below. There were also two symposia reporting on the research undertaken as part of the *Creative Little Scientist* project. We hope to provide further extended abstracts in the next edition of *JES*.

Extended Abstract

What do early years children think is inside a tree?

■ Amauri Bartoszeck ■ Sue Dale Tunnicliffe

Abstract

The children studied have a basic knowledge of plants, which they glean from everyday observations. 189 children (23 aged 3 years of age, 47 aged 4 years, 68 aged 5 years and 51 aged 6 years) were asked to draw what they thought was inside a tree. Afterwards, 20 children were interviewed to explain their drawings. Analysis of the drawings by 3 year-olds showed that most achieved Level 0 ('unidentifiable') (58%); and those at 4 years achieved Level 4 (17%). Drawings by 5 and 6 year-olds achieved Level 4 (19% and 12% respectively). However, older children showed, by means of drawings and interviews, additional understanding that trees are the habitats of living creatures, and roots and water are crucial to the trees' needs.

Plants are a very neglected area in the curriculum and this study shows that children have a poor understanding of the internal organisation of plants, sometimes depicting human organs as a template for explaining their understandings (Tunnicliffe, 1999). Thus, educators working with early years pupils should elicit the knowledge that their pupils have and its representations and then build on such information when assisting children to construct further understanding of living organisms, in this case trees, in the environment. Therefore, this exploratory study shows that, although pupils have a limited idea of what is inside a tree, they are in fact in touch with their environment and recognise that plants are part of their urban and rural settings.

Keywords

Children, trees, drawings, environment

Background, rationale and purpose

Research about plants and young children in their early years, as well as their understanding of the concept of 'plant', is limited (Tunnicliffe & Reiss, 2000; Bianchi, 2000; Tunnicliffe, 2001). Children from the earliest years notice plants in their everyday lives and build a bank of knowledge, gradually acquiring an understanding of adaptation to habitats (Patrick & Tunnicliffe, 2011). Driver *et al* (1994) explain that children will have a developed theory about the natural world before they experience any formal teaching.

Children who attend nursery, kindergarten and the first grades of primary school classes also obtain information about the natural environment from a variety of informal, non-school sources, including furnishings and the media (Gatt *et al*, 2007). Furthermore, young children learn about organisms from family, friends and self-observation. However, when children are asked to draw what they think is inside a tree with which they are familiar, either in the school grounds, a park or a home orchard, they seem to transfer their knowledge of bones, muscles, veins and heart that are peculiar to vertebrates to trees, using themselves as their template (Carey, 1985).

Children also show some understanding that the tree is a habitat of other living creatures, with a view that water and roots are important for a tree´s needs. Children interpret what is inside the tree from the perspective of the needs of the plant. Children have little understanding of the internal structure of plants, but suspect that there is something inside and seek to explain what they observe by referring to what they already know (Tunnicliffe, 1999).

Drawings were used to elicit the mental model that children have for a tree, its internal structures and surface features, from the expressed model. Drawings channel graphic information, and communicate children´s ideas as a translation of visual properties of objects and scenery into graphics (Rapp, 2007). Symington *et al* (1981) identify three stages in the development of the ability of children to produce pictures: 'scribbling' – an exercise with a pencil, with pictures bearing very little resemblance to the object; 'symbolism', where the picture is used more as a symbol of the child´s idea of the object rather than to show what it is really like; and 'visual realism', where the object and the picture bear a closer and more detailed resemblance.

Research questions:

- What do children reveal they know about the internal organisation of trees through drawing?
- What do children reveal they know from the perspective of ecological views and habitats associated with trees?

Methods

Participants and location

Schoolchildren drawn from the nursery class (22 aged 3 years of age), kindergarten I (41 aged 4 years of age), kindergarten II (65 aged 4 years of age) and first grade of primary school, G1 (53 aged 6 years of age), were asked by the first researcher to draw on a sheet of paper what they thought was inside a tree. Children were allowed 15 minutes for the drawing. A total of 20 pupils were interviewed in a separate room, post-drawing, about what they had drawn. The children attended four public schools in Southern Brazil, one located in a rural area and three public schools in the urban area of Curitiba, Paraná State. Paraná State is known in Brazil as the 'ecology state' on account of its rich ecodiversity. We might expect that these children may have been influenced by this factor from an early age.

Analysis of the drawings

A rubric scale of levels was compiled based on those constructed in other biological fields (e.g. Tunnicliffe & Reiss, 1999; Bartoszeck *et al,* 2011) on conceptual levels of anatomical features drawn for the tree on the drawings. Features of environmental surroundings and meteorological factors depicted were also rated. Once features were identified, a score was allocated to the drawings based on the items included by the raters (Table 1).

Table 1: The rubric scale used to allocating a grade to the drawings.

Level	Source of knowledge
0	Scribble
1	First-hand observations remembered (resemblance to a tree)
2	Internal parts of a tree (water tubes, veins, heart, lungs)
3	External parts of a tree (roots, branches, leaves, fruit, bark)
4	Ecological & habitat views associated with trees (birds, ants, butterflies, nest, grass, sun, clouds).

Exemplars of drawings and grades allocated are shown in Table 2:

Table 2: Drawing grade levels achieved by children by age and gender.

Age	Female/level					Male/level					Total
	0	1	2	3	4	0	1	2	3	4	
3 y. o.	6	1	0	1	0	7	5	1	1	0	23
4 y. o.	2	9	3	7	6	3	12	1	2	1	47
5 y. o.	1	10	2	10	6	3	18	1	10	7	68
6 y. o.	4	7	2	6	5	5	8	5	8	1	51/189

Figure 1: A drawing by a three year-old girl, which scored as Level 0 according to grades in Table 1.

Figure 2: A drawing by a four year-old girl, which scored as Level 1 according to grades in Table 1.

Figure 3: A drawing by a four year-old boy, which scored as Level 2 according to grades in Table 1.

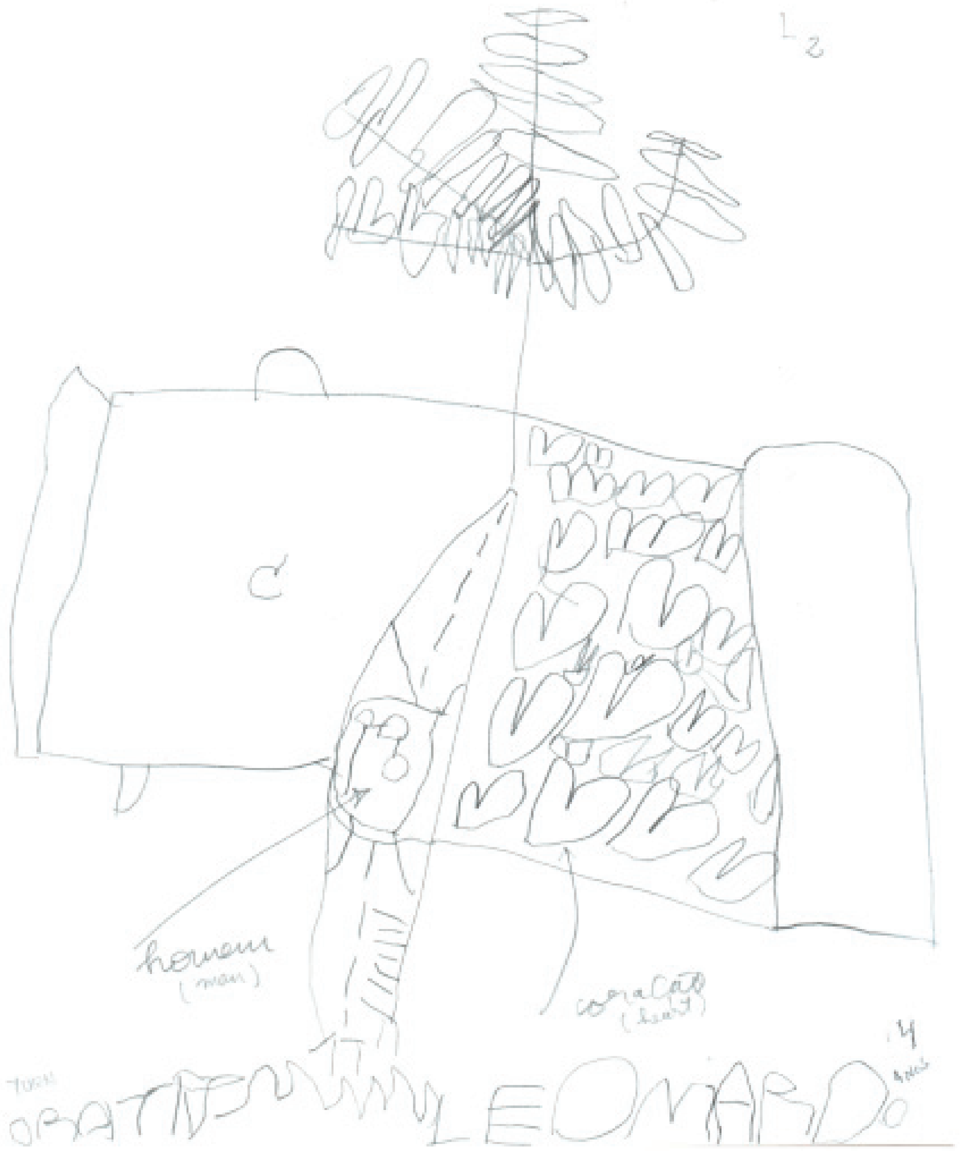


Figure 4: A drawing by a three year-old boy, which scored as Level 3 according to grades in Table 1.

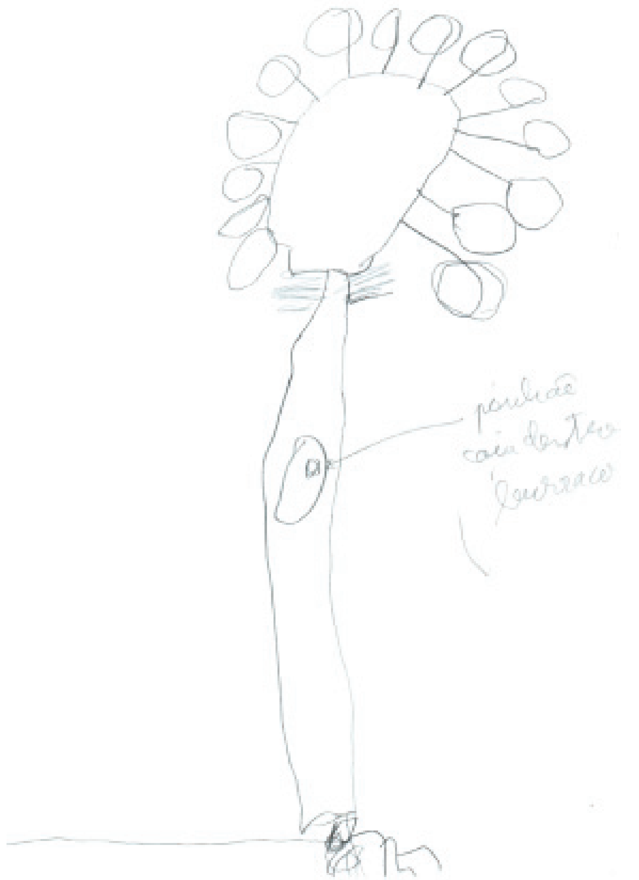
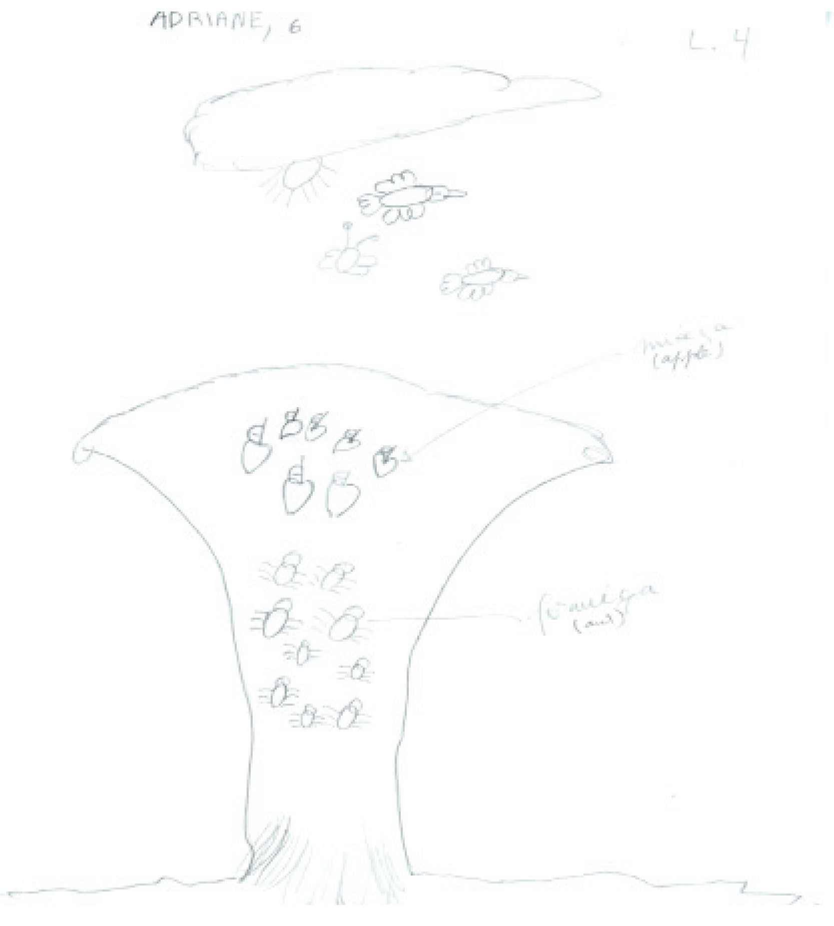


Figure 5: A drawing by a six year-old girl, which scored as Level 4 according to grades in Table 1.



Some children, chosen randomly, were interviewed and they explained what they thought was inside the tree depicted in their drawing. Their comments were tape-recorded and transcribed.

Results

Most of the nursery children´s drawings were unidentifiable (56%), or achieved Level 1 (26%) according to the rubric used to allocate a grade to the drawings (Table 1). The four year-old children achieved Level 1 (44%), Level 3 (19%) and Level 4 (17%). The 5 year-old group achieved Level 1 (41%), Level 3 (29%) and Level 4 (19%). However, the 6 year-old children, who were in the first year of primary school, achieved Level 1(29%), Level 3 (27%) and Level 4 (12%).

During the interview, a 4 year-old girl said that inside the trunk is timber, the roots make the tree grow and leaves are outside the plant on the branches. A 5 year-old boy said that the roots hold the tree onto the ground, preventing it from falling, the trunk is inside the plant, and the apple is an inner part of the plant. A 6 year-old girl stated that a snake is crawling on the grass and enters through the roots inside the tree, a caterpillar eating the leaves changes into a butterfly, and boughs with lots of leaves and apples are 'inside' the tree, because it grows a flower that later turns into a fruit! A 3 year-old boy from a nursery school represented the tree with its structural elements and the pine fruit *(pinhão)* inside a hole in the trunk, revealing his natural world observation (see Figure 4).

Conclusions

Although the botanical information supplied by this sample of pupils was not totally accurate in scientific terms, the children provided their conceptions of the environment and trees from their own observations, the basic anatomical features of trees and the concept that this segment of the environment provides a shelter for animals in which to live, and water to allow trees to survive and produce edible fruits and timber. It seems that, as children grow older, the representations of trees by 5 and 6 year-olds show progressive complexity, reflecting a better grasp of internal and external parts of trees. Younger children seem to interpret 'inside' as within the branches. Older children interpret 'inside' as internal to the outside of the tree, inside the trunk and branches, reflecting Symington´s perspective varying from scribbling to realism (Symington *et al*, 1981).

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Extended Abstracts: from the 2013 ICASE World Science Education Centre Conference

Introduction

The triennial ICASE World Science Conference was held in Kuching, Sarawak, Malaysia, at the end of September 2013. The papers submitted and presented reflect the paradigm shift that is occurring in science education; namely, that recognition that early years science is the most important stage of science learning is gaining momentum. In *JES*, we follow the definition given by UNESCO, being that early years is concerned with children up to eight years of age, involves experiencing and learning about science and that there is a need for educators to find more about how this occurs.

The US recently introduced a new curriculum for science, New Generation Science Standards (NGSS), in an attempt to educate learners to meet the challenges of the 21st Century. Hence, the emphasis of NGSS is on transferable skills and process and not just the learning of facts. However, education in the US is the responsibility of each state and then the districts and school boards. Thus, NGSS is not necessarily going to be adopted everywhere; indeed Texas, for example, has voted not to follow them.

The three papers from the World Science Education Conference included here reflect this move towards interest in and recognition of early years science learning.

Padilla, a former President of the US National Science Teachers Association (NSTA) and ICASE representative for North America, discusses these new standards and their relevance to early years learners.

Mauritius, a member of the Commonwealth, has a new science curriculum. Cyparsade and Adiapen from the Mauritius Institute of Education discuss the effectiveness of 3-D mind maps with young children in science-focused activities. This technique enables children who are 'concrete' learners to develop the idea of 2-D maps in 3-D reality with real objects. This hands-on approach facilitates the learners in using the sensory and manipulative skills so evident amongst early years children. The authors found an increase in the learning of children when this approach was used in a topic. This also provides policy makers with another approach to advocate in evidence-based learning.

John *et al*, from Wales, in their paper, explain the effect on the understanding of young learners of a complex biological principle introduced through the use of a story, which can be referred back to as a framework, and which helps children develop understanding.

Extended Abstract

The role of 3-dimensional mind maps in science teaching and learning of early childhood

M. Cyparsade ■ V. Adiapen

Abstract

Literature shows that innovative strategies such as mind maps have been a highly effective tool for teaching and learning in both primary and secondary schools for many years. A mind map is a visual representation of knowledge or a concept. It is based around a central idea, subject, concept or image with radiating branches or connections that highlight further major branches or minor ideas, as stated by Howitt (2009) in Buzan and Abbott (2005). Mind maps allow individuals to express their own personal understandings and generate their own description of an idea. Apart from their main function as a tool to represent knowledge structures, mind maps have also been used to facilitate meaningful learning, evaluate learning, facilitate co-operative learning, and design instructional materials (Novak, 1996).
This paper analyses how far the 3-dimensional (3-D) mind maps can help early childhood learners in the acquisition of basic vocabulary in science, an area of learning that is referred to as 'Body and Environmental Awareness' in early childhood education in the National Curriculum Framework for Pre-primary Sector (NCF) (NCF, 2010).

In this study, qualitative data have been used with an epistemological approach to evaluate how young children aged 4+ share knowledge, create connections and develop oral language. They do so while being engaged in active sensory, explorative and meaningful learning experiences by using 3-D mind maps as a pedagogical tool. To this end, the role of schoolteachers in the use of this teaching strategy has also been analysed to bring further light on the research aims. The observation of young learners in classroom interactions, focus group discussions with learners, along with teacher interviews, have been used to seek views and enrich the research with reliable information. It is expected that this research will, in the first place, provide yet another innovative tool to educators to translate the content and processes at classroom level. It will also encourage policy makers to include such innovations in official documents and teacher education programmes, with evidence-based information for 3-D mind maps. This could finally trickle down to classroom teaching on a large scale.

Keywords

Meaningful science learning, early childhood education, 3-D mind maps, oral language, classroom innovation

Introduction

The first National Curriculum Framework – Pre-primary (NCF, 2010) was launched by the Ministry of Education and Human Resources in Mauritius (GIS, 2010) in July 2010. In line with government's vision to provide a world class quality education, this NCF has been developed within reforms of curriculum polices as spelt out by the curriculum policy document (MOEHR, 2006: 7–16) and in the Ministry of Education Strategic Plan (MOEHR, 2008: 46). It aims at implementing a quality curriculum at pre-primary level (3–5 years) and lays emphasis on the knowledge, skills, attitudes and values to be gradually acquired and developed during early childhood years (3–8 years). The NCF triggers changes for the pre-primary teachers and the young learners in the classroom. This is so because there is a significant paradigm shift, as commented on by Sheldon (1980) in Johnson (1990), which lies at the root of the policy. This shift brings focus on the implementation of child-centred teaching and learning in pre-primary schools by using a holistic approach. As outlined in the goals of the NCF (2010: 3), the whole-child approach is vital for the provision of learning experiences in all areas of learning at early childhood education (ECE) level.

Consequently, the NCF policy drives a major change in the aims and contents of learning that will allow young learners, for example, to acquire language skills for effective communication and meaningful interaction with themselves and others, enjoy learning by experiencing, participating in arts, music, dance and drama, appreciating the diversity of Mauritian culture and interacting positively among themselves (NCF, 2010: 3). This paradigm shift calls for the use of innovative strategies and the elimination of those passive strategies that have not produced meaningful learning in the past. The three-dimensional mind map (Howitt, 2009) is one of the effective tools for providing engaging, kinaesthetic and sensory experiences for learners, which also enable sharing of knowledge and the creation of connections through the use of real-life objects.

Aim of the study

This study aims to investigate how far 3-D mind maps can engage early childhood learners aged 4+ in the acquisition of basic vocabulary in early childhood science education.

Objectives of the study

To achieve this aim, the objectives are as follows:

- To implement 3-D mind mapping as an innovative strategy in early childhood education;
- To bring about meaningful learning by early childhood learners through manipulation of real-life objects;
- To empower educators to use 3-D mind mapping as an innovation in their repertoire of teaching strategies; and
- To evaluate the effectiveness of the 3-D mind map in oral language acquisition by learners.

Significance of the study

The outcomes of this study provide the early childhood teachers with a guide in the preparation and planning of teaching strategies and resources that are more adapted to the learning needs of early childhood learners. It would help early childhood teachers to have a deeper understanding of the teaching and learning processes, by creating opportunities for meaningful learning experiences to occur in the classroom. Through this study, educators' consistency in usage of present and future tenses results in more contextual and powerful teaching experiences for their pupils. For the early childhood learners, this study also contributes to their learning and practice of basic words in oral English and French, as well as the Kreol Morisien language. It helps early childhood learners to acquire important concepts in science such as names of body parts, names of objects used for maintaining body hygiene and action verbs (to brush, to clean, to wipe, to rub, to comb, to cut). Additionally, this strategy helps to develop science learning processes and skills such as observing, classifying, pattern-seeking, inferring and predicting (NCF Pre-primary, 2010). At this stage, young pupils are taught about the following, amongst others:

- developing body awareness;
- using the five senses;
- acquiring scientific skills;
- demonstrating co-ordination in their fine motor tasks;
- exploring and studying the environment; and
- communicating thoughts and experiences.

This study also helps lecturers involved in teacher education to review and innovate the design and implementation of teacher education programmes for early childhood education, and to identify teaching methods that bring positive progression. The outcomes of this study would also benefit and guide future researchers in this field. It can also lead to the development of future research projects in other subject areas. Educational research that is conducted in the area of early childhood education is quite scarce in Mauritius. This posits the need for academics, early childhood practitioners and educators to carry out studies, in order to provide a broader and deeper knowledge and understanding of best practices in early childhood educational institutions. We also intend to provide a database for future researchers in the field of early childhood education.

From January 2013, by governmental policy, early childhood education became compulsory for children aged 3–5 years (Businessmega, 2012). The most important foundation for future success of early childhood education is by developing the young child to learn to believe in his/herself as a capable, resourceful and productive learner. It seems that, quite often, teachers' expectations and preoccupations are to meet accountability requirements for measurable bits of learning, rather than sensitively respond to the child's needs. This study will help to develop key knowledge that young learners need to thrive in an early childhood classroom. This feasibility study serves as a starting point in the preparation of a pilot project run in 2014 by the sole teacher education institute in Mauritius, the Mauritius Institute of Education (MIE). This will aim to produce a broader and more up-to-date database for future researchers and policy makers in ECE. All educational stakeholders in the early childhood sector, such as teachers, school administrators, governmental agencies and lecturers in teacher education, will benefit from the study through the provision of new knowledge and the application of innovative teaching strategies in the education of young children.

Theory

The theoretical framework of the study is underpinned by several concepts, namely meaningful learning at early childhood level (ECL), the cognitive development in young children, language development in early childhood and 3-D mind mapping.

1. Learning at early childhood level (ECL)

Piaget (Huitt & Hummel, 2003) referred to the concept of children in the early years as 'constructing' their own meaning. He believed that children learn most efficiently when they are able to take new knowledge and integrate it into their previous knowledge and experiences, thus constructing a new knowledge base each day. Because children are constantly rethinking and updating their construction of how the world works, Piaget recommended learning experiences that emphasise autonomy and self-direction as a sound preparation for later intellectual development. Montessori (Huitt & Hummel, 2003) also discussed the importance of sensori-motor experiences. She designed learning materials and manipulatives that use concrete and real materials to capitalise on the child's learning style. An effective early childhood programme enables children to learn in ways in which they learn best. It provides opportunities for them to observe, explore and build. Verbalisation with other children and adults is encouraged. Learning experiences encourage the development of the whole child: cognitive or intellectual, social, emotional, physical, aesthetic and in psychomotor domains.

2. Meaningful learning at early childhood level

Bredekamp (1990) describes how young children *learn* and indicates effective ways of teaching them:

How young children learn

Young children learn by *doing*. Piaget (1950, 1972), Montessori (1964), Erikson (1950) and other child development theorists and researchers (Elkind, 1986; Kamii, 1985) have established that learning is a complex process, which results from the interaction of children's own thinking and their experiences in the external world. As children get older, they acquire new skills and experiences that facilitate the learning process. For example, as children grow physically, they are more able to manipulate and explore their own environment. Children acquire knowledge about the physical and social worlds in which they live through playful interaction with objects and people.

How to teach young children

How young children *learn* should determine how teachers of young children *teach*. *Teach* tends to imply telling or giving information. However, the correct way to teach young children is not to lecture or verbally instruct them. Teachers of young children are more like guides or facilitators (Forman & Kuschner, 1983; Lay-Dropyera & Dropyera, 1986; Piaget, 1972). They prepare the environment so that it provides stimulating, challenging materials and activities for children. Then, teachers closely observe to see what children understand and pose additional challenges to push their thinking further. Learning information in meaningful contexts is not only essential for children's understanding and development of concepts, but is also important for motivating children.

Children in the developmental stage of early childhood (ages 3 through 8 years) are concrete learners. They are exceptionally sensory, which means that they learn best by touching, tasting, hearing, smelling and moving their bodies. They are interested in experiments, trial and error, representing what they are learning through construction and play, finding answers in picture books and finding things out on their own.

3. Learning of science at early childhood level

Children are naturally curious about their bodies and their environment. They observe and are curious to understand about themselves, about objects, changes and phenomena around them, by asking questions in order to make sense of their surroundings. The National Curriculum Framework for the Pre-primary (3-5 years) (NCF, 2010) has developed an area of learning entitled 'Body and Environmental Awareness (BEA)', which aims to engage young learners in activities that help them to develop science skills such as observation, classification, hypothesis, prediction and pattern-seeking, and exploration. This learning area encourages them to develop care and respect for all living things, environmental protection and health and safety measures for themselves and others.

4. Language development at early childhood level

Researchers have proposed several different theories to explain how and why language development occurs. Skinner (in Cherry, 2013) suggests that the emergence of language is the result of imitation and reinforcement. The nativist theory of Chomsky (in Cherry, 2013) suggests that language is an inherent human quality and that children are born with a language acquisition device that allows them to produce language once they have learned the necessary vocabulary. At age 4+, children speak in increasingly complex sentences (Berk, 2006) by joining small sentences together, and will use sentences in different ways. For example, they are able to say both 'The dog was chasing the cat' and 'The cat was chased by the dog' to mean the same thing. By age 5, the child is able to use long sentences of up to nine words. The child develops the ability to talk about things that have happened in the past, rather than just those that are currently happening. The child also uses past tense and the plural form. In addition, the child can imitate speech patterns accurately and his/her sentences contain four or more words and are grammatically correct. His/her vocabulary is large, e.g. knowing parts of the body, names of household objects and animals, and he/she develops and refines his/her language and makes fewer mistakes.

5. 3-dimensional mind maps

According to Howitt (2009), 3-D mind maps are a highly effective tool for providing engaging, kinaesthetic and sensory experiences for young children. Real objects are used to promote the sharing of knowledge and the creation of connections. The author opines that the use of real objects allows children the opportunity to connect with those objects at a personal level, thus placing the children at the centre of their own learning. As observed by Howitt and Blake (2009), the advantages of using a 3-D mind map are: (1) the triggering of children's memory through the handling of objects (in this way, children are stimulated to think, assisting them to connect with prior knowledge and encouraging them to express their views and ideas (Warden, 2006)); (2) social skills enhanced as children can take turns in discussions, respectfully listen and acknowledge ideas and contributions from peers; (3) concentration practised as children remain focused on the process rather than the product in the construction of the 3-D mind map; and (4) confidence boosted for all children, as they come to realise that their contributions are useful and valued.

Design and procedure

The design of the study was carried out through the following steps. There were several brainstorming sessions among the researchers in order to discuss the applicability of this innovation in the Mauritian context. In line with the National Curriculum Framework for Pre-primary Education, a theme was identified in consultation with the class teacher. The theme chosen was 'parts of the body and hygiene', which is in line with the theme 'develop body awareness' of the National Curriculum Framework (NCF, 2010). The strategic plan 2008–2015 for the MOEHR for the early childhood sector was consulted to find out what has been stipulated on issues such as innovative strategies leading to meaningful and contextual learning, assessment for learning, and vision of the Ministry for ECE learners. From this discussion, a 2-D mind map was generated by the researchers on the modality of the intervention at classroom level. Based on this mind map, a set of resources was identified that are child-friendly and safe to use with these learners. In addition, pupils are familiar with these as they use them in their daily activities. The resources identified were: sponge, water, shampoo, body oil, cotton buds, soap, liquid whole body wash, nail cutter, hair brush, towel, nail polish, comb, body powder, toothbrush, mirror, body cream, toothpaste, tongue cleaner and two dolls that were the main objects of exploration for the children.

A checklist for classroom observation was prepared for use during the classroom intervention. On the days of the intervention, two similar dolls were used for the classroom interventions. One of them was placed at the centre of the table and the other was dismantled into different body parts, such as the head, trunk, arms, hands, legs, toes and fingers. Some parts of the face and body were also drawn on separate cards to be used during the intervention. An interview was planned with the class teachers to elicit their views on this intervention and innovation brought to their pupils. An informal focus group discussion with pupils was envisaged to find out if they had appreciated this innovation in their classroom and their reasons for this.

The schools were then contacted and school managers, who are also teachers, were identified for this study. All the procedures, purpose, safety aspects, modality, duration, aims and objectives were explained in detail to ensure total transparency and confidentiality, given that small children were involved. Consent forms were filled in by parents prior to the study. There were discussions with the class teachers on the modality of interventions, team teaching, and ethical issues such as the taking of photographs of learners during the interventions. It was ensured that the photographs would be used solely for this research and, after this study, all photographs would be destroyed.

A lesson plan was prepared prior to the intervention so that the managers and educators, as well as researchers, were aware of the detailed modality of the interventions. Each lesson was planned to last about 30 minutes. This ensured that learners were attentive to instructions given and were engaged. A short list of simple instructions was also prepared to engage the learners in meaningful discussions and interactions. Lastly, a set of questions was prepared for the informal focus group discussion with learners.

Classroom interventions with the interactive 3-D mind mapping

The interventions began with the introduction to two researchers by the class teachers, stating the purpose of their visit, requesting learners to be attentive and to respond to their questions and interventions. Then, teachers and researchers explained about the study, rules, brief methodology of the study and consequently the session started.

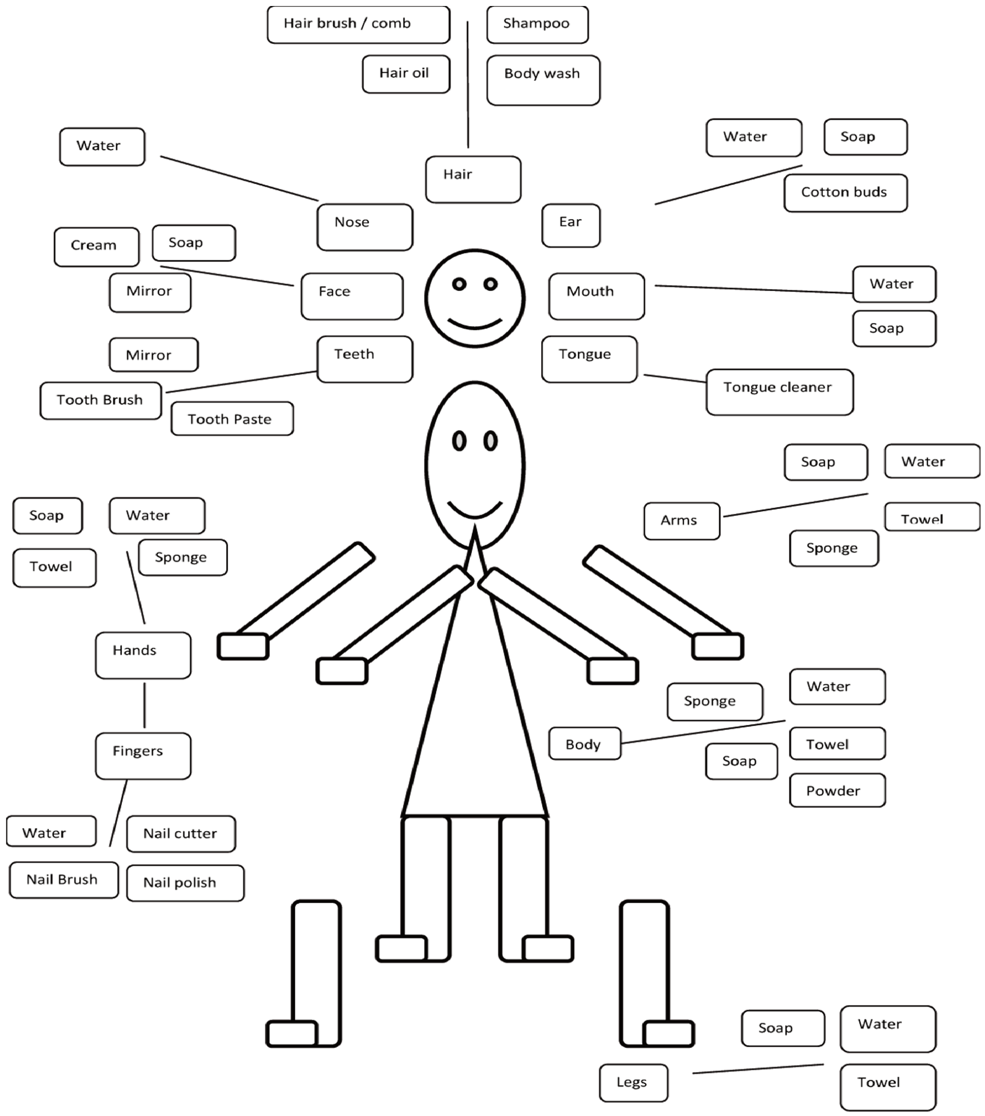
The table was set at the centre of the room and another table was placed at the side upon which to place all materials brought in. Pupils were seated round the table and the big doll was kept lying at the centre of main table. Pupils were asked to imagine that the doll, named 'Cecilia', was 'one of us'. They were asked to identify the different parts of Cecilia's body and name these parts (English, French & Kreol Morisien languages used). Questions were asked about what we do to keep these parts of our body clean (theme: body hygiene). Role play was performed by pupils to show how each body part is kept clean. Then, the separate body parts from the dismantled doll were shown, one by one, by teachers/ researchers, and pupils were asked to identify and name the part and then show its location on the big 'whole' doll. One pupil was asked to place this separate part of the body next to the big doll to show where it belonged. This was repeated for all the body parts shown. The next activity was to show learners the materials, such as the comb, related to the cleanliness of the body. These were shown one by one and pupils asked to identify the objects and name them. They were required to explain the use of these items and the benefits derived from them. Questions used to elicit responses from learners were: *'what is this object?'*, *'what is it used for?'*, and *'which part of the body is it related to?'.* The pupils then demonstrated the use of the items on the doll and finally placed the object next to the relevant body part.

Students performed role play to demonstrate the use of these objects. Pointers made of paper were used to link the body parts to the objects shown. This was repeated for all the objects brought into the class. Pupils were allowed to talk freely about the items and relate small stories of their own. These talks were also used as a summary of the lesson. Further questions were asked to summarise the different steps undergone.

Figure 1: A side table for display of materials.

Figure 2: Children working in small groups.

Figure 3: The connections within the 3-dimensional mind map.



Classroom observation using an observation checklist

The use of the observation checklist identified the following issues during the classroom intervention. Pupils felt comfortable with the researchers due to their welcoming nature. Pupils' familiarity with resources was enhanced and they were curious to know what else was in the bag. Learners were participating very actively and enthusiastically. Learners looked very motivated and were eager to relate their own stories about each item seen. They were able to make good connections to the different parts of the body. Learners also enjoyed participating in or watching the role play. It was observed that not all children use the same kind of resources at home; for instance, some use body soap while others used liquid soap or whole body gel; some use different types of hair brushes, but they were able to relate to this range of materials.

Class teacher intervention

Class teachers were present in the class throughout the session and were encouraged to intervene freely at any time, in order to be able to consolidate the learning process of their pupils. It was also intended to empower the teacher to use this strategy for other topics or subject areas.

Interview with class teacher

After the teaching sessions, teachers were interviewed to find out how this innovation had been accepted by the learners, how the energy levels differed from regular classes, the applicability of this technique for other topics, and their own impression of this innovation, given that currently in Mauritius it is not common to use 3-D mind maps.

Video recording and photographs taken

The whole working sessions were video-recorded and photographs were taken at different points. These would be used solely for this study and would be destroyed after analysis and dissemination.

Informal questioning with young learners during sessions

During the intervention, while children were manipulating the objects on display, several questions were asked in order to make learners talk. Pupils were also asked about the difference between how this lesson was conducted as compared to their regular lessons.

Findings

It was found that learners were very motivated throughout the lesson and this was the case from the start until the end of the intervention. They were very curious to know what else was in the bag as items were removed one by one. It was also encouraging to note that all the items could be identified and named and then placed at the right location around the body. Pupils could spot the body part and make a link with the objects shown.

Outcome of intervention with class teachers

At the end of the session, the class teacher intervened to further question the learners and consolidate the concepts learnt during the lesson. She highlighted the connections among the concepts that were referred to during their generation of and interaction with the 3-D mind map.

Outcome of focus group discussions with pupils

When pupils were asked about this new technique and the range of materials used, they stated that they would like to always study in this way. The interactivity was very important to be able to translate the concepts and terminologies into action.

Limitations of this study

This was a small-scale study with a limited number of pupils. It was conducted in a city where pupils are more exposed to these kinds of resources and where they are more proficient in English and French languages. This may have biased the results to a small extent. Large-scale studies are needed to be able to establish a theory.

Recommendations

The same session should be conducted in different localities, where a wide range of learners with different capabilities are involved. Moreover, teachers should prepare themselves and the resources to be able to use this innovation efficiently and to produce meaningful learning. Teachers should adapt the resources and the intervention according to the locality, economic, cultural and social background of the learners and their capabilities.

Seeing the enthusiasm that the 3-D mind maps have generated in the classroom, it is recommended that educators use this technique for the benefit of our young learners. It has shown to be a very appropriate and powerful tool for language acquisition and development, if used regularly.

Conclusion

Through this study, the researchers, with the help of the educators, have been able to implement the use of 3-D mind maps in the teaching and learning of science at early childhood level. Educators have also been introduced to this technique and can start using it confidently. 3-D mind mapping is also used for assessment, when the lesson is observed against a detailed marking scheme for each task performed by pupils.

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Extended Abstract

Next Generation Science Standards: stimulating change in US science education

■ Michael Padilla

Science education in the United States (US) is in the midst of a revolution in terms of what is expected of students in all grade levels and, perhaps more importantly, of teachers and science education leaders. New national standards have been written and were scheduled to be released in final form in April 2013. At time of writing, public drafts had been circulated and these indicate that the new standards, called the Next Generation Science Standards (NGSS), will set a high bar for both students and teachers.

Background

Unlike the educational systems in most other countries, the US system is controlled by individual states. While the US constitution specifies many aspects of the American political system, it is mute on the issue of control of education. Because of this fact, control devolves to each of the individual 50 states of the union. States set regulations for all aspects of schooling, including, but not limited to, curriculum standards, student evaluation, teacher education and school accreditation.

The federal function in American schooling has evolved into a supporting role, with numerous federal agencies supplying funds for specific school subjects and purposes. Some of the funds from agencies flow directly from the federal government to states and school districts. For example, many of the programmes overseen by the US Department of Education distribute funds to states that then distribute them to schools on a per student basis. Other funds are distributed competitively through grant processes. For example, since the scientific workforce is such a critical component of the economic security of the country, the National Science Foundation has developed competitive grant programmes to improve the curriculum and teaching related to science and mathematics. Thus the federal government asserts an indirect, although highly influential, control over schooling, primarily because the amount of money distributed through federal programmes is so great.

Curriculum standards provide structure

States control curricular content by setting standards and then testing student achievement relative to those standards. In past decades, state standards may have been as simple as an outline of the content to be covered in a course or grade level. However, since the early 1990s, a major change has occurred in which states set measurable learning outcomes in each discipline. Guided by the efforts of the National Council for the Teachers of Mathematics, most national disciplinary groups have developed and promoted national curriculum standards and these have been highly influential in all the states. While national standards are only advisory in nature, most states have used them extensively to develop their own state standards. For example, many states have used both the National Science Education Standards (NRC, 1995) and the Benchmarks for Science Literacy (AAAS, 1993) to create state science standards.

While most states start from the same national standards documents, the standards across states and districts still vary considerably. Most states add standards related to local environmental issues, or science topics with economic impact within the state, for example. And each state sets its own scope and sequence, thus ensuring that the order in which students study the various topics in science is different in every state. Some analyses have found only minimal agreement across the 50 states on a core set of standards in any discipline.

In the middle of the first decade of the 21^{st} century, a movement began to define new sets of standards, called the Common Core Standards. This is a '*state-led effort that establishes a single set of clear educational standards for kindergarten through 12th grade in English language arts and mathematics that states voluntarily adopt.'* Led by the governors and state education commissioners of all 50 US states, the initiative defines its efforts as providing '*a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers'.* (http://www.corestandards.org/). The first two disciplines to set standards were English language arts and mathematics and, to date, 45 states, the District of Columbia and four US territories have adopted the standards. Through its *Race to the Top* initiative, the federal government has given states substantial funding (a total of $4.35 US billion) to implement the standards, within a context of other reforms. Importantly, Common Core Standards are being adopted by states without change, an essential difference from past initiatives.

The Next Generation Science Standards are a similar initiative to that described for Common Core, but with nuanced differences. NGSS is being led by the National Research Council (the staff arm of the US National Academy of Sciences) and Achieve (a non-profit organisation focused on improving student achievement in science) (http://www.achieve.org), who are collaborating with 26 of the US states and professional organisations such as the US National Science Teachers Association (NSTA) and the American Association for the Advancement of Science (AAAS) to write standards. Funding for the effort is being provided by private foundations, including Carnegie Corporation, Dupont and the CISCO Foundation. Twenty-six of the fifty states have signed on to adopt the NGSS as written, indicating a step toward adoption of a national curriculum.

Framework

A Framework for K-12 Science Education: Practices, cross-cutting concepts, and core ideas was developed and released in July 2011 (http://www.nextgenscience.org/framework-k%E2%80%9312-science-education). The Framework provides background, research-based evidence and the philosophy underlying a proposed set of standards. Written by a committee of 18 individuals, including Nobel laureates, cognitive scientists, science education researchers and other experts, the Framework is considered the foundation of the Next Generation Standards. The Framework lays out three dimensions of science (http://www.nextgenscience.org/three-dimensions) that will be represented in each of the forthcoming standards. These are:

- ***Scientific and Engineering Practices*** – These describe *'behaviors that scientists engage in as they investigate and build models and theories about the natural world…'.* Included among the eight practices are 'Asking questions (science) and defining problems (engineering)', 'Analyzing and interpreting data' and 'Constructing explanations (science) and designing solutions (engineering)'.

- ***Cross-cutting Concepts*** – concepts that *'have application across all domains of science'.* Examples include 'Scale, proportion and quantity', 'Structure and function', and 'Stability and change'.

- ***Core Disciplinary Ideas*** – ideas that have broad importance or are a key organising concept in a discipline. Example core disciplinary ideas can be viewed in Chapters 5 (physical science), 6 (life science), 7 (Earth and space sciences), and 8 (engineering, technology, and applications of science) (http://www.nap.edu/catalog.php?record_id=13165).

Standards

The proposed Next Generation Standards will highlight particular content within each of the three domains listed above. In addition, it will specify Performance Expectations (PE) to be used for assessment that show how the three dimensions are interrelated. Examples of PEs in each of the three major content domains follow:

- *'Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for the changes to landforms over time.'* – Elementary school earth science
- *'Develop molecular-level models of a variety of substances, comparing those with simple molecules to those with extended structures.'* – Middle school physical science
- *'Critically read scientific literature and produce scientific writing and/or oral presentations that communicate how the structure and function of systems of specialized cells within organisms help perform the essential functions of life.'* – High school life science

Note that in each of these examples, a Scientific Practice (e.g. identify evidence) is matched with Science Content (e.g. rock formations, etc.) as well as Cross-cutting Concepts (e.g. change over time). This unique way of representing the three dimensions increases their cognitive demand and requires that students show more complex levels of thinking. It will demand that students raise their level of cognitive involvement in their science education and that assessments will require higher levels of thinking than in the past. It also raises the pressure on teachers to teach in ways that help students think about science in new ways.

Impact on the curriculum of young children

One of the most interesting aspects of the NGSS is the impact and focus on young children up to age 8. Over the years, science educators in the US have given lip service to the science education of young children, and the fact remains that this aspect of their curriculum has largely been ignored. Testing occurs in the US for reading/language arts and mathematics, not for science. Thus many school administrators have asked teachers to use science instructional time for additional teaching in the two tested subject areas. In addition, when taught at all, early childhood science has often been focused on classic science topics (dinosaurs, leaves, rocks) with little intellectual rigour. It is often thought of as play time between the two meaningful subjects – reading and mathematics.

Implementation of the NGSS will likely alter this equation. There is intent to create a national test for science, thus eliminating the excuse used by school administrators that it is not an important subject. Time will tell whether this test will come to fruition or whether it will impact the time allocated to teaching science. Furthermore, the NGSS add a level of rigour typically not seen at these grade levels. Young children will be asked to master the same set of eight practices mentioned above (in an age-appropriate way, of course) and curricula in the US will be created that promote this model.

Thus young children will be asked to 'design and conduct an investigation', to 'analyse data', and to 'identify arguments that are supported by evidence'.

Moreover, these same practices are the heart of national standards in reading language arts and mathematics (called Common Core Standards). Taken together, the implementation of the three new sets of standards will dictate a monumental change in the way that all subjects, including science, are taught to these children.

Note

The author of this article was one of the writers of the 1995 US National Science Education Standards and is one of a five-member review team for the Next Generation Science Standards under the auspices of the National Science Teachers Association.

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Extended Abstract

Developing the scientific curiosity of 3-7 year olds

■ Sue John ■ Rebecca Cullen ■ Delia Cole ■ Catherine Cooper

Introduction

The aim of this article is to demonstrate how it is possible to introduce scientific investigation to 3 and 4 year-olds through standard resources available to nursery settings. This article describes how the teaching team uses their different skills, experience and free resources to introduce natural science to the children, arousing their natural curiosity and openness, through the Welsh Foundation Phase.

The National Assembly for Wales has devised the Foundation Phase as a distinct stage within the Welsh curriculum (Department for Children, Education, Lifelong Learning and Skills, 2009) to support the education of 3 to 7 year olds through child-centred learning. Introduced in 2008, all young children up to the age of 7 have to be educated through this framework. Whether in the state or private sector, all nurseries and schools have to teach to the Phase's 'Seven Areas of Learning'.

This paper describes a series of activities that were delivered to a group of 3 and 4 year-olds in an 'inner city' nursery. The activities undertaken by the children (painting pictures, making clay model owls, telling stories with hand puppets and investigating owl pellets using hand lenses and microscopes) were based on a much-loved storybook about three baby owls. This series of activities was started after a child asked *'Can we build a home for our owls?'* From this starting point, the practitioners followed and stretched the children's interest by providing new resources for the children to develop within their zones of proximal development. To reinforce ideas and to further the children's knowledge and understanding on owls and their behaviours, the nursery arranged a visit from an owl sanctuary organisation.

Background

Currently every local authority in Wales has to provide a minimum of 10 free hours of nursery education delivered through the Foundation Phase to every 3 – 4 year-old living in Wales (Department for Children, Education, Lifelong Learning and Skills, 2009).

'The Foundation Phase is the statutory curriculum for all 3 to 7 year old children in Wales in both maintained and non-maintained settings... is based on the principle that early years' provision should offer a sound foundation for future learning through a developmentally appropriate curriculum... [It] places great emphasis on children learning by doing... given more opportunities to gain first hand experiences through play and active involvement rather than by completing exercises in books.'

The statutory Areas of Learning are:

- Personal and Social Development, Wellbeing and Cultural Diversity;
- Language, Literacy and Communication Skills;
- Mathematical Development;
- Welsh Language Development;
- Knowledge and Understanding of the World;
- Physical Development; and
- Creative Development.

Each of these Areas of Learning has its own educational programme and sets out what children should experience (Department for Children, Education and Lifelong Skills, 2013). The Phase centres on the child and advocates a balance between child-initiated/practitioner led/practitioner initiated activities. This is in place of more traditional forms of teaching; instead, the child experiences the world and learns through play.

In practice, the child's allocated free hours are offered in two-and-a-half-hour segments, spread over the school week in either morning or afternoon sessions. Given this method of allocation and combined with our levels of staffing facilities, the Ely and Caerau Children's Centre is able to offer 35 places in each of our morning and afternoon sessions. Therefore, each day of the academic year we, as practitioners, work with seventy 3 to 4 year-olds in the English and Welsh nurseries. These children will have varying abilities, disabilities and be at different stages of development. The places are allocated according to the first language through which the parents wish their child to learn. So, English first language children get priority in the English setting and Welsh first language children get priority in the Welsh setting. However, both settings will use both languages to support a bilingual education. The Ely and Caerau setting is fortunate to be able to offer parents the choice of an English or Welsh speaking setting in the same nursery.

This extra capacity and staffing enables the Children's Centre, which operates in one of the most deprived areas of the city, to offer a valuable choice for parents in their children's early education. To complement the Foundation Phase, the Centre is able to offer additional free early stage educational development activities, such as a Saturday morning Fathers' Group, English and Welsh language and play sessions, parent nurturing classes, Gym Tots, as well as nutritional and cooking workshops for parents. This is as well as regular 'Open Days' where we invite parents and our 'neighbours' into the centre.

Having set out the legal and social context within which we operate, we now show how we have put this framework into practice to support the education of the pupils.

Case Study: *Owl Babies*

Owl Babies is a storybook that is popular with the children and staff in the nursery. Using their interest in the story and the characters, we developed a series of child-directed and practitioner-supported activities. This process shows the way that the Foundation Phase should operate. In this case, and without requiring any additional resources, we were able to cover all the Areas of Learning.

Owl Babies, by Martin Waddell and Patrick Benson, centres around three baby owls that are left in their 'house' while their mother hunts for food. During their wait, they worry about whether their mother has encountered a fox, if or when she will return and, if she returns and is successful in her search for food, what kind of food will she bring them. When telling this short story, one of our teachers enhances the reading by using owl hand puppets, which naturally play the parts of the three chicks. Using this combination of storybook and puppets means that the children are immediately engrossed in the story and the technique provides listeners with more context.

As is customary after reading a tale, the children are asked questions and are encouraged to comment on the story. During one of these discussions, one of our children commented that our owl puppets, which are stored in a 'story sack', did not have a home the same way as the owl chicks in the story. This led to a further child-led discussion as to what type of home they could build for the puppet chicks. The children decided that they wanted to build a nest similar to the one they saw in the book. This is where the teachers' and the teaching assistants'[1] roles as facilitators take over. Staff have to show and provide evidence that each day is planned according to the Areas of Learning, therefore, as part of this evidence, staff planned into the daily scheduling an assortment of activities based around *Owl Babies*.

Nest building was planned as a creative development and also centred around knowledge and understanding of the world. This could also be a physical development, as some of the children's materials were collected during their Forest School activities. The staff monitoring this activity for the Language, Literacy and Communication area of learning made notes. It is also practice for staff to introduce new and basic Welsh words and phrases into the conversations during different activities. As the children work in groups, this covers the personal and social development aspect of the Phase. An essential part of the Foundation Phase is for staff and children to use natural resources as far as possible. To follow this practice, the children are encouraged for this type of activity to collect some of the material for their 'nests' from the nursery's garden. As the children had decided that they wanted to make a nest, for this activity and all the children's activities, the staff provided the basic resources, in this case modelling clay. The children collected and used twigs, feathers and leaves to build their version of an owl's home. Others wanted to expand on building nests by completing them through adding clay owls to live in their nests. For these, the children moulded clay into owl shapes and added feathers and 'eyes' to make their owls of various shapes and sizes. Throughout this activity the children were talking about owls. They were telling others what they knew (or thought that they knew) and what they thought owls did.

To help the practitioners to establish exactly what the children knew and did not know about the lives of owls, a teacher facilitated a mind mapping activity. During this investigation, she noted that the children knew that owls were birds and had feathers and beaks. Their misconceptions were such that one child said that owls ate sandwiches, while another commented that they had teeth. Following this comment, two of the children sat and happily discussed whether or not owls had teeth to eat their sandwiches.

To satisfy this natural curiosity, and to 'correct' their misconceptions, the nursery arranged a visit to Cardiff Castle, where they were introduced to three different types of owl that live there. This visit gave the children an appreciation of the differences between the varieties and size of owls and to understand that owls did not eat sandwiches, in fact, they much preferred to eat chicks, rats or mice. The children's level of questioning concerning the birds' diet was such that the keeper gave them some owl pellets to look at when they returned to the nursery. The children wanted to find out what was in these pellets and this led to a spontaneous investigation into the owl pellets. Once again planned into the daily activities, the pellets were dissolved in water, to separate the undigested food matter, which was then examined under microscopes and hand lenses[2]. The children placed the undigested material into Petri dishes before

[1] Teaching Assistants are qualified members of staff who support teachers in the classroom and whose roles are very varied. There are situations in which the only difference between teaching assistants and teachers is that assistants do not have a teaching degree.

[2] RMS. The Royal Microscopical Society lend out a microscope activity kit free of charge to schools throughout the UK. http://www.rms.org.uk/outreach/activitykit

placing these under the microscopes for further examination. This process and type of activity was new to the children but, when they then examined the material under the microscopes and hand lenses, the children they could see for themselves the types of food that owls eat. The children could not stop themselves from telling everyone what they were looking at. From the very beginning of the activity, observations of the children were made and notes taken of their comments and, for this part of the activity, their language in particular was noted. One child, without any hesitation, said '*It's like cat fur. I'm looking at fur'.* Another: '*It looks like chickens'* and went on to comment about the microscopes themselves, saying '*These are good, aren't they?'.* Another child spotted something yellow, while another said that the microscope-focusing wheels resembled toy motorbike tyres. This activity introduced mathematical language, such as 'more than' and 'less than', as well as enabling them to use scientific instruments with ease.

By this time, the children wanted to draw, paint and mould owls and they wanted to know more. This time, instead of the children visiting the owls, the owls came to visit the nursery. A local bird of prey rescue society was invited to bring their hand-reared owls into the nursery. This was a wonderful experience for the children, as it gave them a chance to feel the weight of these birds, feel the softness of their feathers, and observe how much the air moved when the owls flapped their wings. They saw for themselves that some owls have round, bright orange eyes, while others have round black glassy eyes; and that some owls are very tall and some are very small.

To draw the series of activities to a close, another of the nursery's teachers retold the story of the owl babies but, this time, she asked the children to close their eyes and visualise their own images of the owls and to remember how the owls felt when they touched them. They expressed their thoughts and memories by using natural materials to create their own representations of parts of the story. Some children built tree houses; others retold their own versions using the materials as props; and others drew or painted more pictures. All the children's work was recorded and displayed in the nursery, the moulded owls were taken home and many brown spotted feathers were used in the making of their work.

Reflection

As practitioners in the Foundation Phase, we provide the initial ideas for interesting the pupils. In this case, it was a storybook and hand puppets. The children saw these as real owls and wanted to build a home for them to keep them safe and warm. We, as practitioners, need to have open minds to follow the children's ideas, and provide them with suitable resources to enable them to follow their thoughts and stretch their knowledge and understanding of the world. Working within the Foundation Phase, we practitioners have to possess many skills, and we also have to have a sense of fun, use our imagination and be able to 'think on our feet' but, most of all, we must pay the children the respect they deserve, value their ideas and feed their wish to understand the world around them.

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Notes & News

Finnish science clubs for 3–6 year-olds

Curiosity towards our surroundings is something we recognise as a deeply human characteristic. This ability to wonder is linked to our ability and willingness to learn new things. Small children, especially, display candid interest in everyday phenomena. For adults, these phenomena have long since lost their novelty but, upon reflection, they may reveal fundamental matters about the world and nature. By encouraging children's curiosity, educators can support and nourish their awareness of natural phenomena and even spark further interest in science.

First steps into STEM

Researchers at Finland's Science Education Centre, LUMA, have explored ways of supporting the curiosity and interest of young children. Project co-ordinator Jenni Vartiainen used design-based research to develop a science club model for 3 to 6 year-olds. The club model draws on the principles of socio-emotional learning to construct informal and inspiring STEM learning environments for young children. '*Design research is an excellent way to develop a completely new approach. It is a great tool for analyzing the achievement of set goals and for redefining aims and research questions in further development cycles*' (Vartiainen).

How to engage young children and their families in science? The first clubs were organised as a pilot project in spring 2013 in Helsinki for 25 children in total. The club meetings were held for two age groups, 3 to 4 year-olds and 5 to 6 year-olds.

A similar structure was used for the club meetings in both age groups, consisting of three stages: motivation, inquiry and sum-up. In each meeting, a different theme was explored; for example, colours, density, space and dimensions and states of matter. In addition to the scientific themes and activities, the club sessions were built on the development of social and emotional skills and motivation through art, narratives, music, drama and play. Repeated elements such as familiar songs were employed to enable a sense of security and familiarity in the children.

According to Vartiainen, successful engagement in STEM begins with promoting a child's natural ability to wonder and explore their surroundings:

"In my opinion, it is crucial to familiarize children with the role of natural sciences and mathematics in their daily lives and to help them connect everyday phenomena to science and technology. Long-term engagement cannot be sparked with cheap tricks. Children should be given a chance to wonder and ponder on something that interests them and, with the guidance of an adult, to realize their own solution. Interest and motivation in children is often awakened by exploring together the diverse ways in which natural sciences, technology and mathematics affect our lives.'

The club model encourages parental involvement and the participation of families. Vartiainen gives an example of how families participate: '*After each club session the children are given an activity or exercise to be completed at home together with the rest of the family. The homework includes, for example, mathematics puzzles and simple practical experiments with household equipment. Parents can help the children record their answers, solutions and questions, which are discussed together at the next club meeting.'*

According to feedback from the participants in the pilot clubs, the model had successfully achieved its goals of increasing enthusiasm and curiosity towards natural sciences and supporting the development of personal thinking skills as well as social skills.

Vartiainen's current research focuses on analysing the questions children asked during club discussions and in developing new concepts based on the pilot club model. '*Our next plan is to launch virtual science clubs to increase the number of children involved in this kind of informal STEM education. Virtual clubs have the advantage of wider availability as participation becomes possible for children living further away. Currently we need to solve the challenge of spreading and sharing the club model. The number of willing participants far exceeds our capacity and sadly we are not able to offer a club spot for all. This is an indication that, despite the demand, there are limited opportunities for science hobbies at a young age.'*

She feels that the best feedback comes directly from the responses of the young club participants: '*Every time it moves me to see how fascinated the children are when they* *understand what they are doing and find a solution to the task at hand. The best reward is to witness how young eyes are lit by the excitement of discovery: "I understood, I figured this out, I could do this!"'*

Find out more from: Vartiainen, J., & Aksela, M. (2013). 'Science clubs for 3 to 6-year-olds: Science with joy of learning and achievement', *LUMAT*, **1**,(3), 315–321

International Conference on Science, Technology, Gender and Sustainable Development, Republic of Mauritius, 17-19th April 2014

Organisers: Association pour le Développement Durable (ADD) and the Gender and Science and Technology Association (GASAT)

Theme: Challenges and Opportunities 2025: Legacy for Future Generations

Objectives of the Conference:

- To promote scientific and technological literacy
- To increase the participation of women and youth in environmental issues
- To enhance action-oriented activities on sustainable livelihood
- To share good practices of entrepreneurship among vulnerable groups
- To submit outcomes to policymakers at national and international platforms

Selected papers presented will be published as conference proceedings.

The Conference will be composed of presentations, divided along the three broad thematic areas:

- Theme 1: Capacity building
- Theme 2: Sustainability
- Theme 3: Resilience and culture

The papers may deal with the broad range of issues including scientific literacy policy, legislation, sustainable development, environmental ethics and examples of practical applications of the concept of sustainable development.

Since the time for presentations is limited, delegates are advised to register as soon as possible. Participants can register themselves until 14th March 2014. The registration fee is $200 for foreign participants and MUR 2000 for local delegates. Early Bird registration is available at $150 and MUR 1500 respectively.

Children's painting competition

ICOM NATHIST (International Council of Museums, Committee for Museums and Collections of Natural History) is pleased to be associated with The United Nations Environment Programme (UNEP) in promoting their 23rd International Children's Painting Competition on the Environment. For more information, please visit: http://icomnathist.wordpress.com/

ASE Annual Conference

The ASE Annual Conference 2014 will be held from 7th to 11th January 2014 at the University of Birmingham. There is always a strong early years and primary strand in the conference programme.
More information on all ASE conferences and events can be found at www.ase.org.uk.

ASE and you!

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

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

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

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

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

The Annual Conference itself is the biggest science education event in Europe, where over 3,000 science teachers and science educators gather for workshops, discussions, frontier science lectures, exhibitions and much more… Spending at least one day at the ASE Annual Conference is a 'must' for anyone interested in primary science.

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

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Emergent Science

Teaching science from birth to 8

By Jane Johnston

Emergent Science is essential reading for anyone involved in supporting scientific learning and development with young children aged between birth and 8. Drawing on theory, the book helps to develop the essential skills needed to understand and support science in this age range.

The book is organised into three parts: development, contexts and pedagogy, exploring the underpinning theory alongside practical ideas to help trainees, teachers and childcare practitioners to create high-quality science experiences for the children they teach.

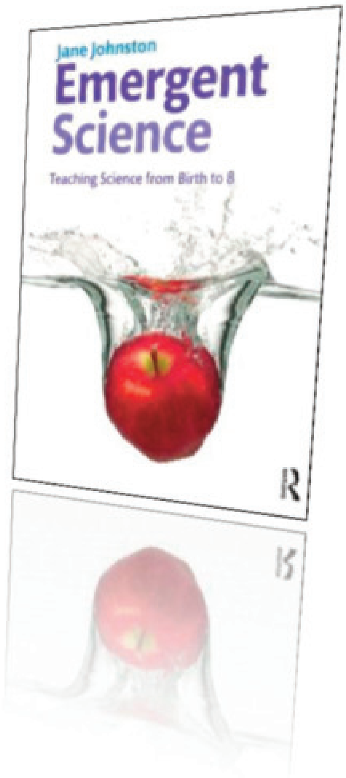
The text includes guidance on developing professional, study and research skills to graduate and postgraduate level, as well as all the information needed to develop scientific skills, attitudes, understanding and language through concrete, social experiences for young children.

Features include:

•Reflective tasks-at three levels of professional development;- early career/student, developing career/teacher and later career/leader.

•Case studies that exemplify good practice and practical ideas.

•Tools for learning - explain how science professionals can develop their professional, study skills and research skills to Masters level.



ABOUT THE AUTHOR

Jane Johnston has recently retired as a Reader in Education at Bishop Grosseteste University, Lincoln. She has extensive teaching and writing experience in early years science, coordinates the international emergent science research network, is co-editor of the Journal of Emergent Science and coordinator for the early years special interest group of the European Science Education Research Association (ESERA). In 2006 she was one of the first of five teachers to be awarded Chartered Science Teacher status in the UK.

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Resource Review

Science for the Next Generation – preparing for the new standards

by William Banko, Marshall L. Grant, Michael E. Jabot, Alan J. McCormack and Thomas O'Brien. Published in 2013 by NSTA Press, Arlington, Virginia, USA, price $34.95. ISBN 978-1-936959-26-6. Available from www.nsta.org/store

Like many countries worldwide, the USA is concerned about developing expertise amongst its citizens in the STEM subjects and the development of essential skills rather than merely the acquisition of facts. New Generation Science Standards (NGSS) introduced in 2012/13 is an initiative aimed at achieving this. As O'Brien states in the book overview, '*Following the release earlier of the Common Core State Standards in mathematics and English language arts (which also include literacy in history, social studies, science and technical subjects), this also builds on the recent document, "A Framework for K-12 Science Education" (NRC, 2012), and invites teachers to be key contributors to an educational revolution'.*

NGSS is aimed at elementary pupils and teachers, who very often are not confident about science. Thus, the book is offered as a resource to assist practitioners in interpreting and delivering the vision of the standards and the previous framework, (NRC 2012). The main emphasis of the new standards is on skills and how to use inquiry-orientated science lessons to consolidate, develop existing knowledge and '*extend children's innate curiosity*', thus providing a sound basis for an interest in, and enjoyment of, their world outside school. The book firmly reinforces the increasingly voiced and accepted idea that the work done in pre-secondary schools is crucial to the development of scientifically literate citizens, as well as future engineers, technologist and scientists.

The authors write pieces on the latest research about how children learn and how such information is relevant and can be applied in the classroom. The text explains what teachers need to know about the new standards and how literacy can be combined with science. There are contributions from teachers and seven samples of 5E instructional model-based mini-units to provide guidance for practitioners. Details about this model are available at: www.bscs.org/bscs-5e-instructional-model

These new national standards published in the USA need to be adopted by individual states. On the National Science Teachers Association (NSTA) News Roundup of September 2013, it was announced that Delaware had become the seventh state to adopt the NGSS. The News Roundup also informed readers that '*leading business executives from key firms such as Intel, Cisco, and ExxonMobil Foundation met to urge colleagues to "take up the fight to defend Common Core State Standards [CCSS]." They outlined plans to promote the NGSS through a number of strategies, which include national advertising and outreach campaigns to parents and company employees.'*

Whether these aspirations happen remains to be seen, but this book is certainly worth a read by curriculum organisers and science co-ordinators in other countries, many of whom are focusing more on skills than just facts.

Reference

National Research Council (NRC) (2012) *A Framework for K-12 science education: Practices, cross-cutting concepts and core ideas.* Washington, DC: National Academies Press

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