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ABSTRACT

Many primary school teachers feel a lack of confidence in teaching science and technology. This paper aims to demonstrate useful and practical strategies for non-specialist science teachers to use in stimulating a positive scientific attitude among primary school students. It proposes that teachers should strive to develop children's natural inquisitiveness and curiosity about the world around them, and that a constructivist approach facilitates scientific investigation because the curriculum is not teacher-centered. It describes how the constructivist approach uses specific strategies, including observation, designing, making, questioning, prediction, discussion, and recording experiences, which are characteristics of successful scientific inquiry. The paper explains that the constructivist approach to science encourages the process of discovery and learning rather than the "book teaching" of science, and that teachers who use this approach become good role models for developing a positive and successful scientific attitude. It encourages the strategy of using everyday situations to demonstrate basic scientific principles, and the example of investigating melting ice is given as a sample experiment. Three different experiments are created from the concept of melting ice: (1) Does ice melt at different rates in different locations?; (2) Does ice melt quicker on colored surfaces?; and (3) Are all thermoses effective in keeping ice? Each of these experiments is described in detail to show the use of the constructivist approach. (SD)

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PAPER TITLE:

THE CONSTRUCTIVIST APPROACH TO SCIENCE AND TECHNOLOGY

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ABSTRACT

CONTENT

THE CONSTRUCTIVIST APPROACH TO SCIENCE AND TECHNOLOGY

Many primary school teachers feel a lack of confidence in teaching Science and Technology. I was one such teacher until I began to use the 'constructivist' approach.

It is my belief that children come to school with a rich perception of the world around them. Children are naturally inquisitive, observe something interesting and ask questions about it. The 'constructivist' approach is not teacher-centred, rather the teacher facilitates scientific investigation by using many different strategies. These include observation, designing and making, questioning, prediction, discussion and recording experiences. Another part of the 'constructivist' approach includes planning fair tests. The emphasis is on the 'process' of science where children are encouraged to explore by using all of their senses rather than on book learning. Teachers need to develop the art of skilful, stimulating questioning techniques and to provide good role models for the development of positive scientific attitude. Constructivist science lessons are those which stimulate natural curiosity and imagination.

OBJECTIVE

This paper will aim to demonstrate practical, useful strategies to use in the classroom for unscientific or non-specialist teachers.

PRESENTATION

The paper will be presented as a lecture followed by group discussion. There will be samples of children's work, photographs and the use of OHP.

IMPORTANCE

There is evidence that suggests that a child's attitude to science is fixed by the age of 13. Through anecdotal evidence of my own classroom practice this paper will provide methods of developing teacher confidence and a positive scientific attitude amongst our students.

THEME

Appropriate Teaching and Learning and Curriculum in the Early Years.

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"Schools should recognise that Science and Technology education has an essential place in the primary curriculum if students are to be adequately prepared for life in the 21st Century." NSW Board of Studies Science and Technology K-6 Syllabus and Support Document.

Joan Dalton's "Big Picture" context shows us why Science and Technology is so important to our children. (Show OH)

Science and Technology lessons are a vital part of a child's schooling since they basically provide children with a hands-on opportunity to investigate their world. The investigating process is outlined in this flow chart from the BOS Syllabus. (Show OH)

The constructivist approach to teaching Science and Technology emphasises the process through investigating rather than the "teaching of science". **How** scientific answers are found is called the **process** of science and **what** is discovered is known as the **content**. The process whereby a product is invented to fulfil a need is known as **technology**. Constructivist science lessons are those which stimulate natural curiosity and imagination. The constructivist approach is not teacher centred rather the teacher facilitates scientific investigation through the processes on the flow chart. (Refer to OH) Children are naturally curious,finding out about their physical world systematically by observing something interesting and asking questions about it. It is my belief that children come to school with a rich perception of the world around them created by social and cultural characteristics as well as personal experience. Children need to explore their world through investigating, designing and making and using technology. When ideas can be proven or verified then children accept their findings.

Let us first look at the way children learn. Gray and Garaud's description of four common learning styles are shown on the OH. These categories aren't an overall description of a child's learning style but they may describe certain behaviour at a particular time on a particular task. These categories mustn't be used to "label" children or to generalise but it could be useful when grouping children for activities. eg. when three of my 2nd Graders were grouped together they were all "undisciplined" and didn't complete the task. However, when split up they became "creative". One of my "creative" individuals became quite "rigid" when faced with new materials. Once familiar with the concrete material through play, she became "creative" again! The teacher also has to be aware of the self fulfilling prophecy and to realise that teacher expectations have a profound affect on children. I make a point of exclaiming and telling my whole class that they are "clever little scientists". They are confident and there isn't one child who doesn't enjoy science lessons.

Another important issue that describes differences in performance refers to convergent and divergent ability. (Show OH of p.18 Biggs and Telfer) As an example show OH of p.20 of divergent responses. Divergent answers aren't always relevant. Convergence and divergence are not opposite ends of one dimension but are of two separate dimensions. Nor should divergence be confused with creativity. Divergent thinking is a process and creativity is a product.

Studies by Getzels and Jackson reported that high divergers are not always liked by teachers and can be seen as disruptive, non-conformists, comedians or nuisances. (Relate anecdote about Dane, James) In Science and Technology lessons, I find that the high divergers are extremely useful in instigating and initiating activities or investigations due to their unusual outlook and ideas. I value and encourage their input. The constructivist approach lends itself to divergent thinking. A good technology problem tends to be divergent. eg. package a cookie so that it can be sent in the post; the cookie must arrive in one piece. If in the design and make process a product has fulfilled a need then technology has been achieved. There is no right or wrong answer in technology. It may take time for the convergent thinkers to become comfortable with the constructivist approach because these children like to give "correct" answers. In time they will loosen up and the teacher may be surprised in the transformation of thinking style.

Teachers need to offer a range of activities that cater for all learning styles and blends of learning styles. eg. kinesthetic, audio and visual.

Young children's developing science ideas will not be those of a secondary student and will not necessarily be accurate either but they provide a good basis for forming concrete science ideas as they develop and are no less important. Another point to consider is that, "children 'observe' not everything that is relevant - if details are not thought important, then they don't see details - and in their investigations they will control as variables in a 'fair' test those things which past experience has suggested to them may affect the result." (Harlen,1985,p.185) A very important teacher strategy is the ability to listen to the students and to be able to guide them through skilful and stimulating questioning. Language must be "user friendly" since much of the process involves talking. Instructions need to be explicit otherwise children may find an alternative use for materials. (use anecdote). Children are happy to use scientific words so long as they are explained first in terminology that they understand. Teachers will be able to determine a child's understandings and attitudes through questioning and talking. Students' responses reveal their strengths, weaknesses, misunderstandings and interest . Questioning may take on different forms in order to elicit different responses. eg.

* "What is going to happen when you.......?" (problem posing)
* "What is that?" (fact finding)
* "Why did you do that?" (reason seeking)
"How did you do it?"
* "What shall I do with this?" (routine)
* "Have I done it right?" (reassurance seeking)
* "What does deaf mean to you?" (perception seeking)

The more questions asked, the more illuminated the young scientists will be.

Science work for young children needs to be collaborative so that children need to develop co-operative learning skills. Let's look at the Social Interaction Skills sheet by Bennett, Rolheiser- Bennett, Stevahn (1991). Show OH. Begin by brainstorming the class to find out if they know about that particular social skill. The skills need to be demonstrated by the teacher, recorded on a chart and practised.

eg. Sharing materials

What does it look like?	What does it sound like?
smile, eye contact, touch,	"May I have a turn?"

nodding, closeness

"Would you like a go?"
"I like the way you share."

When children slip out of the behaviour, a gentle reminder and reference to the chart will help. Learning social interaction skills greatly assists co-operative learning.

Working in pairs is a useful strategy in a few ways. The children are more accountable. Listening skills are enhanced. Children can self assess and adopt different roles of questioner/ listener. Teachers can observe a pair and assess them easily. An affective technique to begin a lesson is to engage in "Inside Outside Circle". (Explain and show OH photo)

Many primary teachers feel a lack of confidence in teaching Science and Technology. I was one such teacher until I began to use the constructivist approach. As T.H. Huxley wrote, "Science is organised common sense." In order to develop positive scientific attitude amongst our students we need to address the confidence of our teachers and to provide methods of developing happy science classrooms.

When together outside my class and I often observe the natural phenomena around us. We talk about our observations and ponder the reasons why. Why can an ant carry such a huge crumb and how does it know the way back to the nest? Why are the magpies so vicious during September and quite tame otherwise? During a sudden downpour why did it rain on one side of the building and not the other? These observations lead to healthy discussions and productive research in the library. "Science begins when we notice something interesting, and ask a question about it." (Ward, 1983,p.8) Teachers need to keep an open mind and to be flexible when teaching the constructivist approach bearing in mind that some lessons crop up spontaneously and are not part of the planned unit of work. Spontaneous lessons usually end up the most exciting for all concerned.

During one lunchtime chat with K/1 the children identified a problem that turned into an investigative science activity that allowed us to pursue an answer. This was a wonderful constructivist lesson where the children were actively engaged in the learning process.This is when children learn best. "Students actively participate in the learning process through self-direction and experimentation. No longer is the teacher's role one of giving information and facts. Teachers have become guides. Children are encouraged to do more independent study." (Bethel, George, 1979,p.24)

The children observed that some drink bottles kept iced drinks longer than others and that different coloured popper boxes kept drinks chilled longer than others. "Infants concentrate on using the senses of sight, touch and hearing." (Ward, 1983,p.11) This is exactly how the children assessed the drink bottles. They felt them with different parts of their bodies ie. fingertips, cheeks, legs, tongues. They tasted them to check the temperature. They shook them to ascertain which ones contained ice. All the while I remained a passive observer. From their observations I encouraged the children to conduct a fair test.

Through brainstorming we planned a series of lessons and we raised three problems.
PROBLEM 1
Does ice melt at different rates in different locations?

Investigable Questions:

* Will ice melt quicker in the sun or inside the cupboard?
* Will the ice melt quickly under the fan?

What to look at:

* The time it takes for the ice to melt.
* The ice.
* The different locations.

What must be the same:

* The size of the ice cube.
* The surface we put it on.
* The investigation should be done on the same day.

How will results be used to answer the question:

* According to the location of the ice the children should be able to work out if ice melts quicker in some places than others.

We began the lesson with a whole class discussion with special focus on understanding the meaning of key words - location, quick, quicker, quickest, rate, speed, size, ice cube, surface. "An apt author's choice of words is an inspiration for the teacher's task of translating technical information into language children will understand." (Ward, 1983, p.5)

When I was satisfied, I allowed the children a period of exploratory play where they held ice cubes in their hands or felt the fan full on their face. The children talked amongst themselves about different sensations and observations. "Communication with friends by continuous discussion during the experiment is extremely important." (Gilbert & Mathews, 1990,p.20) K/1 tend to talk a great deal about their findings and feelings which is great. It is something to encourage. The exploratory play period should not be underestimated since it provides opportunities for children to tinker with new or different materials as well as to offer exposure to unfamiliar tools and equipment. Play is a good way to find out about the environment.

After the exploratory play I invited the children to make predictions. K/1 can generally predict by the end of the year if encouraged. But sometimes they will have trouble putting forward explanations for their predictions which shows that hypothesising is inappropriate for their stage of development. If the classroom learning atmosphere encourages students' initiatives, ingenuity and originality the children will express opinions openly and take risks without fear of embarassment.

The children and I worked together to set up a fair test for our first problem. The children examined each container and the ice cube within. We placed one container out in the sun, one in the school library, one in the cupboard and one under our fan which was set on the highest speed. At ten minute intervals, I sent out a patrol to check the progress of the melting ice. Each patrol verbalised their findings to the rest of the group. The children relied on the teacher to be the time keeper because there were no students who felt confident enough to read the time. At the end of the hour the children observed that all of the ice cubes had melted. The ice in the sun melted quickest and then the ice under the fan. The ice in the cupboard took the longest to melt and some of the children found that they had predicted correctly.

To finish this session, we engaged in a whole new sphere about the weather.
Problem 1 would fall under the content strand of 'Physical Phenomena' in the unit 'Hot and Cold'. The topic is an hypothesis -generating topic. "The hypotheses that are made and tested out are ones concerning the effect of variables in the situation rather than the general scientific principle." (Harlen,1985,p.167) K/1 were able to identify the variables and to offer knowledgeable reasons.

I will outline Problems 3 and 4 without going into detail.
PROBLEM 2
Does ice melt quicker on coloured surfaces?
Problem 2 would fall under the content strand of 'Physical Phenomena' in the unit "Hot and Cold'. The topic is a pattern finding topic. "There is more value for developing the skill of finding patterns if the variables that are related are not pointed out and the children have to distinguish them from those where there is no regularity." (Harlen, 1985,p.168) I tried to encourage the children to equate their findings with their first questions. I asked them such questions as: Now that you've tested the ice on different coloured paper, do you think the colour of the popper box affects the temperature of the drink?
"Yes!" Tyler (5yrs)
"Lucinda had a yellow popper box so I think her drink was warmer because of that." Shaun (5yrs)
"It depends where the drinks were before lunch. Someone might have had their bag in the sun." Moira (7yrs)
"Some people might have a better bag than others. It could keep the drink cool and have nothing to do with the colour of the carton." James (7yrs)
"Science is ultimately then concerned with the applications of its findings." (Gilbert, Mathews, 1990,p.8) The responses led me to realise that a group of children were on the right path to understanding variables but many children had not reached the developmental stage where they could apply their findings. "Of course some process skills are more complex than others. Thus it is more likely that younger children will devote a larger proportion of their time to developing observational skills than to learning to control variables." (ILEA, 1988,p.18)

After completing the first two problems, it was apparent to me that some children were capable of instigating further investigations and were be allowed to pursue their curiosity. Not all children agreed with one another and some children like to do their own thing. Co-operative group strategies need to be implemented if children are to learn to value other children's ideas and opinions.

PROBLEM 3

Are all thermoses effective in keeping ice? Children bring a thermos from home. Which of these thermoses is the best for keeping ice?

This problem is a topic that involves a fair comparison. K/1 began exploring the properties of each thermos to find similarities and differences. Some thermoses were metal with glass interiors whilst others were totally plastic. Some were black inside and some were silver. These were all discussed amongst the students and I had relatively little input.

Following our three problems was a group task to design a container that would keep ice longer than anyone else's. This covered the 'Design and Make' aspect of the curriculum. The children enjoyed this activity and used only recycled materials. Their efforts were imaginative, resourceful and creative. The students were given a sharing time and were encouraged to self - evaluate their designs and to offer suggestions to other groups. Quite often children are happy to redesign. (Display flow chart of possible sequence of the design process and refer to Big Books)

Earlier this year my class were challenged to package their pottery presents for Mothers' Day so that they would arrive home "in tact". The children came up with all sorts of nifty, snazzy boxes covered in exotic decorations. They did a great job and technology was achieved. Imagine my delight to find the children in their lunch time months later, packaging their Christmas craft in the same careful fashion!

Primary science need not be threatening for either the teacher or the student. It is exciting to watch young, curious minds go about their discoveries undisturbed.

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Board of Studies NS, Science and Technology K - 6 Syllabus and Support Document

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