Teaching children to generate questions designed to improve their capacity to think critically about scientific problems

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> Aim

To teach children to generate questions designed to improve their capacity to think critically about scientific problems.

> Dimensions of this Case Study

Three primary school teachers worked together in three different schools with a target group of 8 children in the early years in one school; target and control groups of 4 children in Years 2 and 5 in another; and two Year 6 classes working in collaborative pairs in the third.

> Summary of Findings for this Case Study

By using a consistent approach involving 'scaffolding', 'modelling' and 'prompting', in a secure environment, teachers helped children to develop sophisticated questioning techniques.

Children who learnt through scaffolding strategies:

- showed sustained interest;
- were more focused;
- retained a deeper level of understanding.

Teacher modelling of questioning and intervention throughout the tasks were essential to the success of the children's learning:

- in all phases, teacher modelling activities enabled the children to progress from hearing and internalising language structures, to verbalising their thoughts, questions and conclusions;
- in Early Years and KS1, the teaching approach led to the development of an interactive dialogue between child/child and children/adults which built on existing language;
- at KS2, teachers modelled a more critical approach to questions which led to the development of independent research skills.

The teaching approach was found to be transferable between English and Science.

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‘Why aren’t our children asking questions?’

Our study grew out of revisiting the issues raised in the ORACLE project (Galton et al). Pupils in science rarely asked questions, particularly higher order questions. A review of the literature confirmed our own classroom experiences. Smith & Peacock (1995) discovered that "real difficulties arise when children do not ask questions, perhaps because of the lack of response from adults."

We started from the premise that the development of children’s questioning skills would enable them to become enquiring, autonomous critical thinkers, empowered to access information in the future. As Fleer & Hardy (1996) pointed out: "allowing children to have significant control over the learning process is critical. Asking, and being encouraged to investigate their own questions, is one aspect of that." Our study set out to examine how best teachers could lend their support to the development of questioning skills which promoted pupil learning in primary science.

The strategy

We designed the intervention strategy across all three schools by taking Rosenshine et al (Teaching Students to Generate Questions: a review of the intervention studies.1996) as our starting point. Our subsequent threefold approach was designed to be transferred from the original English context to science-based activities.

The strategy involved three distinct but complementary approaches:

- scaffolding;
- modelling;
- prompting.

The approaches were adopted for use within a range of activities and phases, including:

- investigative play in the early years, to cultivate and improve young children’s questioning behaviour;
- practical science investigation in Years 2 and 5, to encourage children to raise questions to develop their own investigations; and
- the use of ICT to extend children’s scientific knowledge in year 6 through active inquiry rather than passive reading of information.

A similar project was carried out by a group of university students working with Years 3 and 5, which enabled some comparative observations across year groups.

New roles for the teacher

Implementing the teaching strategy required the teacher to take on new roles, appropriate to each age group involved.

- Teacher as ‘model’:

  Modelling involved the provision of appropriate vocabulary, giving examples as a stimulus for children’s own questions and demonstrating the use of ICT.

"Why is that hard thing sinking and this hard thing floating? I wonder what’s different about them?" the teacher thinks aloud.

- Teacher as ‘scaffolder’:

  Scaffolding involved the teacher in providing a secure framework where children received support to become independent, confident questioners.

"How can we make it stronger? How can we make it not fall down?" the teacher asks, while playing alongside the early years children.

- Teacher as ‘prompt’:

  This term was redefined to include other intervention strategies, such as using questions to redirect, or providing alternative language, to ensure questions could be investigated successfully.

"I want to find out how fish breathe, but I can’t find anything using breathe."

"Let’s find another word to help you search: what do fish use to breathe?"

"Oh yes they use their gills."

"Well let’s look under gills."

The research method and organisation

The threefold approach of modelling, scaffolding and prompting was the common thread linking the research at the three schools.

The Research Groups

In each school, a control group and target group were formed. The teaching approach differed slightly to cater for the requirements of the different age groups. Each target group received question-generating input from the teacher, while the control group explored the activity without using questioning as the main focus. This approach had to be adapted for the early years' group after the first two activities, when it was evident that the children in the control group were losing their concentration and interest. It was decided that both groups should benefit from the sensitive support and scaffolding.

All the children were in mixed ability groups. The number of children in the groups differed. In the early years' investigative play, there was a target group of 8 children. The science investigation research consisted of a target group of 4 children and a control group of 4 in both Years 2 and 5. The ICT research moved from target and control groups of 6 using CD-ROMS to the whole class using the Internet in collaborative pairs. One Year 6 class was used as a target group and the other as the control group.

Assessment

Teacher observation was used consistently in all groups as a means of assessment.

Pre-intervention assessment was carried out by the teacher 'brainstorming' with the children in 'we think' and 'we know' sessions. This ensured that the target and control groups started off at similar levels in their thinking.

Children's ability to recall and report back on their investigations was also used as part of the assessment process. The early years' children revisited the activity, then explained to their peers.

Reassessment for the science investigation and ICT groups involved revisiting and repeating their original what we think/what we know exercises, together with teacher observation. In the case of the ICT group children also presented their findings to each other.

Findings

In all three schools the 'target' groups were more motivated, remained on task longer and showed a greater depth of understanding when reporting back to peers or through reassessment by teachers at a later date than their peers in the control group.

- In the early years' activities teachers found the target group developed confidence, enthusiasm and remained focused on task. Using the brainstorming/activity/review process, with the adult as model, scaffolder and prompter, a variety of questions, hypotheses and predictions were generated by the children:

"What will happen when we pour on the water?"

"It will get wet"

"It will be rained on"

"The water will push it, won't it?"

"It will knock it down"

"How can we make all the houses the same?"

"The same shape?"

"Yes, how can we make all the houses the same, so we can see what will happen?"

In the practical science sessions, the target group's investigations appeared to be of a much higher quality in terms of focused discovery and sustained interest in the scientific concepts concerned. The children showed evidence of development in their perceptions and conceptual thinking about floating and sinking. The difference between the target and control groups was more marked in the Year 2 groups than in the Year 5, suggesting that the optimum time for interventions such as these is likely to be earlier rather than later in a child's primary school life.

- In the ICT sessions, teacher preparation of materials, tasks and contingency plans took time but was essential. The teacher scaffolding methods resulted in immediate improvements in the standard of the children's questions in the target group. This group's presentations and folders were also better organised and of higher quality than those of the control group.

Implications of the research

Our research is merely a snapshot, limited by time. There are longer term implications which can be inferred from our results. The National Curriculum emphasises that 'Pupils should be given opportunities to ask questions such as 'How?' 'Why?' 'What will happen if...?' In order to do this effectively and to improve learning, we found that approaches such as scaffolding, modelling and prompting were invaluable. During the short period of this research we found changes in children's attitudes and abilities to recall information.

This project has indicated some of the benefits that could accrue if this teaching approach was adopted consistently from early years and then on throughout a child's school experiences.

Further reading

Fleer, M. and Hardy T (1996) *Science for Children* Prentice Hall

Jelly, S. (1985) Chapter 5 'Helping Children raise Questions and Answer Them.' in Harlen W. (ed) *Taking the Plunge* Heinemann

Rosenshine, B. Meister, C. and Chapman, S. (1996) 'Teaching Students to generate Questions: A review of the intervention studies' Review of Educational Research Vol 66 (2) pp181-221

Smith, R. and Peacock, G. (1995) *Investigations and Progression in Science* Hodder and Stoughton

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