PRE-SERVICE TEACHERS' USE OF PROBLEM-SOLVING IN PRIMARY SCIENCE

Christine Chin, Ngoh-Khang Goh, Lian-Sai Chia, Kam-Wah Lucille Lee & Kay-Cheng Soh
Nanyang Technological University, Singapore.

ABSTRACT

The use of problem-solving in science instruction implies a change in the teacher's role from dispensing content information to encouraging critical reflective thinking in the student. For problem-solving to become an integral part of the science curriculum, teachers must make it the focus of their instruction. This study investigated the extent to which pre-service primary teachers used the problem-solving approach in their science instruction. It also identified the factors affecting their efforts to teach science using this approach. The issues considered are important in whether problem-solving becomes part of the science curriculum, as teaching behaviour influences student learning outcomes.

INTRODUCTION

In recent years, the use of problem-solving in science instruction has received increasing attention. Rather than teach science as a body of facts, teachers are encouraged to employ teaching techniques that foster problem-solving skills. However, the use of problem-solving in teaching science implies a change in the teacher's role from dispensing content information to encouraging critical reflective thinking in the student. The consequent teaching approach would also be different. The use of an inquiry-oriented, investigative approach in teaching science has often been advocated. This suggests the use of a variety of teaching techniques that have been linked to the development of problem-solving skills in the context of science education. For example, Pérez and Torregrosa (1983) advocate that in a problem-solving approach, teaching strategies that reflect the process and nature of a scientific investigation should be adopted. The nature of the investigative task or problem should also to some extent involve a novel situation (Gagné, 1977), be open-ended in nature rather than have one correct or obvious answer (Garrett, 1987, 1989), require the use of higher-level thinking skills beyond the knowledge and comprehension levels, and emphasize the process towards attaining the solution rather than the correct solution only. Lock (1990) argues that in order to develop inquiry skills in problem-solving investigations, it is important to enhance the open-endedness of practical work by providing opportunities for students to have more control over the identification of the problem, planning, and interpretation of results. If students are given the problem, together with the detailed procedure and solution, little if any problem-solving is present.

Pizzini, Shepardson and Abell (1989) proposed a problem-solving model for science instruction based on the assumption that a problem needs to be identified and defined by the students for it to be meaningful to them, and that they meaningfully learn problem-solving skills and concepts through concrete experiences in solving problems in science. This model is less teacher-directed and less procedurally structured to encourage students to become involved in their own learning. It encourages an inquiry approach that is as open-ended as possible, with activities that stress divergent thinking, where there may be a variety of acceptable solutions to the problem, and where the resources and methods are student-centred. Students brainstorm to identify and formulate a researchable question or problem in science and generate and implement their plans for finding a solution to the problem. Detailed 'recipe-following' procedures are not given. Students design their own experiment, decide what to do, how to do it best, what data are important, how accurate measurements
must be, and why each step in the process is necessary. They also form hypotheses, predict outcomes, collect and analyze data, and interpret the results. They then present their findings, solutions, and conclusions to teachers and fellow students.

Studies by Abell and Pizzini (1992) and Pizzini and Shepardson (1992) have shown that in classes where the teacher adopted the problem-solving approach (compared to a control group which did not), there was increased use of brainstorming, an increase in time allotted to identifying, refining and presenting the problem, as well as more student-selected research questions and student-designed investigations. The teachers also substantially decreased time spent on expository and procedural talk, fact stating and explaining. This shift in control of learning from the teacher to the students is essential to developing student thinking and problem-solving skills. First-hand student interaction with materials which ensures active processing of ideas is also valued in the problem-solving approach (Martens, 1992). The use of small group settings which encourages student-student interactions and co-operative group work, where students pool their efforts together, is also considered to be effective for problem-solving investigative tasks. While the change to a problem-solving approach is desirable, teachers also experience constraints (e.g. time constraints) in implementing this approach in their science classes. Pre-service teachers could well face further constraints. This study investigated the extent to which pre-service primary teachers used the problem-solving approach in their science instruction. It also sought to identify factors which hindered their efforts in teaching science using this approach.

METHOD

Sample
The sample consisted of 100 pre-service primary science teachers (77 female, 23 male) who were in the second year of their Diploma-in-Education programme (77 in the Dip-Ed and 23 in the B.A./B.Sc with Dip-Ed). Their mean age was 22.1 years (s.d. = 2.0 years). Fifty-five percent had passed 'A' level science (Grade 12), 30% had attained 'O' level science (Grade 10), and 15% had studied science up to the lower secondary level. All had studied English as a first language and all their science classes had been conducted in English. In their science methods classes, they were taught and encouraged to use an inquiry investigative approach to teaching science which would foster problem-solving skills. The use of hands-on activities was also advocated. The pre-service teachers had 15 weeks of teaching experience in primary schools; 7 weeks in their first year of the Dip-Ed programme, and 8 weeks in their second year.

Instrument
A questionnaire was developed to measure the teachers' extent of use during their teaching practice of instructional techniques associated with a problem-solving approach to teaching science. Items focused on the pupils' tasks, the nature of questions or problems in science investigations, and the time spent on various activities during a typical science lesson. They were adapted from the instrument used by Lawrenz (1990) in her survey of science teaching techniques associated with higher-order thinking skills. Some items were modified and additional ones were included based on existing knowledge and theoretical considerations consistent with the literature on the problem-solving approach in science teaching. For example, items that represent an emphasis on problem-solving involve tasks that require more reflective thought such as designing an experiment, or pertain to questions that are open-ended and require higher levels of thinking. On the other hand, activities oriented to following detailed instructions and verification of taught concepts, or questions requiring the use of definitions and recall of information rate low on problem-solving.