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FOSTERING CREATIVITY IN SCIENCE EDUCATION

Review by Lucille Lee Kam Wah

INTRODUCTION

In recent years, the Singapore Ministry of Education has placed a great deal of emphasis on teaching thinking skills in schools. “Thinking School and Learning Nation (TSLN)” was launched in 1997, with the aim of fostering higher order thinking skills (critical thinking, creative thinking, and problem solving) among Singapore students. Teachers have been encouraged to teach creatively and to find ways to develop students’ thinking skills, including creative thinking, through content instruction in various subjects. The Thinking Programme, aiming to help our students become critical, creative, and self-regulated thinking learners, has since been incorporated as part of the secondary school curricula. Courses in the teaching of thinking have been conducted by the Ministry of Education (MOE), the Singapore Centre for Teaching Thinking (SCTT), and the National Institute of Education (NIE) (Tan, 2000) for teachers at both secondary and primary levels.

Fostering creativity among students through science teaching has now become a challenge for all science educators in Singapore.

Despite the need to foster creative talent in science, creativity is seldom discussed in the science education literature (Garrett, 1989, 1987; Moravcsik, 1981; Washington, 1971). Creativity and the so-called ‘creative subjects’ are separate areas of the curriculum commonly isolated from science, and usually not thought of as a proper domain of the school science curricula (Garrett, 1987). It is the purpose of this article to review the literature on some issues in creativity in science education. The discussion will focus on the following three aspects:

- What is creativity in the science context?
- Why do we teach or foster creativity through teaching science?
- How can we foster creativity or creative thinking in Science Education?

REVIEW

What is creativity in the science context?

Creativity is difficult to define. Christensen (1988) in his award lecture referred to creativity as a joining together of two or more concepts, to produce a new idea or useful product. Moravcsik (1981) defined creativity in the science domain as the attainment of new and novel steps in realizing the objectives of science. Science — the activity of producing new knowledge about the
The world around us — has three objectives. The first objective is to serve as a foundation for technology. The second is to fulfill our general human aspirations in solving the countless riddles or problems surrounding us. The third objective is to develop awareness and appreciation of how science and technology influence people and the environment. Moravcsik (1981) argues that creativity plays an important role in the development of science in following excerpt:

"Scientific creativity is, therefore, an attribute that permits the infusion of new elements into any and all of these aspects and objectives of science. Thus creativity can manifest itself in the conception of new ideas contributing to scientific knowledge itself, in the formulation of new theories of science, in the devising of new experiments to probe nature's law, in the development of scientific ideas applied to particular domains of practical interest, in the realization of new organizational features of scientific research and of the scientific community, in the novel implementation of plans and blueprints for scientific activities, in trail-blazing undertaking to transmit the scientific outlook into the public mind, and in many other realms." (p. 223)

Creativity is divergent thinking that includes such factors as 'fluency (the ability to generate many ideas), flexibility (the ability to generate different classes of ideas) and originality (the ability to generate novel ideas) of idea production' (Williams, 1972; McCormack, 1971). On the same note, Guilford (1959) believes that creativity requires divergent production, which involves the ability to synthesize and recombine material to form new solution to problems, as opposed to convergent achievement that emphasizes a person's stock of information. Creativity is also a part of problem solving and laboratory work (Garrett, 1987). Problem solving entails the processes of formulating questions and hypotheses, planning investigations, experimenting, collecting and evaluating data, and drawing conclusions (Pizzini, Shepardson and Abell, 1989). Being able to identify or recognize a problem that can be solved and then find a way to solve it actually is a form of discovery. Problem solving is therefore a uniquely creative way of thinking. Moravcsik (1981) has suggested creative thinking in pupils can be promoted by using open-ended experimental-based problems.

West (1981) suggests that as one of the aims of science education, science studies should include the component of creativity: "the scientific study of creativity - a study of problems and the production of solutions." (West, 1981, p.233).

Why do we teach or foster creativity through teaching science?

Baez (1980) argued that through science education four important traits, namely curiosity, creativity, competence and compassion, must be generated in people in order to improve the quality of life. The first three traits are obviously important to science and technology as we move forward in scientific understanding and invention, but while curiosity and
competence have for many years been part of science curricula, creativity has been relatively neglected (Garrett, 1989). Why is creativity an important feature to foster in our school science curricula? Garrett has summarized the answers to this question as follows:

1. It is a fundamental aspect of the process of science, which in turn is now being seen as a prime feature around which science curricula are currently being designed.
2. More specifically, problem-solving, another key component of current courses, requires an element of creativity if it is to be practised.
3. The sort of cognitive creativity that is required in the practice of science is not likely to be encountered in those subjects usually termed ‘creative’.
4. If creativity in all its forms is not continually exercised it will not develop (Garrett, 1989, p. 128).

DISCUSSION

How can we foster creativity or creative thinking in science education?

As the literature reviewed above suggests, it is important to foster creativity or creative thinking through science teaching. But can creativity be taught, and if so, how? Christensen (1988) claims that even though the ability to create is largely gene-dominated, creativity can be taught to some extent, though he suggests it is better to say creativity can be enhanced, rather than be taught. A study was conducted by Hill (1976) to determine if creativity could be enhanced in a specific discipline, such as chemistry. Students received laboratory instruction in which they were encouraged to practise processes considered to be creative and were rewarded for successful attempts. The results of the study suggest that explicit teaching in divergent thinking and rewarding creativity can increase students’ creative abilities in science.

If creativity can be enhanced or taught, how can we do it in science teaching? What teaching approaches can science teachers use to encourage creativity in students? Based on the work of Goh, Lee, Xu, Tan, and Chia (2000), Garrett (1989), Christensen (1988) and Moravcsik, (1981), the following suggestions are given:

1. Teachers can discourage excessive memorization in science teaching as far as possible, and instead teach science concepts and process skills and their application, with emphasis on conceptual understanding.
2. Teachers can demonstrate science or natural phenomenon through experiments. Experimentation is a crucial element in the scientific discovery of knowledge and it cannot be replaced by simply resorting to books because science is not just a set of fixed facts.
3. Use an inquiry or problem-solving approach in teaching science. Open-ended problems that have more than one answer should be used more frequently for creative problem solving. Genuine problems or real-life problems can also be used to provide open situations and perplexities. In the process of trying to comprehend or
encounter a perplexing situation, creativity is likely to be exercised to its maximum extent.

4. Project work which involves problem solving and scientific application, can be used to promote creative thinking.

5. ‘Play’ and ‘fun-making’ can help develop creativity. Play and work are not opposed to each other. They can provide challenging and exciting experiences that require lots of creative thinking and planning.

6. Encourage students to think of more ideas though brainstorming activities. Being creative means having more ideas. We may be surprised at how many successful ideas can result from ideas that might first appear “stupid”.

7. Develop students' ability to see or observe things in different ways.

8. Teach students to defer judgment of ideas until they can be tried, tested, analyzed, and viewed in relationship to other ideas and concepts.

9. By being more open-minded, receptive, and appreciative towards students' creative behavior, teachers can create a teaching and learning environment that is more conducive to fostering creativity.

CONCLUSION

Fostering creativity is an important element of the Singapore curriculum and an integral part of national development. The three issues related to creativity in science reviewed above are important and relevant to all science teachers in schools. Creativity contributes to the building of scientific infrastructure. The science knowledge and process skills are most suited for fostering creative thinking. Creative abilities can be enhanced through science content instruction by emphasizing divergent thinking and scientific inquiry. Teachers can develop students' creative abilities by being more open-minded, receptive, and appreciative towards students' creative behavior. Science instruction emphasizing creative thinking can help develop our students to be more creative citizens.
IMPLICATIONS

There are several implications for teachers to consider when fostering scientific creativity.

- Appreciate the relationship between creativity and science education. Creativity is closely related to the development and application of science knowledge and scientific method. The creativity that is required in the practice of science, e.g. scientific process skills, is not likely to be experienced in other subjects.

- Use an inquiry or problem-solving approach that involves experimentation and hands-on activities to teach science in order to foster scientific creativity. Project work and ‘fun-making’ activities can also be used to promote creative thinking.

- Create conducive teaching and learning environments to facilitate the development of students’ creative abilities. Encourage students to generate more ideas, different classes of ideas, and novel ideas. Teachers can be more open-minded, receptive and appreciative of students’ creative behavior.

SOURCES


