Title	Improving explanation skills for enhancing understanding in science
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Source	*REACT*, *1995*(2), 1-4
Published by	National Institute of Education (Singapore)

IMPROVING EXPLANATION SKILLS FOR ENHANCING UNDERSTANDING IN SCIENCE*

Review by
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INTRODUCTION

Students sometimes complain about being unable to understand science even though it appears to be an interesting subject to many of them. Science is a subject to be taught preferably by an inquiry approach through the use of many hands-on activities and teaching materials. With this teaching setting and the first-hand learning experience offered to our students, why do students still have difficulty in understanding certain concepts? Besides using the teaching ideas and materials already available (e.g. CDIS packages), what can a teacher do to further facilitate student learning of science? This article reports on some research findings concerning factors influencing effectiveness of science instruction and the importance of explanation skills in effective instruction. Some suggestions for improving explanation skills to enhance students' understanding are discussed.

FACTORS INFLUENCING EFFECTIVENESS OF SCIENCE INSTRUCTION

There are numerous studies researching teacher effectiveness and clarity. One such recent study (Killen, 1994) investigated the factors influencing students' understanding of science lessons. The study involved 955 junior high school students from four countries, Australia, USA, Finland and the Republic of South Africa, in an attempt to identify aspects of teacher effectiveness that were common and unique to the four countries. The age of the students ranged from 13 years to 16 years. The students were asked two open-ended questions at the end of regular lessons in general science, physics, chemistry, biology or mathematics by their own teachers. The two questions were: "In this lesson what things did the teacher do to make it easy for you to understand the lesson?" and "In this lesson what things did the teacher do that confused you or made it difficult for you to understand the lesson?"

The students in the study identified 43 distinct teacher behaviours that helped them to understand the information presented by their teachers. These behaviours, namely, facilitating teacher behaviours, were further grouped into six broad categories: teacher explanations, demonstration/use of teaching aids, students activities, teachers interaction with students, teacher help for individual students and teacher communications style. The common **facilitating** teacher behaviours identified by students from these countries are listed below:

Teacher explanations

- *Were detailed*
- *Well sequenced/step by step-by-step*
- *Clear and simple*
- *Were repeated*
- *Incorporated everyday examples*

Demonstrations/use of teaching aids

- *Diagrams/charts were used*
- *Transparencies were used*
- *Demonstrations were included*
- *Things were written on the board*

Student activities

- *Activities/worksheets/homework were given*
- *Notes were taken*

* Article published in REACT, 1995, No. 2 issue.

Teacher interaction with students

- *Students were asked questions*
- *Students comprehension checked*

Teacher help for individual students

- *Things were re-explained when students didn't understand*
- *Individual help was given to students*

Teacher communications style

- *Humour injected into lesson*
- *Words were clearly and loudly spoken*

The teacher behaviours that confused the students or made it difficult for them to understand the information presented were called limiting teacher behaviours in the study. Twenty-nine limiting teacher behaviours were identified and they were classified into five broad categories: teacher explanations, lesson structure, pace of the lesson, teacher questioning, and teacher communications style. The common limiting teacher behaviours identified by the students are listed below:

Teacher explanations

- *Used words that students did not understand*
- *Things were not explained in detail*
- *Explanations were not clear*
- *Too much content was included in the lesson*

Lesson structure

- *The subject was changed from one thing to another*

Pace of the lesson

- *Words were spoken too quickly*

Teacher communications style

- *Too much talking was involved*

The results of the study indicated that about half of the students considered their teachers' explanations as one important factor that helped them understand the lessons. This is not surprising since a large part of science teaching is concerned with explanations. Explanation serves a significant instrumental purpose within science for making the content knowledge comprehensible.

SOME SUGGESTIONS FOR IMPROVING EXPLANATION SKILLS

It is clear from the above review that explanation is very important for helping students to understand science concepts and the links between the concepts and the phenomena observed. Very often, teachers do not explain adequately or in detail (Dagher and Cossman, 1992). As a result, student learning of content knowledge is acquired by rote learning rather than conceptual understanding. A few suggestions are raised now for the improvement of explanation skills.

1. Make explanations clear and systematic

To explain a concept or phenomenon, teachers must decide precisely what they want to explain, e.g. three states of matter. They set the key points by identifying the key words related to the topic concerned. These key points can be transformed into questions to raise students attention, e.g. what is matter? Each key point is then explained with appropriate examples or everyday examples. Students' comprehension should be regularly checked. Repeat the explanation if students still do not understand. Attempts should be made to conceptually link all the key points to allow

students to fully understand the whole explanation. Teachers should avoid using difficult words or talking too much about irrelevant matters (Killen, 1994).

2. Use different types of explanations

A teacher's understanding of the nature or types of explanations can promote the use of more clear explanations and, subsequently, serve to facilitate student learning. The types of explanations by science teachers have been studied and reported. Dagher and Cossman (1992) investigated the nature of explanations used by science teachers in junior high school classrooms. Ten types of explanations, namely, analogical, anthropomorphic, functional, genetic, mechanical, metaphysical, practical, rational, tautological, and teleological, were identified based on observations of 40 class periods of science instructions during which the classroom discourse was audio taped and later transcribed. *Genetic, mechanical, practical, and analogical* explanations occurred most frequently in this study. A *genetic* type of explanation relates an antecedent sequence of events. Talk about what happens but not why. A *mechanical* type explains causal relationships using scientific law. A *practical* type involves instructions as to how to perform the practical. An *analogical* type involves using analogy in explanation. The results indicated that teacher explanations did not vary considerably. The former three types of explanations, genetic, mechanical and practical are quite similar to the three types of explanations described by MacDonald (1991) as interpretive, reason-giving and descriptive. The *interpretive* explanation answers 'what' questions and establishes the meaning and the boundaries of a concept. Reason-giving explanations answer 'why' questions. A *descriptive* explanation answers 'how' questions and illustrates a procedure or series of steps or events that occur when achieving a final goal.

3. Use analogies

Treagust (1993) suggests that the use of analogies can effectively communicate concepts to students of particular backgrounds and prerequisite knowledge. The familiar world concept is usually used as the analogy to assist in the explanation of the scientific concepts. Analogies can help student learning by providing visualization of abstract concepts, and by comparing similarities of the students' real world with the new concepts. For example, students walk around the classroom in such a manner that their direction of travel is analogous to the motion of electrons through a solution during electrolysis. However, there are some constraints of analogies. Inappropriate use of analogies can lead to incorrect or impaired learning. For example, the analogy used in the explanation may be unfamiliar to the students, or the students may lack visual imagery or analogical reasoning, then the use of analogies may be limited. Treagust (1993) suggests that teachers should reflect on the clarity and usefulness of the analogy and consider ways in which the analogy may be improved.

4. Use an interactive approach

Appleton (1993) investigated the effect of the Interactive Approach described by Biddulph and Osborne (1984) on student behaviours in science lessons. The study examined Grade 7 (equivalent to Secondary one) students' responses in the two science lessons that were designed to encourage students to ask questions then propose and test their own hypotheses. The teaching involved a demonstration designed to present a discrepant event or puzzling situation. The demonstration was conducted with little explanation or comment. The students were then invited to ask questions about the demonstration and materials. The teacher answered questions with either a 'yes' or 'no' or repeated the demonstration to provide an answer. Students were free to discuss ideas amongst themselves whenever they wished. Each of these lessons was intended to serve as an introduction to the topic and were followed by subsequent lessons.

CONCLUSION

An important contribution to the effective instruction of science lessons can be made by teachers' understanding of content knowledge and knowing how to transform it into knowledge for teaching. It is evident that clear explanation is essential for students' understanding of science concepts. For developing more effective explanation skills, the teacher can stress the key points and try to use different types of explanations such as 'interpretive', 'descriptive', or 'reason-giving', to make the lessons more interesting and stimulating. Appropriate analogies can be frequently used for explaining abstract or difficult concepts. The teacher needs to constantly check on the effectiveness of analogies used and avoid creating confusion or introducing misconceptions. The teacher can use the interactive approach with or without discrepant events to make the teacher-students interaction more dynamic and hence promote student active learning. Explanations can be introduced after the students' ideas are elicited as this is the time when the students are more prepared for learning.

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