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Thinking Aloud about Pair Problem Solving in Chemistry

Lucille Lee Kam Wah

Background

Students' ability to develop problem-solving skills depends largely on a teacher's instructions. Teaching which generates inert knowledge, that is, knowledge that may be recalled but not used, does not promote the transfer of skills and ideas from one context to another (Lipman 1987). Achievement in science courses can be multiplied when educationally disadvantaged students are taught problem solving together with the subject matter (Carmichael, Bauer & Robinson 1987). Pestel (1993) has found that conventional teaching methods which rely predominantly on presenting information, showing prototypical examples of workout problems and providing students with practice in solving similar kind of problems do not help to develop the students' problem-solving skills. This type of teaching allows students to remain passive. Many students assume that "you either know the answer to a question or you do not", and that if they do not know the answer, there is nothing they can do about it (Lochhead 1985). This accords with Reif's report (1983) that students are more concerned with the answers than with the process involved in solving the problems.

Lee (1986) investigated the teaching approaches used by Australian teachers in teaching problem solving and found that the teachers predominantly concentrated on presenting information while students witnessed their teachers' demonstration in using rules and algorithms for solutions to problems. The teachers spent very little time on teaching problem-solving skills such as analysing the problem statements or discussing strategies pertaining to solving science problems. Garrett's review paper (1986) on problem solving in science education shows that, many researchers have suggested that problem solving can be substantially improved if the task is approached more scientifically and systematically. More emphasis should be placed on the systematic organization of the thinking process required for problem solving. A model of problem solving employing Whimbey's think-aloud pair method (Whimbey 1984; Woods 1985) can be used to develop the awareness of process skills while solving a problem. The

approach involves students working in pairs with each person assigned a specific task; each student works on the problem with a partner who does not directly participate in the problem solving but forces the problem solver to verbalize all thought processes.

At the Xavier University of Louisiana, the emphasis on problem solving in general chemistry is one component that has helped assist students reach expected levels of performance. An adaptation of the "Whimbey method" of teaching problem solving is used whereby students work in trios and focused on careful, methodical work in which all the steps are clearly articulated and constantly checked for accuracy (Carmichael, Bauer & Robinson 1987). As for Pestel (1993), during a preliminary evaluation of the teaching strategy, one course was taught using Whimbey's think-aloud pair method and another using the conventional approach to problem solving. The outcome was that although the class under the think-aloud pair method had fewer problems completely right, they also had fewer problems completely wrong. The decrease in the percentage of problems answered correctly by the class taught using the think-aloud pair method might be a result either of fewer students memorizing templates or of students relying on problem-solving skills not only to begin the problem but to solve the problem itself.

Lee (1993) has introduced the Whimbey think-aloud pair method to in-service chemistry teachers in Singapore. Most of the teachers recognize the usefulness and importance of the strategy in developing problem-solving skills. They consider the think-aloud pair method a good technique for tapping the thinking in one's mind and that it is useful to have students solve aloud unfamiliar problems. They also indicate that teaching the method would not increase the complexity of the chemistry curriculum. The strategy is transferable to areas other than chemistry.

In an attempt to investigate the effect of this method on students' problem-solving skills, a follow-up preliminary case study was undertaken. Two secondary schools and two junior colleges took part in this study (Lee 1994). The results of the study show that through think-aloud pair method, many students have become more motivated, confident and systematic in solving chemistry problems. They have shown signs of spending more time in translating the problem statements and are more particular about checking the answers or solutions.

In the light of the research findings described above, it is suggested that teachers use Whimbey, think-aloud pair method (Whimbey 1984;

Wood 1985) to develop students' awareness of their problem-solving processes. This approach has been proposed as a valuable resource for teaching science students how to solve academic and personal problems (Woods 1984; Carmichael, Bauer & Robinson 1987; Pestel 1993; Lee 1993, 1994).

The next few sections document the information that can be used for conducting a workshop on teaching the think-aloud pair method. These include the objectives of the workshop, the importance of the think-aloud pair method in problem solving and the procedure of conducting the activity. Teachers may wish to use these materials with some modifications, where necessary, for conducting similar workshops.

OBJECTIVES OF THE WORKSHOP

- To help participants become aware of the problem-solving process.
- To develop the ability to verbally describe the process of solving problems.

OBJECTIVES OF THE THINK-ALOUD PAIR METHOD

To develop the ability to:

- identify where you are when you are solving a problem;
- develop a methodical approach;
- identify an obstacle whenever it is encountered;
- describe to others what has just been done and any difficulties encountered;
- become aware of what skills need developing;
- develop skills of carefully attending to details; and
- be confident.

ACTIVITY - USING WHIMBEY THINK-ALOUD PAIR METHOD

1. Choose a partner. One will be the problem solver and the other will be the listener.

2. The pair reads the instructions* given.

3. The listener's role is not to solve the problem and not to get the problem solver to give the right answers. The only "right" answer in this task is **good verbalization** of the process, **independent** of whatever answer is achieved.

4. The problem solver solves one content-free problem* first, and when this is done, reverse the role and work on another content-free problem*.

5. At the end of the task, both will evaluate the process with the use of the forms:

   - Problem Solving Style*
   - Feedback for the Listener *

   The pair evaluate themselves as both problem solvers and listeners, and their partner as problem solvers and listeners.

6. The instructor gathers the students' reactions to how the activity went.

   Questions for the problem solvers and listeners could be as follows:

FOR PROBLEM SOLVERS

- Was it enjoyable?
- What did you discover?
- What did you do to complete the task?
- What have you learnt about yourself in this exercise?
- How do you solve problems?

FOR LISTENERS

- Can you describe how you performed your task? (They will find this very difficult because they were trying to solve the problems.)

- Has anyone anything new to add?
- What is the most significant impression as a listener?
- In one word to five words, what advice would you give to a new listener?

7. The process is repeated by using chemistry problems*.

8. At the end of this activity (step 7), both partners will evaluate again how the process went by using the same forms: *Problem Solving Style** *and Feedback for the Listener**.

9. After this, the students are asked to comment on or share or discuss their evaluation with their partners and try to resolve any major discrepancies with the evaluation.

10. At the end of the workshop, the instructor discusses and summarizes what the students have learnt. He may also gather from the students what they feel they have learnt from the experience.

11. A follow-up exercise, for example, content-related problems (preferably small or short problems within the students' ability) may be given to students as homework to practise using Whimbey's method.

Conclusion

Think-aloud pair method is a useful strategy for developing students' awareness of the processes involved in problem solving. This strategy can help develop students' confidence in solving problems and provide a methodical approach for problem solving. Teachers may like to try this strategy in conjunction with other strategies for solving chemistry or science problems. Teachers may also need to constantly reinforce this strategy by demonstrating problem solving through the use of the think-aloud pair method. To conclude, the comments of the two teachers who took part in one of the workshops conducted by the author are quoted here to illustrate what they have experienced in the use of the think-aloud pair method.

> *Speaking out helps my thinking process; the process becomes clearer. A good method for a mixed group of students. It is harder to be a listener than a solver. I must learn not to supply the answer.*

My thoughts might not be so organised in solving problems. Would do more of this.

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**Teachers who wish to obtain instructional materials may refer to the following report, which is available in the National Institute of Education (NIE) Library, Singapore: Lee, K.W.L. (1993). Workshop on thinking aloud pair method for improving problem solving in chemistry. Workshop conducted at the 5th Asian Chemical Congress, Kuala Lumpur, Malaysia.*

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