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Training Teachers to Facilitate Inquiry

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Within the broad context of the topic Pre-Service and In-Service Education I've decided to focus my attention on one rather narrow aspect of the pre-service education of Primary School teachers. The topic which I want to consider is one which I've called "Training Teachers to Facilitate Inquiry".

I've chosen this topic for three reasons:

Firstly, in recent years there has been a major curriculum reform effort, which, at least in science and the social sciences has had as its major thrust an improvement in both the quality and quantity of student inquiry. I hope therefore that some thoughts on student inquiry and how teachers may be trained to facilitate this, will prove both topical and interesting.

Secondly, as an audience of educators all of whom are concerned with observation of the teaching act, I hope that what I say will provide another framework within which you might view some of the activities which take place in the classrooms you enter.

Finally, from the vantage point of one involved in Teacher Education, it's my firm belief that progress in the pre-service preparation of teachers is most likely to be achieved through the identification of specific teaching skills and the development of a training programme which fosters these skills.

The examples which I'll use are drawn primarily from the broad field of primary science education. But since the type of intellectual activity involved in inquiry is desired in all areas of the primary school curriculum, I trust that what I have to say will have application beyond the field of Primary Science.

Let me begin by trying to answer the troublesome question of "What is Inquiry?"

When one goes to the literature for an answer to this question one is immediately struck by the confusion which arises when some writers use the terms "inquiry", "discovery", "investigate" and "problem solving" synonymously. Lee Shulman, who has written extensively on the role of inquiry in both science and mathematics points out that "one man's inquiry can very easily become another's guided learning". And it was Jerome Bruner who whimsically began his presentation to a conference on Learning by Discovery by saying "I am not quite sure I understand anymore what Inquiry is and I don't think it matters very much".

While it's quite unfair to take Bruner's remark out of context, I think

that what is meant by inquiry does matter. For all the confusion it is important that we establish an acceptable definition of inquiry if only for the reason that it will greatly aid our discussion this morning.

At least part of the confusion was resolved for me when I realized that discussions of student inquiry take place on two different though related levels. The first, and in some respect more fundamental, attempts to describe inquiry in terms of student thought processes. This approach gives major attention to how the student assimilates new ideas and forms an understanding of new relationships. The second deals with the overt behaviour of students from which the thought processes of inquiry can be inferred. Consideration of inquiry at both levels is important. But as people who are often engaged in classroom observation, the practical question which we want to answer is "Is Inquiry taking place?"

On a purely intuitive basis we can differentiate between classrooms where it seems as though inquiry *is* taking place and classrooms where it seems as though inquiry *is not* taking place.

If, for example, you went into a classroom as I did, and found the teacher drilling the parts of the grasshopper from a meticulously prepared chart, you wouldn't hesitate to say that inquiry was not taking place. Nor would you hesitate to say that inquiry wasn't taking place if you entered a classroom where the class was sitting rigidly to the front with science books open with all children following as one child reads.

On the other hand, if you went into a classroom where there were huddles of children manipulating materials and where you overheard the following conversation you'd be quick to say "Yes that's the sort of thing I'm looking for – That's what I mean when I talk about student inquiry".

This conversation was recorded by Dr. Mary Rowe of the Institute for Development of Human Resources at the University of Florida. It took place in a group of three boys who had just rolled two balls, one big and one small, down a ramp and watched their effect on two boxes which were placed as obstacles at the bottom of the ramp.

First child:
The big ball and the little ball went down the ramp just as fast. That doesn't make sense.

Second child:
Well, the big ball knocked the box farther, so something is different.

Third child:
If they went just as fast I think they should move the box just as far.

Second child:
Would you rather be tackled by Joe (a small boy) or by George (a big boy?) (Rowe, 1973, p.76)

We come then to the problem of definition. I submit that since teaching is primarily a verbal activity, the most useful type of definition is one which defines student inquiry in terms of student talk characteristics. Such a definition is the following:

"If student talk contains speculation, conversational sequences, arguments over interpretation of data, and alternative explanations, then inquiry is taking place."

I admit that this is a somewhat incomplete definition since it ignores situations where there could be a high level of cognitive activity of the type sought, without the overt manifestations identified here. Nor does the definition include reference to the important manipulative qualities of inquiry. It is nevertheless still true that the student talk characteristics which are contained in the definition are important indicators of the type of intellectual activity in which children are engaging. For it's in talking about what they've done and observed and arguing about what they make of their experiences that children's ideas multiply, become refined and finally eventuate into new questions and new experiments.

My first point then, in answer to the question "What is inquiry?" is that inquiry is a particular type of intellectual activity and that the presence of this activity may be inferred from the appearance in student talk of speculation, conversational sequences, arguments over interpretation of data and alternative explanation.

The next question I want to consider is "How can Inquiry of the type defined be developed?" To answer this question I want to begin by trying to relate one or two surprising outcomes of the curriculum reform movement which took place in the United States in the 1960's. This movement was different from past curriculum development practices in a number of important ways. First; curriculum development projects were established as autonomous organizations which were independent of existing education systems and of each other. Second; each project was staffed by both classroom teachers and distinguished university scholars.

Not surprisingly, the curriculum materials which were developed differed markedly from one project to the next. As well as noticeable differences in publishing style, the materials reflected differences in theoretical base, in content, and in instructional strategy. Some projects, for example, produced materials which were tightly structured saying to the teacher "Begin here, follow these paths and you'll end up here." Others said "We're not sure how best to arrange the programme but here is a collection of activities which we know interest children. Devise a programme to suit your class by selecting from these activities." Still others said "We believe that the most appropriate position lies somewhere between these two extremes: Our programme gives both freedom and structure."

It would be quite incorrect for me to emphasize the differences between projects to the exclusion of similarities. For while it is true that differences typify the materials which were produced, each project asserted either explicitly or implicitly that one of their major goals was to increase the type of student inquiry behaviour which we've already defined. It was with some dismay, therefore, that researchers found that while the new materials helped to generally upgrade the quality of

instruction, the student inquiry which was so earnestly sought fell far short of desired levels.

An attempt was made to explain this surprising finding in three ways. Some said that the poor result in inquiry stemmed from deficiencies in programme design. However, when patterns of inquiry exhibited by children trained in different programmes were compared, no significant differences could be distinguished. Another explanation blamed the difference in teacher science background. To examine this possibility, the instruction of teachers with strong science backgrounds was compared with that of teachers without strong science backgrounds. In both cases levels of student inquiry were found to be substantially the same. The third explanation blamed the extent to which teachers were trained in the use of the new materials. When children, taught by teachers trained extensively in one of the programmes were compared with children taught by teachers with less training in the same programme, however, it was again found that rates of student inquiry were substantially the same.

As you can imagine these surprising outcomes caused considerable consternation in the different project camps. If the factors of teacher preparation, curricula design, and teacher science background were not critical determinants in the development of improved student inquiry, then other factors must be operating in the classroom which held the key to the type of inquiry which was sought. In an effort to find a solution to this very perplexing problem, one researcher, Dr. Mary Budd Rowe of Teachers College, Columbia, turned her attention to the rate of classroom instruction.

In a significant series of investigations, Rowe found that in all but three of two hundred classrooms she observed, teachers taught at a very fast rate. Most significantly, she found that the rate of instruction was controlled by the amount of time a teacher was prepared to wait after asking a question, and after receiving a response. An analysis of tape recordings of the classrooms which were observed showed that teachers allowed children an average of slightly less than one second (in fact .9 sec.) to start the answer to a question. When a child did not begin a response within one second teachers usually repeated the question or called on others to respond. Equally surprising was the finding that after receiving a response, teachers again waited slightly less than one second before commenting on the response, asking another question, or moving to a new topic.

In classrooms where there was a fast instruction rate, patterns of verbal interaction were characterized by rapid question answer sequences with the question usually coming from the teacher. By contrast, in the three classrooms where teachers allowed longer periods of time (3 + seconds), both after asking a question and after receiving a response, student talk exhibited the characteristics of inquiry which we've already identified. That is, student talk contained speculation, conversational sequences, alternative explanations, and arguments over the interpretation of data.

The time teachers were prepared to wait after asking a question and after receiving a response, Rowe called *teacher wait-time*.

The wait-time for a particular instructional sequence is calculated using established procedures. As you can imagine, with pauses of less than one second to be timed, something other than a stop-watch is necessary to accurately record the length of the silent periods. The method devised employs a tape recorder to record an instructional sequence. The sound from the recording is then fed into a strip chart recorder which plots the sound on calibrated chart paper. (See Appendix A and B for examples of short and long wait-time recordings.)

Typical of the differences Rowe observed under long and short wait-time conditions are the following two sequences:

Children had built and flown paper aeroplanes in a flight distance contest. The rules of the contest stated that all planes had to be built out of identical pieces of paper and that nothing could be added to or taken from each piece of paper during the construction process.

The question the teacher asked after the contest was "Were some planes heavier than others?"

Under short wait-time conditions the following sequence was typical:

Question: Were some planes heavier than others?

1. Yeah.
2. No.
3. Yeah.

Under long wait-time conditions the following sequence was typical:

Question: Were some planes heavier than others?

1. Yeah.
2. Yeah.
3. Yes.
4. No.
5. Yes.
6. Yes.
7. Yes.
8. No – 'cause all the paper was the same.
9. Some people folded theirs over and that made it smaller.
10. Does that make it heavier?
11. No it doesn't. If you take two pieces of paper exactly the same and double one of them and leave the other the same as it was, is the one you doubled going to be heavier?
12. No.
13. Well?

In the first sequence none of the characteristics of student inquiry is evident. In the second sequence on the other hand, speculation, conversational sequences, arguments over interpretations of data and alternative explanations are all in evidence.

Among the other outcome variables which change under long wait-time conditions are the following:

1. The length of student responses increases.
2. The number of unsolicited responses increases.
3. The number of student questions increases.
4. Student to student talk increases.
5. The number of evidence inference statements increases.
6. The complexity of student responses increases.
7. The number of questions a teacher asks decreases.
8. The type of questions a teacher asks changes to include not only information seeking but also many more of a leading and probing variety. (Rowe, 1972, pp. 7-8.)

While no one would claim that any single variable operates in isolation in the dynamic classroom environment, it becomes evident that wait-time, probably acting in concert with question type, holds the key to the type of inquiry behaviour which we've identified.

Thus, for the teacher educator, the question becomes one of how best prospective teachers can be trained to manipulate the time dimension of their instruction. Or, more precisely, how can the prospective teacher be trained to implement an extended wait-time schedule.

Typical of the problems encountered by teachers who try to change to a long wait-time schedule are the following comments:

Teacher 1:
"I'm afraid that if I wait any longer the class will get out of control. Everyone wants to talk, there is no time to wait."

Teacher 2:
"I don't know how to react anymore. I thought I knew but now I can't be sure. I can't wait all the time. Sometimes something really good happens and sometimes they just sit and look at me. I think they have to learn to listen to each other too. I tried to stop repeating, but I'm still afraid they might miss the point. (Pause.) Well, I'll keep trying but it isn't going to be easy." (Rowe, 1973, p.240).

Furthermore, the teacher who wishes to implement a long wait-time schedule faces another very real difficulty in trying to ensure that his verbal cues which usually fill potential silent periods are not simply replaced with their non-verbal equivalents.

A training schedule which has been successfully employed with practising teachers begins by sensitizing participants to the wait-time phenomenon. Once sensitized teachers are then trained to deliberately extend their wait-times until they can achieve and maintain a mean wait-time of from 3 to 5 seconds. Such training uses well established micro-teaching procedures and includes the following steps.

Step 1. Tape recording of participant instructing either a class or a small group prior to wait-time training.

Step 2. Identification of wait-time as the time a teacher is prepared to wait

(a) after asking a question, and

(b) after receiving a response.

Step 3. Presentation and analysis of recordings (preferably video) of instruction conducted by teachers who have achieved long wait-times.

Step 4. Analysis of the initial sound recording to establish the teacher's natural wait-time and to examine the occurrence of the desired student inquiry chacteristics. And finally,

Step 5. Training in the implementation of a long wait-time schedule. This training would include

(a) discussions during which a deliberate attempt is made to slow the pace of verbal interaction (simply counting slowly to 5 is an aid to achieving this goal);

(b) conducting small group instruction which is recorded and analyzed;

(c) conducting small group instruction in which both verbal and non-verbal cues are manipulated.

To conclude, let me reiterate what I said at the outset of this presentation. It's my firm belief that progress in the pre-service preparation of teachers is most likely to be achieved through the identification of specific teaching skills and the development of a training programme which fosters these skills.

Such a skill is the ability to facilitate inquiry through the implementation of a long wait-time schedule.

While there are many questions still to be answered concerning the influence of this important variable, research has now established that wait-time is a significant factor in the development of student inquiry. Thus, training in the ability to establish a long wait-time schedule and in the ability to recognize inquiry in student talk, characteristics become important parts of the pre-service preparation of all teachers.

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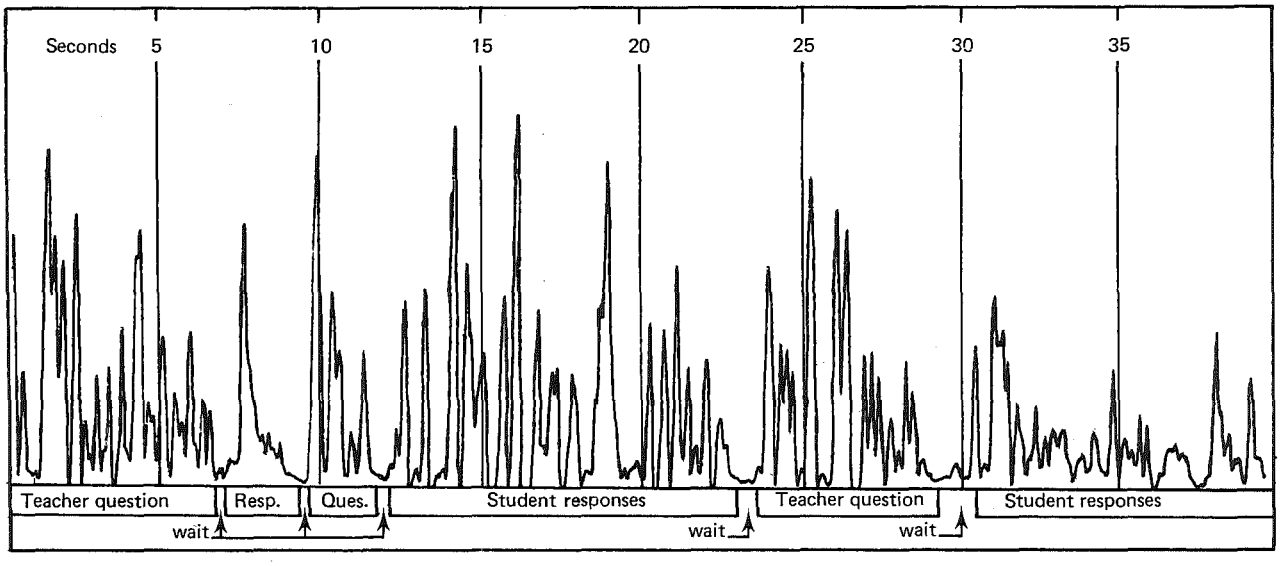
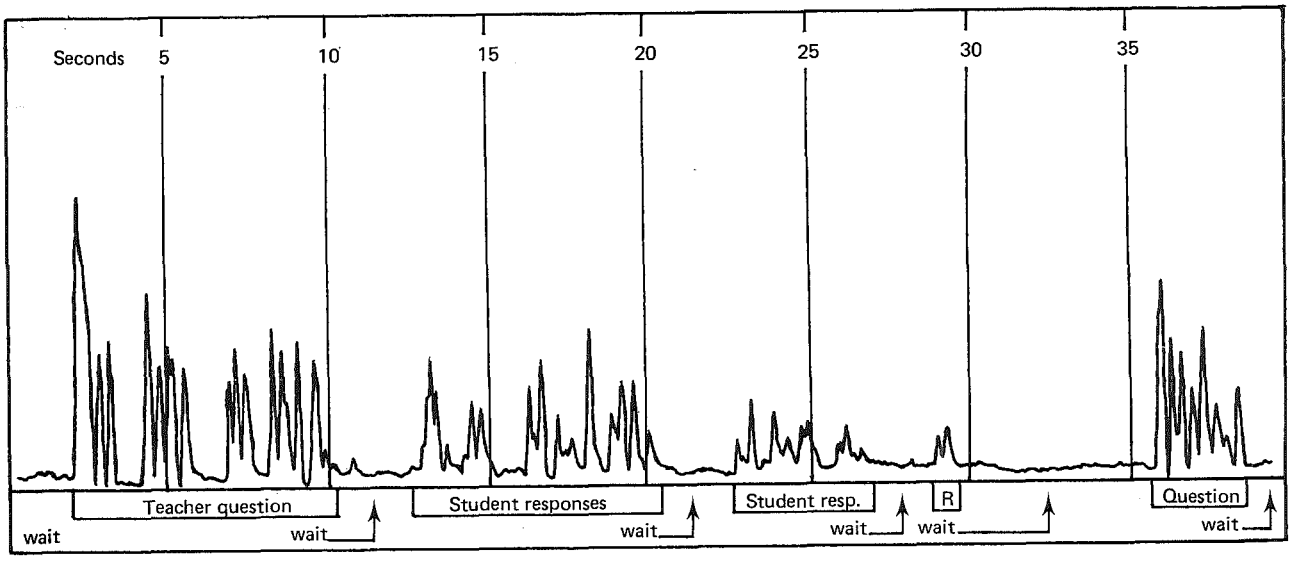


APPENDIX A Servo chart-plot showing discourse pattern under short wait-time conditions



APPENDIX B Servo chart-plot showing discourse pattern under long wait-time conditions