"They Said It Couldn't Be Done"

(A true-life drama in which three chemistry teachers look at their teaching practices, make some major changes in the way they teach, and earn their master's degrees)

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Cet article a pour but de rendre compte d'un programme de formation pédagogique pour les étudiants titulaires du B.A.; programme qui fut monté à l'université Simon Fraser en 1972. Les cours étaient placés vers la fin de l'après-midi et pendant la soirée. Le programme destiné aux éducateurs qui en même temps exerçaient leur profession se concentrait surtout sur l'amélioration de la qualité des procédés et des habitudes de l'enseignement pratique. Les étudiants étaient obligés d'examiner leurs procédés pratiques dans la salle de classe par moyen des enregistrements audio-visuels de l'exécution de la leçon. Il leur fallait réfléchir sur ce qui pouvait être amélioré et ensuite exécuter les changements nécessaires de nouveau devant les caméras audio-visuels. "On a dit que c'était impossible" est l'histoire anecdotique de trois des professeurs inscrits au programme, qui ont subi l'expérience difficile de l'examen et de l'évaluation de leurs procédés et habitudes professionnels, et qui ont révisé et restructuré leur programme d'études et leur comportement vis à vis de leurs élèves.

PROLOGUE

One of the wonderful and terrible things about working in a new university is the demand for the creation of new programs. Wonderful — because one can start fresh, *tabula rasa,* to use new and old data about teaching, about learning, about program development, and utilize the combined talents and expertise of a hundred resource people to create a set of experiences that will finally make a difference in what actually happens in the classroom. Terrible — because we keep wanting to do more of what we know did not work in the past, and because there is no clear paradigm for the change.

The development of the new Graduate Program in Educational Practice[1] at Simon Fraser University presented such wonderful and terrible challenges. Intended to be a 2-year, late-afternoon–evening program for practising teachers, which would culminate in a master's degree, it offered the Faculty of Education the opportunity of attempting to put together a series of experiences which would result in the improvement of the quality of teaching practices in the classrooms of the province.

When we were faced with the blank sheets of paper on the drawing board, there was a great temptation to "create" a program much like the ones we had all experienced ourselves and condemned as inadequate – a 2-unit course in X; a 3-unit course in Y; add them up to 35, and out pops an M.A.

Until somebody said, "Just a minute. What is it we'd like these people to be able to do once they've got their sheepskins clutched in their hands?"

The decisions we made, in response to that key question, resulted in a program which (*a*) required students to take a long and hard look at their teaching practices, through focused videotape feedback; (*b*) presented options for change, specifically with regard to teacher–student interactions and curriculum development, and (*c*) provided opportunities for students to grow in competence in newly acquired skills (via videotape feedback).

This tongue-in-cheek (or cheeky) scenario attempts an accurate account of what occurred when three highly intelligent, experienced secondary school teachers enrolled in the Graduate Program in Educational Practice, looked at videotapes of their own teaching, and confronted possible options for change.

THEY SAID IT COULDN'T BE DONE
A scenario in four episodes

Cast of Characters:	Hans, who teaches Chemistry 11 Dave, who teaches Chemistry 11 Dennis, who teaches Chemistry 11 Selma, who teaches at Simon Fraser University
Setting:	The Professional Development Centre of the Faculty of Education at Simon Fraser University
Time:	There's no time like our time

EPISODE 1

Scene: The Professional Development Centre of the Faculty of Education at Simon Fraser University. It is the third meeting of the class in the new Graduate Program in Educational Practice. There are about 30 students (all practising teachers) present, seated at tables in groups of about 5 or 6. Animated discussion is heard at all tables.

Hans: What do you know about the Chem 11 curriculum, anyway?

Selma: Very little, I admit.

Dave: Then you really don't know what we're up against.

Selma: What do you mean?

Dennis: Look, our job is to cover the Chemistry 11 curriculum so that the students will do well on the provincial exams.

Hans: There's just too much material in the Chem 11 curriculum to cover in one semester, anyway. Why, we only have one week to spend on really difficult concepts like force and pressure and there's not even enough time for the students to digest the material before we are forced to proceed to the next topic.

Selma: So what you are saying is the pressure of covering the curriculum does not permit you to concern yourselves with students' thinking ability.

All three (somewhat defensively): Naturally we are concerned with students' thinking; but you don't realize what we have to cover in the Chem program. We just don't have the time.

Dennis (still defensively): It's really the content of the Chem 11 program that should be revised. In the meantime, we are stuck with it.

(Hans and Dave nod in agreement.)

Selma: So you have your priorities clearly identified. Covering the curriculum takes priority over developing thinking skills.

Dave: It's what the provincial exams demand. They demand that students learn the content. That is why we have to hammer home the content.

Selma: So that they will do well in the exams.

(Dave nods.)

Selma: How well do they do on exams, generally, with current methods?

Dave and Dennis (shifting uncomfortably, with grins that look like grimaces): Not as well as we hope for. About 60% pass. But that's because we are forced to go so quickly over such difficult material.

Selma: You are forced by the pressure of the provincial exams.

Dennis: Right. If we didn't have to worry about the exams . . .

End of Episode 1

(Music: "It seems to me I've heard that song before" . . . , fade out.)

(In local adaptations of this scenario, subjects like English, History, Geography, etc., may be substituted for Chemistry. In addition, Grades 1 through 10 and Grade 12 may be substituted for Grade 11.)

EPISODE 2

Scene: Same as Episode 1. This time, however, videotape equipment is present at all tables. Students are engaged in viewing and analyzing videotapes made of their own teaching. Three weeks have passed.

(Music: Low, in background, "Onward Christian Soldiers . . ."

Action: Zoom in on videotape being shown. Dave is scheduled to show a videotape that was made in his classroom that week.)

Dave (prefaces the showing of his videotape with the following comment): This question was assigned to the class: If a piece of copper metal is dipped into a solution containing Cr + 3 ions, what will happen? Explain using E^0s. This problem is #14 on page 222 of the book.

(The video is turned on. Dave is seen as the teacher in the class.)

Dave (on video): Let's start off. What have you got on that paper, Johnny? INFORMATION question

(As the videotape progresses, the other graduate students in Dave's group "code" the kinds of questions and responses which Dave is making in this videotaped lesson.)

Johnny: Oh, a reaction will occur.	
Dave: And, uh, what else is there?	LEADING question SUSTAINING response
Johnny: Um, there's a positive charge.	
Dave: What has a positive charge?	LEADING question SUSTAINING response
Johnny: Um, the sum of those two, um, . . . numbers.	
Dave: What numbers?	LEADING question SUSTAINING response
Johnny: Um, oxidation numbers.	
Dave: Oxidation numbers?	LEADING question SUSTAINING response
Johnny: Um . . .	
Dave: I don't agree with that, so . . .	CLOSURE
Johnny: Um, um . . .	
Dave: Would you read the question?	CLASSROOM MANAGEMENT
Johnny: Yeh.	
Dave: What does it say?	CLASSROOM MANAGEMENT
Johhny: It says using *E*'s.	
Dave: *E* what? . . . Give up?	RHETORICAL question CLOSURE
Johnny: Yeh.	
Dave: Terrible. Who can help him? What is it that is positive in this case, then, if the reaction will occur? Ellen.	CLOSURE
Ellen: The *E* net.	
Dave: *E* net? What is that?	INFORMATION question SUSTAINING response
Ellen: Um, well, that's the sum of the numbers that uh, the numbers you find back here. The oxidation numbers.	
Dave: They are oxidation numbers?	LEADING question CLOSURE
(Megan raises hand.)	
Dave: Megan.	
Ellen : The sum of the oxidation numbers.	
Megan: Volts.	
Dave: They're volts?	LEADING question SUSTAINING response
Megan: Yes.	
Dave: Yes, they are volts. Sure, if you have an *E* zero net, then you are talking about the net voltage, aren't you, in your electrochemical cell. And we're trying to find out here whether or not the *E* zero is going to be a positive value or a negative value. Now, if it's positive, what does that mean, Terry?	INFORMATION question CLOSURE
Terry: It's um, . . . an increase in reduction.	

Dave: Would you explain that a little more?	INFORMATION question SUSTAINING response
Terry: It's just eh, . . . a reducing agent. *Dave:* If the *E* zero net is positive, it means something is a reducing agent?	LEADING question SUSTAINING response
Rob: The reaction occurs. *Dave:* Yes, it means simply that the reaction occurs. So we have to find out, then, using our half-cell reactions whether or not this will occur.	CLOSURE

(Dave's videotape continues in this fashion for 10 minutes more of teacher–student question and response. When the videotape is concluded, Dave posts on the blackboard the analysis of his interactions with his students. The other graduate students in Dave's group have coded his questions and responses on the transcripts which Dave has provided. Dave posts the following analysis [1].

Types of Questions	%	Thinking Required of Students
RHETORICAL: those questions for which the teacher supplies the answer or for which the teacher does not expect an answer	24%	No response is expected of students.
INFORMATION: questions calling for facts read, heard, discussed in class, or for facts readily available	54%	Pupil must remember or recall something previously learned.
LEADING: questions seeking specific answers for which teacher provides the clues directing pupil to that answer	14%	Pupil mentally processes information identified for him by the teacher. Teacher "leads" the student to "discover" insights predetermined by the teacher.
PROBING: open ended questions which invite exploration of new relationships, ask for application of principles to new situations, require generation of new principles	8%	Pupil mentally processes information based upon his own analysis of concepts and principles. Teacher provides opportunities for pupils to develop and validate insights through research and inquiry.

Types of Responses	%
CLOSURE: a response which cuts off or terminates pupil's line of thinking	29%
SUSTAINING: a response which maintains the level of student thinking	64%
EXTENDING: a response which raises the level or complexity of pupil thinking	5%

(In his analysis of proportion of teacher to student talk, Dave calculated that he, the teacher, was talking 62% of the time in this lesson.)

Dave (speaking to the graduate students in his seminar): This lessons looks like an information-oriented, teacher-controlled lesson, rather than an inquiry-oriented lesson. I find it very difficult to break old teaching habits. Perhaps I ought to plan my lessons more carefully, even writing down the probing questions I might ask, if my lessons are to be more inquiry-oriented.

Selma: What changes might you make if you were to do this particular lesson again, in a more inquiry-oriented mode?

Dave: Well, I might begin the lesson with a probing question, such as, "How can this type of problem be solved?" By carefully feeding in data as required, I would sustain the level of thinking and then use further probing questions to promote more problem solving.

Selma: What other strategies might you consider?

Dave: I could carefully plan the strategy of the lesson in order to reduce the number of rhetorical questions. Also, I could try to stimulate more student talk.

Selma: How do you feel about your videotape?

Dave: I'm unhappy with this profile. Seeing what I am actually doing with the kids on videotape and analyzing what is happening with these coding sheets forces me to confront my didactic teaching style and I don't like it. I would really like to change my teaching strategies to inquiry-oriented approaches, but it's hard for me to break old habits.

End of Episode 2

(Music: "Raindrops keep falling on my head and just like the guy whose feet are too big for his bed, nothin' seems to fit . . . ," fade out.)

EPISODE 3

Scene: Same as for Episodes 1 and 2. It is four months later, the beginning of the second semester of the graduate program. It is the dinner hour. Most of the students have left the class for the cafeteria. Dave, Dennis, and Hans are having sandwiches at one of the tables. Selma is at another table.

(Music: "This is the dawning of the Age of Aquarius . . ."

Action: Dave, Dennis, and Hans are talking together. They call Selma to come over to their table.)

Dennis: Selma, do you have some time to talk with us now?

(She walks over to their table and sits down.)

Hans: We've been talking about the possibility of working together on a project and would like to get some feedback from you.

Selma: What did you have in mind?

Dave: We've been thinking about revising our entire approach to teaching Chem 11.

Selma: Oh?

Dave: Yes, we think that if we use the Chem 11 curriculum content, but develop activities which put the kids into situations where they are required to do some thinking, we would change the whole nature and tone of Chem 11 for the students.

Selma: What are some of your ideas?

Dennis: We think we could take the important and big ideas of the Chem 11 program and use these as a basis for creating problem-solving situations for the kids. Then, having presented the kids with these situations, interact with them in ways which promote and extend their thinking.

Hans: But there's one thing more we'd like to do. We'd like to see if, as a result of this approach, kids really do improve their thinking skills as well as learn as much if not more chemistry.

Dave: What do you think, Selma? Do you think kids will learn chemistry if we take the focus off covering the content and emphasize thinking?

Selma (permits herself a small sigh): Well, of course there is already in existence a lot of evidence which suggests that such an approach would indeed promote chemistry learning as well as improve the quality of thinking skills. *(She refers them to several studies and readings [2,3,4].)* What's more, you might even discover that students develop more positive attitudes about the chemistry course. *(All three raise eyebrows. They appear to like the possibilities.)*

Hans: If we were to work this out as a special project, could you recommend some tests that we might use to measure gains in thinking ability?

(She refers them to several instruments [5,6] and to the behavioral instruments in Teaching for Thinking: Theory and Application *[4].)*

Dave: You know, if this is to be demonstrated as a reasonable alternative to teaching Chemistry 11, we will really have to show, on reliable tests, that students are improving. *(There seem to be some doubts lingering.)* Do you think the tests will show improvement?

Selma: I am really convinced that they will. Keep in touch with me and let me know how things are working out.

Dennis: We're really excited about this project. We think it's about time that kids were beginning to think in the chemistry program. We feel we've been going nowhere with the focus on covering the content. What's more, it's really clear that kids aren't learning a lot of chemistry; they're learning formulas, which they apply, indiscriminately, in rote fashion, without any real understanding of concepts or any ability to reason things out. Then, of course, not only do they get a distorted view of what chemistry is about, but they get a distorted view of science. And, in addition, they really don't even like the subject.

Selma (keeps from cheering): What happened to your original idea that this kind of approach could not be taken in Chem 11?

All three (sheepish grins): Well, two things. Looking at videotapes of what we were doing in our Chem classes really confronted us with our values about teaching. It really put us into a state of dissonance and forced us to decide what our real values were in teaching chemistry to our students. Then again, we see what is happening in this class as a model of what we ourselves could be doing. The way we are instructed in this class is really a model of what the class itself is advocating.

Selma: You think we have been putting our money where our mouths are?

End of Episode 3

(Music: "This is the dawning of the Age of Aquarius . . . ," fade out.)

EPISODE 4

Scene: Same as for Episode 2. Graduate students are seated at tables, viewing and analyzing videotapes of their own classroom teaching. The time is one year later.

(Music: "The times they are a-changing . . . ," or, "It was a very good year. . . ."

Action: Dave is showing one of his recent tapes which all the students in his group are coding with the G.S.A. schedules [1]. On the table is the report of the combined efforts of the three, entitled "A New Approach to Chemistry 11" [7]. Dave introduces his videotape to the graduate student group with the following statement.)

Dave: Chem Study, Lab 4 – Combustion of a Candle. The objectives of this lab were (*a*) to engage students in a thinking task, requiring them to observe, collect, and organize data, and to critically analyze the conclusions based upon that data; (*b*) to encourage student–student interaction as a means of testing and evaluating each student's ideas; and (*c*) to have students examine the nature of scientific proof, recognize assumptions implicit in their answers, recognize statements unsupported by experimental evidence.

The Chem Study program suggests this laboratory be performed as a teacher demonstration. Since the experiment is easily conducted by students, we saw no reason to limit student activity to that of observer. We believe that experimental observations and data are most meaningful when directly obtained by students. As a result, groups of two students performed the experiment recording observations and data. Data collected must be critically analyzed, if any positive outcome is to be expected from an experiment. The analysis may lead to an hypothesis or a conclusion. This usually requires the student to engage in many thinking activities. He may be required to compare, classify, interpret, analyze for assumptions, summarize, criticize, and evaluate. This is a difficult task for individual students. Recognizing this difficulty, I divided the class into four data analysis groups. The six members of each group compared data and attempted to answer the laboratory questions. Students were encouraged to interact by arranging group desks in a circle.

Students interacted freely, criticizing the collected observations and data. Some students returned to the laboratory benches and repeated part of the experimental work to check the validity of their observations and/or data. Teacher–student interaction was minimal since students were encouraged to think and solve their own problems.

Upon completion of the analysis procedure, each group recorded their answers to the problems on the blackboard. A variety of answers appeared for many of these. Groups automatically compared answers and many seemed uncertain about what they had written. To facilitate thinking, I asked each group to classify their answers by placing the letter "A" besides those containing assumptions and the letter "X" beside any answers unsupported by lab data or observations. Interaction between groups occurred as students disagreed about the way answers had been coded. To complete the exercise, the teacher discussed the coded answers with the class as a whole. Leading and probing questions were asked about the nature of experimental proof, assumptions inherent in group answers, and interpretations unsupported by laboratory data and observations. Student responses were extended whenever possible, in order to raise the level of thinking. Teacher talk was kept to a minimum while students were encouraged to discuss and clarify their thinking (7).

(Dave plays a portion of the videotape to demonstrate the nature of the interaction in this experience.)

Dave (on video): Their group says the liquid film is a result of air being heated and condensed by the sides of the jar into something like water. A very cautious statement.

Bert: Yeh, how do you know about condensation then? You're not supposed to know about it.

Dan: Condensation comes from inside the jar... doesn't it?

Maureen: No!

Dan: Yes it does.

Maureen: No, because the heat goes when the outside of the jar's cold. Right? And when the heat... it heats up the water vapor inside and it goes against the...

Dan: How do you know that it's water vapour inside?

Maureen: Oh... Dan! (Roars of laughter)

Letty: The air in the jar heats up faster than the sides of the jar so the sides of the jar stay colder.

Dan: Wht does that prove?

Betty: That proves that air... that the water vapor in the air is condensing on the sides of the jar.

Bert: How do you know that there's water vapor in there?

Maureen: You said yourself that there is hydrogen and oxygen in water, so you're saying that, um... what you say is wrong. You don't know what you're talking about!

End of Episode 4

EPISODE 5

Scene: Convocation ceremonies at Simon Fraser University — the awarding of the degrees of Master of Science in Education.

(Three masked men, on white horses, ride off the stage with their degrees.)

Dean of Science: Who were those three masked Chemistry 11 teachers?

Dean of Education: I don't know.

Dean of Science: I wanted to thank them.

Music: Full volume, to galloping hoofbeats, "William Tell Overture.")

EPILOGUE

Two reviewers of this paper raised the question of what had become of the three masked Chemistry 11 knights who rode off the stage into the sunset, at the convocation ceremonies in May 1974. Do these teachers sustain their commitment to the promotion of thinking skills, or do they revert back to older patterns of teaching? No research data have been collected in the years that followed the program's completion. Nevertheless, contact has been maintained with each of the three teachers. Each seems to feel that he has not only *not* reverted to earlier patterns of teaching, but that he has moved further ahead in developing his skill in the teaching-for-thinking strategies in secondary school science. Moreover, all three have been involved in training and helping other science teachers in their schools to use similar teaching practices.

NOTE

1. The Graduate Program in Educational Practice at Simon Fraser University, initiated in September 1972, is one of three late-afternoon–evening programs which are offered for practising teachers. In addition, the Faculty of Education offers a program of Individual Study, for students who wish to pursue full-time graduate work.

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