Observations from Secondary-School Science Classes

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Entre 1983 et 1984, l'auteure étudia, dans une école secondaire d'une petite ville universitaire de la Nouvelle Angleterre, l'intéraction entre les professeurs et les étudiants des classes de sciences. Elle découvrit peu d'évidence de sexisme, mais se prit d'intérêt pour la manière dont les méthodes d'enseignement influencent la participation des filles, leur intérêt et leur réussite dans les matières scientifiques.

In 1983-84, I observed science classes in the junior and senior high schools of a small New England university town. Because of the diversity and opportunities the university provides, in some ways these public schools are not typical of other public-school systems. The purpose of my observations was to see if the interactions between the teacher and boys versus between the teacher and girls resulted in the sexism that other researchers have found in regard to science education for girls. Because sexism was not a major issue in the observations I made, my attention was drawn to the methods of teaching being used. I will speculate how these methods of teaching could affect a girl's participation, interest, and achievement in science. I chose the classes randomly as I wanted to visit all levels and grades of biology, chemistry, and physics. I entered the classrooms with the objective of recording any interactions, questions, movements, or discussions which caught my attention.

According to a survey of science classes across the country, it appears that the most common methods used in junior and senior high-school science classes involve the memorization of facts and definitions from books and worksheets. Included in this method of teaching are practices that encourage students to be disciplined and neat and to recite the correct answer. This method implies that there is only one answer to a question. When used alone, it excludes the practices that real scientists follow, such as developing and testing hypotheses and questioning the natural world. An alternative to this approach would be one where the teaching of facts and theories of science was coupled with questions, discussion, and experimentation with ideas and examples in relationship to practical application.

My observations support findings from a study done in the 1970s by the National Science Foundation on science classrooms in America and in the 1980s by the Science Council of Canada on science teaching in Canada. These studies conclude that in most secondary-school science classrooms learning usually involves finding one correct answer in laboratory experiments and the presenting of facts without questioning their origin, use, or value.

The eight teachers I observed each had his/her own approach to the material and students, but the one thing constant in almost all of the classes was the methods used. None of the classes dealt with questions or problems in science and society's relationship to it. In the junior high school the main objectives of the science program are to introduce the students to scientific study, involve them in scientific activities, build habits of scientific inquiry through projects and papers, strengthen skills of communication, and foster co-operation and respect among students through group activities. Each description of the senior high-school classes begins with the statement: "The student will be able to . . ." There follows a list of the things the student will be able to do upon completion of the class. These descriptions give a bit more detail and cover more material in comparison to that on the junior high-school level.

Especially in the junior high school, students showed a certain amount of lack of interest in and boredom with the subject matter. They were often loud to the point of being disruptive while the teacher talked or lectured. At the junior high school, I observed five teachers repeatedly over a period of two months. They were teaching the same classes to three different levels of students and to grades seven through nine. When challenged as to why a lab had to be recorded in a precise, neat manner or why Latin names are used for animals or rocks, the teachers referred to skills the students were learning

as necessary for future science classes. So knowledge becomes a fixed commodity, something to be learned and stored away for a future test or class.

In the junior high school the classes I found to be the most interesting and stimulating intellectually were taught by one genetics teacher. Students of all three levels seemed to be enjoying the process of learning. The teacher was very casual, yet in control of the class, and joked with the students about the subject matter. The students asked questions and participated in the class. His responses were: "That's a very good question," or "I was just getting to that," or "Good to see you're thinking today."

In one of his classes, it was the boys who interacted with the teacher more actively than the girls. The boys were the ones who asked the questions, answered his, laughed at what he said, or later talked with him about sports. In this class the girls sat in a group at the back of the classroom; the boys sat up at the front. In his other classes, both the boys and girls were active members of the class. The questions that they raised related to everyday events concerning genetics and centred on the students' observations. In the advanced class, two boys repeatedly jumped ahead of where the class actually was in the lesson. Without seeming discouraging, the teacher would hold off their questions, coming back to them later. When this occurred with other teachers, the students who knew the answer or had previously done parts of a lesson were ignored or told in a discouraging manner to let the others ask the questions.

In other classes at the junior high school, the questions that the students asked seemed only to be concerned with what points or definitions they were to write down or questions regarding a technical problem on a lab, test, or worksheet.

In one ninth-grade earth-science class, the girls seemed slightly embarrassed to ask questions about a worksheet being done in class. In another seventh and eighth-grade class the teacher assisted the girls more readily. He showed them where the answer to a problem was rather than assisting their learning process with questions or information that would result in self-discovery of the answers. These examples address the question of developing independence and initiative in the students. If a teacher's response to a problem a girl has is to do the problem or procedure for her, he/she can foster in her dependence and lack of self-confidence with regard to scientific learning. In contrast, the response to boys was often to give further instructions or a helpful question to help them solve the problem independently.

Researchers have shown that teachers interact more frequently and extensively with male students. They often ask boys a higher order of question, give them more time to respond extensively to a question, and praise them for their intellectual abilities. These incidences reflect the gender socialization that affects both the teachers and students of science. In order to prove the relevance of these findings to this school system, we need more focussed quantitative observations.

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In the senior high school I observed one biology class, one chemistry class, and three physics classes. These older students were more attentive, and both boys and girls participated in answering questions or doing problems on the board. There tended to be less noise, although there was still an undercurrent of unrelated talking. But even with the increased participation of boys and girls in the classroom, the students were still concentrating on learning definitions and proceeding through set problems which led to only one correct answer. There weren't any inquisitive open-ended questions.

The three physics classes that I observed began with students writing problem sets on the board. Both boys and girls volunteered or were selected to do this. The class then went over each problem, discussing how they had arrived at the answer and any problems that they had had. The teachers in both classes used very concrete and immediate objects to demonstrate the definitions and examples. The students took notes about the problems they did in class. After the homework had been corrected, a short lecture was given and more problems assigned. The students worked individually or in small groups.

The chemistry class I observed was a tenth-grade advanced class. Out of twenty-three students, there were six girls. The girls sat in pairs around the room, intermingled with the boys. At the beginning of classes, the teacher handed back a lab exercise and went over the results, explaining particular points that most students had got wrong. The teacher asked the class to reply to some of the lab questions; they did so by calling out the answers. After one question a girl raised her hand and answered individually, but other than this it was difficult to tell how much the girls participated in this method of answering questions.

The questions the students asked related to equations or problems that they were doing in the class. In turn, the teacher's examples and explanations of abstract ideas were of everyday objects and examples the students could identify with.

In all the classes in the junior and senior high schools I observed, the teaching methods concentrated on learning basic facts and definitions through memorization, usually coupled with labs or problem sheets that supported this approach. There were few discussions or questions of application or relevance to situations outside the classroom. Examples that were given did include concrete and immediate objects but rarely related to the research of real scientists.

Would a student's understanding of facts, formulas, tables, and equations in science be improved if there were more concrete examples and applications to everyday events or discussion during secondary school? Or are some students simply not at intellectual stages where they can understand or completely absorb these concepts? If so, should we be exposing all students to more science throughout their schooling, or limiting the exposure of some students until they can put the facts, theories, and formulas to use?

I cannot answer these questions based on my observations, but from the literature I read it would seem that if interaction with concrete examples was increased, the recall of definitions or facts or theories by the students might also increase. Perhaps my objections and questions are more deeply related

to evaluating what we are teaching and why we are teaching the areas of science we do in secondary school. I am not sure what approach needs to be taken toward science education in secondary schools. It is not just the question of what method is used or the training the teachers receive but involves also re-evaluating the role of the school as a disciplinary force.

By asking these questions I am implying that some of these problems do exist in schools I visited, but more data needs to be collected and analyzed before the questions can be answered. The questions include: What are the cultural rewards and expectations that surround science classes? Are these different for boys and girls? Are girls "taught" that science will have little relevance in their futures?

It is possible that the rewards and expectations are greater for boys to stay in science classes and to take advanced classes as well, even when the course is hard or not particularly interesting. Through social examples and interactions boys may be taught that science and math will have relevance to the stereotypical male occupations, whereas the traditional female occupations often exclude the advanced maths and physical sciences.This suggests that, through gender socialization, boys and girls are receiving different messages as to the importance of their individual participation in science. The effect of gender socialization in the community I studied appears to be minimal in regard to girls' participating in all sciences. But this is an atypical town, and no doubt things could be different elsewhere.

Further Reading:

Myra and David Sadker. *Sex Equality Handbook for School*. New York: Longman Inc., 1982.

Joan Skolnick, Carol Langbort, and Lucille Day. *How to Encourage Girls in Math and Science*. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1982.

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Photo: Ontario Hydro