

THE XEROX SCIENCE CONSULTANT PROGRAM

AND

HOW IT EFFECTS PERCEPTIONS OF SCIENCE

IN ELEMENTARY SCHOOL TEACHERS

THESIS

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INTRODUCTION

Over the course of recent years, much attention has been placed on the educational system in the United States. The media frequently reports that our students are not scoring well on standardized tests when compared with the scores of students from other nations. One subject area that our students have been out-performed in is science. According to an article in the April 9, 1990 issue of *Newsweek*, The International Association For The Evaluation of Educational Achievement found that on a biology achievement test, high school students from Singapore ranked first, followed by England, Hungary, and then Poland. Of all of the students tested, the students from the United States scored last (Cowley, et al., 1990). Yet science is a subject area that is of critical use in today's technological society. With the advent of computers and electronics, physical science is very important, and the emphasis on environmental issues makes an understanding of biology, ecology and chemistry equally important.

Yet, according to recent research on science in the elementary grades, many elementary teachers do not teach science at all (Harty, Kloosterman, & Matkin, 1989; Manning, Esler, & Baird, 1982; Kyle, Jr., et al., 1985). In fact, Mary Budd Rowe (1980) states that "if there were such a thing as an 'endangered subjects' list, science would qualify for emergency help and protection" (p. 19). Considering the tremendous changes from day to day in science and technology and the ways in which science and technology

effect an individual's daily life, this information is cause for concern.

The question, then, is why isn't science being taught in our elementary schools? One answer appears to be that many elementary teachers do not feel comfortable teaching science. Some of these elementary teachers have not had a methods course in science or even an in-service course on teaching science (Manning, Esler, & Baird, 1982). Other teachers just don't believe that they can teach science effectively and therefore consciously or subconsciously avoid failure by minimizing the time for science (Manning, Esler, & Baird, 1982). In some cases, science is being taught as textbook science rather than activity-based science because the manipulative materials are not readily available (Harty, Kloosterman, & Matkin, 1989).

If science were to be taught consistently in the elementary schools, there is considerable evidence that it should be activity-based science rather than textbook science. A number of studies have indicated that activity-based science increases student achievement and skills (Bredderman, 1982; Shymansky, Kyle, Jr., & Alport, 1982). Students also prefer activity-based science over textbook science because it keeps their hands busy as well as their minds and, at the same time, provides them with a chance to escape from the chore of listening to their teacher (Kyle, Jr., et al., 1985; Bredderman, 1982). There is also some evidence that activity-based science is especially effective for improving the achievement of disadvantaged students (Bredderman, 1982).

Based on this information, it appears that teachers need training and guidance in order to teach activity-based science. They also may need

manipulative materials to be provided. A number of in-service type courses on activity-based science are described in the literature (Baum, 1985; Worthy, 1984). However, few of these courses provide the teachers with real students where they can practice their new skills in a supervised setting (Worthy, 1984; Worthy, 1985).

Because of this, many corporations are beginning to involve themselves in promoting science in the educational system. One corporation doing this is the Xerox Corporation. It has designed a program, called the Xerox Science Consultant Program, where its scientists work in conjunction with the elementary school teachers of the Rochester City School District in Rochester, New York. The Xerox people sit down with the elementary teachers in order to plan the specific areas of the science curriculum that the Xerox people will cover. When the Xerox scientists come to the school to teach the lesson, they bring with them the materials needed for the science lesson that are not readily available in the school (i.e. microscopes, chemicals, etc.). Then they engage the students in hands-on science. The elementary teachers are present at these science lessons in order to observe and become comfortable with the hands-on science. After each lesson, the teachers and Xerox people again sit down to discuss the lesson. In this way, the Xerox Science Consultant Program is attempting to promote hands-on science in the elementary schools and help elementary teachers feel more comfortable with science so that they will continue to teach activity-based science.

The purpose of this research is to determine whether or not teachers involved in the Xerox Science Consultant Program perceive elementary

science differently from teachers who do not participate. From this some conclusions may also be drawn about the effectiveness of the Xerox Science Consultant Program.

METHODOLOGY

A qualitative method of recorded interviews and analysis of these interviews was chosen as the best method for this study. The subjects of the study were four elementary teachers from the Rochester City School District. They came from two different schools in the district -- one on the northeast side and one on the southwest side. The schools were chosen because they were located in opposite corners of the city and in somewhat different neighborhoods. The principal of each school supplied the names of four teachers -- two participants in the Xerox Science Consultant Program and two non-participants. One teacher from each category was randomly chosen to participate in the research project. Therefore, two of the final four teachers came from each school. Of the two teachers in the same school, one was presently involved with the Xerox Science Consultant Program and one was not.

The four teachers chosen to participate in the research were contacted, asked to participate in the research, and then interviewed in their classroom. They were asked questions regarding how they teach science, their background in science, and how they perceive the discipline of science (see appendix). Most of these questions were written out ahead of time, but some of the teachers' answers led to additional questions being asked at the time. Each interview lasted approximately 30-40 minutes and was tape recorded.

Finally, each interview was transcribed and analyzed. The answers to

specific questions by each teacher were compared and determined to be similar or different.

RESULTS

After comparing the answers the four teachers gave to each question, it appears that these teachers have many similar ideas about science. All of the teachers claimed to feel comfortable teaching science. It seems, however, that their degree of comfort comes not from past science experiences or previous science courses but from what they do before each science lesson. As one teacher in the Xerox program stated, "I prepare myself to the degree that I will feel comfortable." Other teachers indicated that in order to become comfortable with a specific science lesson they consult with a co-worker or with their school's science consultant. If they can not get the information that they need from within their own school, then they go to the person in charge of science for the Rochester City School District or to the public library.

All of the teachers also stated that they enjoy teaching science, although their reasons for enjoying it varied. One of the Xerox participants enjoyed it because he could tie it in with a lot of literature. The other participant liked the diversity in teaching science -- the opportunity to teach about the environment, plants, and animals. A non-participant liked it because of his curiosity. He stated that he "always had an inquisitive mind -- the need to know -- and ... the need to know and science go hand in hand."

Even though all the teachers claimed to enjoy teaching science, they also believed that it takes more time to plan a science lesson than other

lessons when they do not use a previously prepared kit. One of the teachers involved in the Xerox program stated that he has "to look up more resources to find out what is available. If you teach math, you just use the teacher's manual and it's mapped out for you." He also indicated that he has brought in his own personal microscopes for science lessons in the past and that not only can teaching science take a lot of preparation time, it can also get costly. One of the non-participant teachers also stated that with science lessons:

First of all, you have to be able to understand all of the things you are going to need for that lesson. If you don't have a science background, it takes a lot of work just to prepare yourself to know what you need. That's just to begin with. Once you know what you need, then you have to go out and find it and ..., sometimes, it's available, like in the kitchen or downstairs in the basement, and sometimes you need to know what you can substitute for something else, and that takes background.... It is very time-consuming.

The other non-participant teacher indicated that she frequently uses the library in order to prepare for her lessons.

Even though all of the teachers claimed that preparing to teach science could be time consuming, they all indicated that they had taken some science in high school or college. The two teachers in the Xerox Science Consultant Program had both taken at least two years of science in college, as well as additional science methods courses and science

workshops after college. One of the teachers not participating in the Xerox Science Consultant Program was a premed major in college, while the other had some science in college and attended every science workshop she could find. However, one of the Xerox non-participants did feel that science methods books from his methods courses were not helpful. He thought that "it was almost as if they were written to be teaching someone at a different level." He found these books to be "very non-related to the population of kids that I was teaching."

When asked about the availability of science textbooks, all of the teachers responded that they have a set available to use. They also stated that they use the textbook as a "secondary tool" in their science lessons. One teacher not involved in the Xerox program also pointed out that his science textbooks are very old and that his school is overdue for a new set. The other non-participant stated that she does not think that the science textbooks are "worth the paper that they are printed on". All of the teachers use library resources and manipulatives to a great extent in order to supplement the science textbook. Of all the teachers, however, it appears that the participants in the Xerox Science Consultant Program view the textbook more favorably. One of the participant teachers stated that the textbook is "a reasonably good textbook" while the other participant teacher indicated that he does refer to the textbook for printed information.

Not only did all of the teachers try to use manipulatives and library resources to supplement the science textbook, they all tried to integrate science with other areas of the curriculum. One of the Xerox Science

Consultant teachers stated that he "uses science to teach inferential skills in reading." The other participant said that he doesn't "adhere strictly to the time allotments for subjects." He also said that "it's not important to differentiate between them (the subjects) too much." One of the non-participants stated that "you can teach math through science, you can teach everything through science." The other non-participant said that "science is usually in connection with my social science or math. So we are doing it constantly. ... I spend some time every week, but it is not separated from anything else. I do not have 'This is science.'"

When asked about the support the teachers get for teaching science from their school principals, they all indicated that their principal is very supportive of science and all education. One of the Xerox participants said that his principal is "very pro-education" and that he "targeted 4th grade for the services of Xerox." The other participant indicated that his principal was "very supportive of anything I have to do for science or materials." This principal is also "very supportive of the Xerox program and very pleased with it." One of the non-participants said that his principal is "supportive of things that will turn kids on to learning. She knows that science is one of the ways that does that."

While conducting the interview, the teachers were asked their opinion on cooperating with someone in industry in order to teach science. All of them were very much in favor of the idea. One of the participant teachers said that he thinks "it is wonderful to work with the Xerox people -- in having experts come in and in the materials and expertise they utilize in teaching a lesson." The other teacher in the Xerox program indicated that

utilizing the Xerox people and their materials makes hands-on science much more feasible. He stated that hands-on science "can be done with just the teachers, but it takes much longer." Because it takes longer and the school year is limited, the science is often what is then cut short. One of the non-participant teachers indicated that she wished she could be involved in something like the Xerox program but that the principals assigned all of the Xerox people to the fourth grade teachers because the fourth grade students take the state's Elementary Science Program Evaluation Test (ESPET -- a test designed to evaluate the elementary science program of each district in the state of New York that focuses on science process rather than content). The other non-participant teacher liked the idea of having experts come in to the classroom so long as they are reliable and committed to the program.

After analyzing the answers each teacher gave to the questions, some differences were noted between the Xerox participants and the non-participants. One question that resulted in different answers was "What pops into your mind when you hear the word 'science'?" The Xerox participants were more likely to first focus in on a specific subject area such as "space science", "the natural world", or "trying to balance the world's resources while protecting the planet." On the other hand, the non-participants in the Xerox program were more likely to say that they saw science as "many different ... experiments", "observations", or "trying to make everyday things that they hear about science relevant, have meaning, to them."

From the interviews, it also seems that the teachers in the Xerox

Science Consultant Program are more likely to follow a schedule for teaching science. One of the participant teachers claimed to spend about 1 1/2 - 2 hours per week on science on Wednesdays through Fridays. The other participant indicated that he spends about 3 hours per week on science. On the other hand, one of the non-participants has science scheduled three times per week, about 40 minutes at a time. However, he states that "some days it runs more, some days it runs less. It depends on the interest, so I may take it to 1 1/2 hours if there is interest." The other non-participant stated that her science "is usually in connection with my social science or math. So we are doing it constantly."

Another area that differences were apparent between the Xerox participants and non-participants was in the use of the RISE kits -- previously prepared science kits available to elementary teachers in the Rochester City School District. One of the Xerox Science Consultant teachers felt that the RISE kits are "very important because they reinforce the concepts." The other participant said that the RISE kits were "a big part of their science program." One of the non-participants stated that he uses the RISE kits when he can, but that it depends upon the school's budget. Each kit used costs the school a certain amount of money, and so he is limited in the number he can use. The other non-participant indicated that she usually uses some of the RISE kits, but that she hasn't used them this year. She said that one of the problems she has with them is that "you have to order them so far ahead of time that you don't know what your students are like and I think that you have to fit what you're doing to the children." She also indicated that she doesn't always get the kits when she

wants them.

There was also some disagreement between the Xerox Science Consultant teachers and the non-participant teachers about how supportive the Rochester City School District is of teaching science. One of the teachers involved with the Xerox program stated that the district is very supportive of science in that the district has a person pushing science in the district. This person provides the district teachers with special science workshops. One of the non-participant teachers stated that the district's science person is "excited about what he does and shows you how to apply things in your classroom." This teacher feels that this is exactly what a district needs to promote science. However, he also pointed out that, except for the RISE kits, the resources available for teaching science in the district are very limited. The other non-participant teacher also believes that the district doesn't provide enough supplies for teaching science. She stated that "there are always people going out buying things to bring in for the science program." She suggested that the district should have a center where supplies such as magnifying glasses, microscopes, etc., would be available to check out so that a teacher could build his or her own science program. In contrast, one of the participant teachers stated that he "doesn't feel hindered by not having enough materials for science", while the other participant teacher never indicated that he lacks any necessary materials.

When asked which area of science each teacher prefers to teach, another difference appeared between the participant and non-participant teachers. Both participant teachers indicated a specific category of

science -- one said electricity and the other said environmental science. On the other hand, both of the non-participant teachers indicated that they prefer to teach any science that their students are interested in. One of the non-participant teachers stated:

If I only taught what I am interested in, I may be satisfying my own needs, but I am not satisfying their needs. If I happen to have a class that is into blood and guts and they want to dissect something or they are interested in collecting insects or whatever, then we can do that. You can still incorporate all the scientific questioning and reasoning that goes on with that as with chemistry.

The other non-participant said that "you have to fit what you're doing to the children, even though you have to follow the curriculum" and that she does things that the kids are interested in as they go along.

DISCUSSION

Having looked at the responses of the two groups of teachers to the interview questions, many similarities are apparent. However, some of the differences in responses from the participants and non-participants are worth special consideration.

It seems that the teachers that participate in the Xerox Science Consultant Program are more likely to see science as segmented subject areas to be taught while the non-participant teachers view science more as an opportunity to learn and experience the methodology of science. For example, the non-participant teachers repeatedly used words like "observation" and "experimentation" while the participant teachers used words like "electricity", " environmental science" and "chemistry."

The participant teachers also seem to focus more on the subject areas to be covered in the curriculum while the non-participant teachers are more interested in teaching the subject areas in which the students are interested. The participating teachers continually mentioned that they teach about "animals", "circuits", "space", etc.. On the other hand, the non-participant teachers rarely mentioned specific subject areas and said that they teach subjects in which the students express a special interest. This difference seems to correlate with their emphasis on scientific method since the subject area covered isn't critical in teaching science processes.

The limited use of textbooks by non-participant teachers and their

degree of flexibility in the scheduling of science lessons also seem to fit with their focus on scientific method. Again, content is not of critical importance to them, so this information is not necessarily needed from a textbook. Also, a specific process must be concluded in order to finish a lesson. Since it is difficult to stop in the middle of an observation or before a conclusion has been made, they are flexible about when the science lesson ends.

The question, then, is why are the participant teachers more oriented towards subject areas? Perhaps it comes from the Xerox people coming into the schools and covering specific subject areas. As one of the participant teachers pointed out, he is not covering chemistry this year with his students because the Xerox people are doing it with them. This then leaves the teachers with other subject areas to be covered. Because they are focusing on the subject areas more, these teachers also need more information to pass on to their students which would come from the textbooks.

The other major differences between the participant and non-participant teachers is in their use of the RISE kits and their views about the availability of adequate and appropriate supplies. Since the participant teachers stated that they use the RISE kits regularly and also have access to additional supplies through the Xerox Science Consultant Program, they seem to believe that adequate supplies are available for science. On the other hand, the non-participant teachers indicated that they do not regularly utilize the RISE kits. Neither do they have think that they have access to anyone in industry who can provide them with

additional supplies. Therefore they seem to believe that the district does not provide enough supplies.

It is also interesting to note that, according to the teachers interviewed, the school principals have targeted the fourth grade as the grade to receive the services of the Xerox Science Consultant Program. Considering that the fourth graders must take the ESPET towards the end of the year and that this test is designed to evaluate the science program in the entire school, the use of the Xerox program in this grade may be causing the ESPET results to be inaccurate. It is possible that they may be making their program look better than it really is because of this.

CONCLUSION

Although both the teachers participating in the Xerox Science Consultant Program and the non-participant teachers claimed to like science and stated that they enjoy teaching science, some differences do exist. The main differences occur in two areas -- in viewing science as segmented subjects vs. a scientific process and in the perception of whether or not adequate materials are available for teaching science.

Contrary to much of the scientific literature, all of the teachers in this research project do try to use activity-based science as much as possible. As one non-participant teacher pointed out, he would:

... like science to be, at least at this age, almost totally and exclusively experimental -- where the kids use manipulatives. Kids seem to be action oriented at this level so they like to see fizzes and bubbles and explosions and things move.

All of the teachers have also received a fair amount of training in science and science teaching methods. None of them rely solely upon the textbook to teach science. The only area in which their statements support prior research on science in the elementary schools is in the area of supplies. The non-participant teachers do not feel that they have adequate supplies for teaching science. As one non-participant teacher stated, "the resources we have available to us are very limited and ... they are not very helpful." On the other hand, neither participant teacher felt that his science program was hindered by a lack of supplies. This suggests that the

area in which the Xerox Science Consultant Program is having the greatest effect is in helping teachers bring sufficient and appropriate materials into the classrooms with which the students can work.

On the other hand, the Xerox Science Consultant Program may be causing the participant teachers to lose sight of the importance of scientific method. After analyzing the data collected during the interviews, it is not clear to what extent the participant teachers focus on the process of science. Their responses refer only to the content areas of science. Additional interviews would have to be conducted in order to gain more information about this issue.

One must also consider the limitations of this research when trying to draw conclusions from these interviews. The sample size was very small -- only four teachers were interviewed out of all the elementary teachers in the Rochester City School District. The selection process was not entirely random since the two non-participant teachers were selected from four teachers suggested by the principals of the two schools involved in the project. Finally, the amount of information collected was also limited in that no classroom observations, follow-up interviews, or student interviews were performed. Each of these procedures could have provided additional information.

Overall, it does appear that all of the teachers interviewed view the Xerox Science Consultant Program, and other programs like it, in a favorable light. Not only do the teachers like the additional supplies available through the program and the expertise that is brought to the children, but the teachers also indicate that the children love being able

to interact with a person who is an expert in the field they are studying. They also suggest that it makes teaching hands-on science more feasible because there are more people in the room to interact with the students. Therefore, not only does this program help the teachers participating in this program, it also helps Xerox by supplying additional local students with the science skills necessary for the corporation. Maybe more corporations will join Xerox in its efforts to help educate our nation's future leaders in the area of science.

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APPENDIX

QUESTIONS USED IN TEACHER INTERVIEWS:

(In no particular order.)

1. Do you teach science?
2. Do you like teaching science? Why or why not?
3. What do you think of when you hear the word science? What is science?
4. Do you have a science textbook available for use? Do you use it?
5. Are science kits available to you? Do you use them? How?
6. Do you prefer using a textbook or a science kit? Why?
7. Do you feel that you have adequate supplies for teaching science? What would you like that you do not have? What do you have that you think you could do without?
8. Do you feel comfortable teaching science? Why or why not?
9. What kind of science do you teach? (ie. life/physical)
10. Which scientific topic do you prefer to teach?
11. How do you structure a science lesson?
(ie. reading/discussion, activity/discussion/conclusions, use of notebooks, etc.)
12. Does it take more time to prepare for a science lesson than a reading or math lesson?

13. Do you have someone you can go to for help if you need it when preparing a science lesson? Would you prefer to ask another teacher or a real scientist for help? Why one or the other?
14. Did you take any science during high school? During college? Where these classes helpful?
15. How well do you feel your science methods course(s) prepared you to teach science?
16. Does your principal encourage you to teach science?
17. Does your school district encourage you to teach science?
18. Do parents encourage you to teach science?
19. Do you have a science coordinator for your school or district? Do you find this person helpful?
20. Do you feel that it is important for your students to study science in your classroom?
21. Do you try to use manipulatives in science lessons? Why or why not?
22. Do you try to integrate science with other areas of the curriculum?
23. How do you feel about working with a science consultant from industry? Do you like it? Would you like it?
24. How much do you teach science during the course of a week?
25. How much time do you spend with your Xerox consultant?
26. How important do you think the Xerox program is to you and your school?