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Describing science as middle school students experience it continues to be a challenge. The science that students experience in the classroom is that which their teachers have selected and organized for them. This selection/organization process is itself guided by the teacher's knowledge base and the expectations of the schooling context. Presented here is a contrast practiced in the middle school in 1990 with 1965. The findings show that while teachers today may be better prepared in terms of academic courses, they are still not being adequately prepared to work with the emerging adolescent in the middle school.

Describing science as middle school students experience it continues to be a challenge. As with the sages of Indostan, what is described seems to reflect both the person doing the describing and the reality of schools. In this paper, three "windows" of science in the middle school enable us to reflect on what we how have and the goals we want to achieve for science with the emerging adolescent.

In their carefully documented report on the status of middle school and junior high school science, Hurd, Robinson, McConnell and Ross (1981) cogently described middle school science as follows:

> The middle school and junior high school years are critical ones for education in the sciences. Early adolescents, 11 to 14 year olds, are more varied Physically, intellectually and socially than any other age group. The extent of these variations suggest that the goals and subject matter of science education should be special for this age group. (p. 1)

The science that students experience in the classroom is that which their teachers have selected and organized for them. This selection/organization process is itself guided by the teacher's knowledge base and the expectations of the schooling context. Thus, key factors in understanding the student's experiences in science are the teacher the instruction and the curriculum.

The purpose of this paper is to draw a picture of our practices in the middle school in 1990, and to contrast this picture with earlier descriptions to see if we are making progress toward the oft repeated desired goals of science in the middle school.

To draw these pictures, three sources were used. Hurd, Robinson, McConnell and Ross (1981) described the state of science in American middle and junior high schools based on their assessment of reports, philosophical statements and research studies of the 1960's and 1970's. The second source was Hairston's (1987) literature review and validation of her findings with a sample of 60 middle school life science teachers. The third window consisted of 37 middle school life science teachers from twelve school districts in the southeast. In 1989-90, these teachers participated in a series of science update and teaching enhancement seminars which were part of a leadership institute conducted by the National Association of Biology Teachers and the University of Georgia as part of a grant from the National Science Foundation. From these teachers, a contemporary picture was drawn of what life science in the middle school is like in twelve major cities of the southeast. There are two dimensions to the picture from these teachers. First, they reported what they knew to be the classroom practices in their districts. Second, validity of their report was confirmed through site visits is these schools. Thus from these teachers, a contemporary picture emerges of what life science in the middle school is like in the 1990s.

THE TEACHER

If indeed the science students' experience in the classroom is what the teacher selects, then the teacher is a critical variable in this picture. In their description of the status of middle school science in 1965-70, Hurd et al (1981) found that most middle school science teachers were enrolled or intended to enroll in graduate studies. Also they were not well prepared for teaching a broad range of general science topics. The Hurd study noted that by 1980 most of the middle school science teachers were biology majors who had completed some graduate study but were primarily interested in teaching at levels other than the middle school. Hairston (1987) noted that most biology topics included in teachers's academic courses were conventional taxonomy with little attention to recent advances in cellular and molecular biology. This finding implies a deficiency in teacher's knowledge of contemporary life science concepts.

By 1990, we found that 70% of the teachers in our group had completed graduate degrees. While they were better prepared academically in 1990 than were their counterparts in 1965, most were prepared for the high school classroom. Only one in three had middle school teacher certificates indicating that they were prepared to teach emerging adolescents in the middle school. In the 1990 sample, it was found that

11% had completed post-masters graduate work,

68% had completed masters degrees, and

100% had completed bachelors degrees.

Certification was a contrasting picture for this group:

65% were certified for high school science,

32% were certified for elementary (4-8) or middle school (4-8),

3% were certified in fields other than science and were teaching out of field.

The science concepts a teacher selects to teach requires knowing both the subject matter and the students. Clearly, in 1990 teachers have a somewhat improved background in the subject matter but they have large gaps in their understanding of the students they are assigned to teach.

THE INSTRUCTION

The way the teacher organizes science concepts determines the science that the student experiences. In 1965, the Hurd et al (1981) study found that the textbook was the primary curriculum in 80% of the classes. In 1975-1980, this report indicated that teaching a science class in a middle or junior high school was a highly routinized process of

Table 1
Profile of Middle School Life Science Teachers

	1970s	1980s	1990s
College Major	Biology	Biology	Biology
Primary Interest in teaching	Secondary level	Secondary level	Secondary level
Certification	Secondary	Secondary	Secondary
Graduate Study	Some	Some	Some

lectures, assignments, recitations, discussions and tests as indicated by the textbook. By 1987, Hairston noted that most science in middle school life science classes consisted of lectures, discussions, "busy work" film/videotape projections and "cookbook" laboratory activities. Teachers tended to view instruction as a management task with their most serious problems reported as being discipline and poor reading skills of students.

In the 1990 sample, teachers reported spending 255 minutes per week in science with 151 or 59% of these in lecture/discussion activities and 104 or 41% in hands-on laboratory experiences. They saw this pattern (59% lecture/41% laboratory) as a significant change from their pattern of 80% lecture/20% laboratory activity in previous years. When asked if they were required to have laboratory activities, the teachers' responses were

70% said no laboratory activities were required

19% said laboratories were required, and

10 said laboratories were requested only.

While most of these teachers reported that they do have a science text, 92% said they use a variety of instructional materials in addition to the textbook. These materials included personal collections of resources, instructional modules, supplemental publications, newspapers and videos. The contrast between 1965 and 1990 suggests that today's teachers have a greater level of personal confidence that enables them to reach out and utilize more contemporary resources than teachers did in 1965.

A second characteristic of instruction is looking at what it requires the student to do. Hurd et al (1981) found student activities in 1975-80 to be characterized as follows:

> Across programs that were analyzed, there is some variation in student activities in the amount of craftmanship, the amount and type of logic used, the content coverage and the amount of experimentation. All programs were similar in their lack of activities focusing on affective dimensions and their heavy emphasis on cognitive outcomes. Additionally there is a heavy emphasis on figurative knowledge, that is, most things have been reduced to "nontoxic thinking situations" for the student. All programs are basically void in providing opportunities for decision making, creating things, interviewing, listening, valuing and watching...(p. 17)

Hairston (1987) noted that the laboratory activities in most syllabi examined were simply "busy work" for students. They had little

resemblance to scientific investigations in which the processes of science were utilized. She also noted that the curriculum and recommended teaching strategies did not take into consideration the students' cognitive development. They were too simple and boring for this age group.

After their involvement in a summer institute, 95% of the 1990 group reported using more variety in their instruction, such as role playing, public charts, concept mapping and cooperative learning in the classroom with both hands-on and non-hands-on activities. The teachers were also permitting and encouraging students to solve problems in pairs or in teams of four. The teachers reported better classroom management, utilized more efficient questioning skills and tended to use more than one activity to win a specific concept.

When students are more actively involved in decision making, which is really higher order thinking, they find science to be more challenging and they enjoy this challenge!

This is a real contrast to the 1975 findings of Hurd et al (1981):

> Students in middle and junior high schools are lukewarm about their science courses, but the majority do feel science is interesting and important and should be required of all students, although it is not their favorite subject. Students do not feel particularly competent in learning science because there are too many facts to memorize, but they recognize that teachers try to make the subject exciting for them. (p. 12)

While teachers' organization of science is reflected in both their use of the textbook and the activities students carry out, a third constraint is inherent in the pattern of school organization. What facilities are available and how many students are in those facilities? In 1975-80, Hurd et al (1981) concluded that while equipment was probably minimally adequate, teachers noted a greater need for improvement in space available for science classes. Hairston (1987) found that teachers reported no funding for science supplies and that school facilities (classrooms, storage space, etc) were very poor.

By contrast, teachers in 1990 in the southeast reported that they had adequate physical facilities and support from their school districts for science.

While the support for equipment and facilities may be improving, class size, however is not. In the 1987 study, Hairston found that most middle school science teachers had a heavy teaching load and large classes--6 classes each day with 28 to 30 students per class. In 1990, there seems to be an improvement with teachers having a range of 3 to 6 classes a day with an average of 5. They taught from 85 to 244 students each day, with each teacher having an average of 30 per class--a number far too large to permit students and teachers to really enjoy their interaction with science. Teaching load does seem to be improving, with 1 to 5 preparations each day and an average of about 2 preparations each day for this group of 37 teachers. While teaching assignment and number of classes and preparations are showing signs of a wiser use of the teaching staff, the teaching load--the number of students per classroom--clearly presents a difficult challenge.

The Curriculum

In each school setting, the teachers ultimately selects the content. That selection is guided or controlled by the curriculum imposed by the textbook or by the school system. Hurd et all (1981) noted that teacher were aware of general goals for science teaching such as

+ development of inquiry and thinking skills,
+ scientific literacy,
+ career awareness,
+ science/society/technology relationships,
+ ethical and value implications of science

Table 2
Profile of Life Science Instruction in the Middle School

	1970s	1980s	1990s
Pattern of Instruction	Lecture Assignments Recitations Discussion Tests	Lecture Discussion Films Cookbook Labs	Lecture/ Discussion (59%) Hands-on Laboratory (41%)
Principal Instructional Strategies	Cover the textbook	Cover the textbook	Textbook Cooperative learning Role playing Concept maps Public charts to display student ideas
Science Equipment	Minimally adequate	Virtually no funds	Adequate equipment
Space and Facilities	Minimally adequate	Very poor	Adequate space
Teaching Load		6 classes/day 28-30 students per class	5 classes/ day 30 student per class 2 preps each day

for effective citizenship,
+ appreciation of science and
+ understanding the world in which we live.

But they find these goals to be "diffused, impractical remote and unrealistic". (p.11)

For example, career emphasis was largely confined to one page inserts in the textbook and science/technology/social issues were clearly not considered to be an essential part of science learning. Hairston (1987) found that there was little consideration of such topics as cellular and molecular biology, immunology, human genetics, biotechnology, ecological interactions and human behavior. There was an equally important absence of consideration of relationships between science, technology and society or the

implications of biology and its accompanying technology to established moral ethical values, e.g. in-vitro fertilization, sperm banks, euthanasia, abortion and life support systems for the terminally ill.

After participating in the science update seminars, the 1990 teacher participants noted that they saw the goals listed by Hurd et al (1981) as being more essential to their classrooms. They valued inquiry skills more (43% had environmental issues (38% had increased this focus during the current year) and current events (35% had increased this focus during the current year.) On the other hand, some of the teachers (35%) report that they were not interested in including ethical values in their classroom discussions and 24% believed that career awareness did not fit well into the needs of seventh graders or the life science classroom.

While there were no courses specifically cited for the general goals which Hurd et al (1981) identified, science courses were usually categorized into identifiable patterns:

> Science content at the middle and junior high school levels seems to be organized into three major patterns; (1) a three-year sequence of life, physical and earth science; (2) a one, two or three year offering called general science; and (3) a one, two or three year sequence of integrated or thematically organized materials. Patterns 1 and 2 are found in the vast majority of schools that offer science at this level. (p. 15)

Hairston (1987) found that life science generally was taught for one year, usually in the seventy grade. A few districts had life science courses extending over the fifth, sixth and seventy grades.

In the 1990 sample, teachers reported a sequence of general science in the sixth grade, life science in the seventh grade and earth science in the eighth grade in 86% of the participating schools, Only 14% reported a composite science with all three subjects being taught at all three grade levels.

Knowing the nature of the experiences students have had before coming to a teacher and know that they are expected to know in high school biology classes are two other valuable contributors to what a teacher selects to teach. While Hurd et al (1981) and Hairston (1987) reported that teachers feel an urgent need for more help from supervisors, the 1990 teachers noted that within school districts there is a lack of articulation or coordination of what is expected in science at the different levels of schooling. When asked about their knowledge of the science curriculum in a grade lower than their own, 54% of the teachers said they knew very little about it. When asked about the curriculum to which their students would advance, only about 50% said they knew what it was. They said their best sources of information were their supervisors (54%), their own experience in teaching it previously (38%), other teachers (35%) and the district curriculum guide (32%). They did not see either the textbook or the principal as useful sources of information about what was expected or what was taught at grade levels below or above the seventh grade life science curriculum.

CONCLUSIONS

Based on our three windows of life science in the middle school, it is clear that while teachers today may be better prepared in terms of academic courses, they are still not being adequately prepared to work with the emerging adolescent in the middle school. The findings also revealed that teachers do not have an adequate access to contemporary ideas in biology. This gap is reflected in the absence from the curriculum of many contemporary topics which students need to cope with their daily life. The increase of hands-on science activities is encouraging, as is the expanded number of teaching strategies now available and being used. While the improvement in equipment and facilities is