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ABSTRACT

This study attempted to determine which combinations of student, teacher, curricular, and task factors characterize effective life science instruction, where effectiveness is defined as the acquisition of scientific literacy. The framework of scientific literacy used includes five teacher behavior components: (1) explaining science content; (2) relating content to science as a social historical process; (3) relating to science as a reasoning process; (4) relating to science and society/technology; and (5) positive attitudes toward science. Data were obtained from 11 seventh grade teachers and their students using student pre- and post-surveys (respresenting the scientific literacy components), classroom observation records, and curriculum content analyses. Results indicate that teachers carried out academic instruction largely through means of recitation, seatwork, and laboratory exercises (in that order), followed by a fairly consistent use of audiovisual materials. In addition, when presenting academic information to the entire class, the teachers rarely made explicit reference to the historical, reasoning, social, or attitudinal implications of the subject matter. Possible explanations for this latter finding are offered and discussed. (JN)

Life Science Instruction and Its Relationship to Scientific Literacy at the Intermediate Level

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Life Science Instruction and Its Relationship to Scientific Literacy at the Intermediate Level

This paper will introduce a study of 7th grade life science instruction which was conducted during the current 1983-1984 school year. After an initial description, the paper presents one set of results focusing on the quantity and quality of teachers' instructional time use. A companion paper (Mergendoller and Packer, 1984) focuses on student interest and its relationship to the academic tasks assigned in class.

The guiding question of the study can be stated as follows: What combinations of student, teacher, curricular, and task factors characterize more effective life science instruction, where effectiveness is defined as the acquisition of scientific literacy? Here, scientific literacy refers to a set of goals shared by many science experts. While there are a plethora of different interpretations of the term "scientific literacy" (for a review, see Roberts, 1983), and while much can be made of the distinctions among these interpretations, there exists considerable conceptual overlap among recent definitions (e.g., Noe, 1978; Orpwood & Souque, 1984). It is the overlap that guided our own definition of scientific literacy.

The framework of scientific literacy used in this study is summarized in Table 1. Stated in terms of teacher behavior, the framework has five components. It includes not only the explanation of science content, but relating content to science as a social historical process, science as a reasoning process, science and society/technology, and positive attitudes toward science. This framework is compelling for at least two reasons. First, any of the last four components can be used as a perspective for integrating the specifics of science content; furthermore, such a perspective may be a cognitive tool for students' retention of knowledge. Second, presenting science content from any of the four perspectives allows the teacher to explicitly communicate how science facts have relevance for the human enterprise; this, in turn, may foster students' motivation to learn.

[Insert Table 1 about here]

Design of the Study

The design of the study was comprehensive, involving the collection of in-depth, multivariate qualitative and quantitative data in 11 classes. The variables of interest fall into three groups: 1) Background variables, which include initial student and teacher characteristics and the formal curricular materials; 2) Classroom Process variables, which include the instructional behavior and perceptions of teachers and students along with characteristics of the academic tasks that are assigned; and 3) Outcome variables, which include a set of cognitive and affective student variables. Figure 1 summarizes the variables in the three groups.

[Insert Figure 1 about here]

In developing instruments to measure the variables in Figure 1, care was taken to design many of the instruments so that they would map onto the study's defined components of scientific literacy.

Table 1

Scientific Literacy Framework Used in the Study

1. EXPLAINING CONTENT	There are several ways in which a teacher can attempt to communicate content--e.g., by short statements, by writing things on the board, and even by a demonstration. What is important is that regardless of the instructional method used, the teacher is trying to communicate facts and concepts that are fundamental to the understanding of the topic.
2. RELATING TO SCIENCE AS A SOCIAL HISTORICAL PROCESS	This takes place when a teacher attempts to communicate the historical context of some scientific knowledge or process. This context can be portrayed in specific or general terms. In specific terms, the teacher would refer to particular individuals in history and their contributions--e.g., Mendel's work in genetics, Salk's development of the polio vaccine, Fleming's discovery of penicillin, Watson and Crick's determination of the structure of DNA, etc. In general terms, the teacher would refer to scientists or other people, without mentioning specific individuals.
3. RELATING TO SCIENCE AS A REASONING PROCESS	A teacher is relating science content to the specific reasoning process when he/she attempts to communicate how scientific knowledge is acquired. This would include talking about observing natural events, formulating and testing hypotheses and theories, deductive and inductive reasoning, concepts of randomness and probability, and the tools and methods of measurement. This component also includes references to the general point that scientific knowledge is not accumulated in an accidental or arbitrary fashion, but instead is accumulated through a set of agreed upon standards that have a logical foundation.
4. RELATING SCIENCE AND SOCIETY/TECHNOLOGY	This refers to a teacher communicating how specific areas of scientific knowledge have implications for society or for technology. Often, there is a direct link between a technological product (e.g., a new fertilizer) and its societal consequences (e.g., more productive farming). The teacher who does this area well goes beyond a cursory mention of some connection and really encourages students to consider how specific scientific knowledge affects people. Furthermore, it often will be most ideal for a teacher to present at least two points of view (e.g., the advantages and disadvantages of pesticides), thus, modeling parts of a decision-making process that students can apply in their own lives as they consider their use of science-based technologies.
5. POSITIVE ATTITUDES TOWARD SCIENCE	Here, a teacher refers to the individual or collective affective reactions people have towards science as a discipline and specific science knowledge, concepts, and applications. The teacher who does a good job of relating in this area will try to foster well-founded positive attitudes and curiosity toward science. The teacher may also model his or her own positive attitude toward science as a discipline.

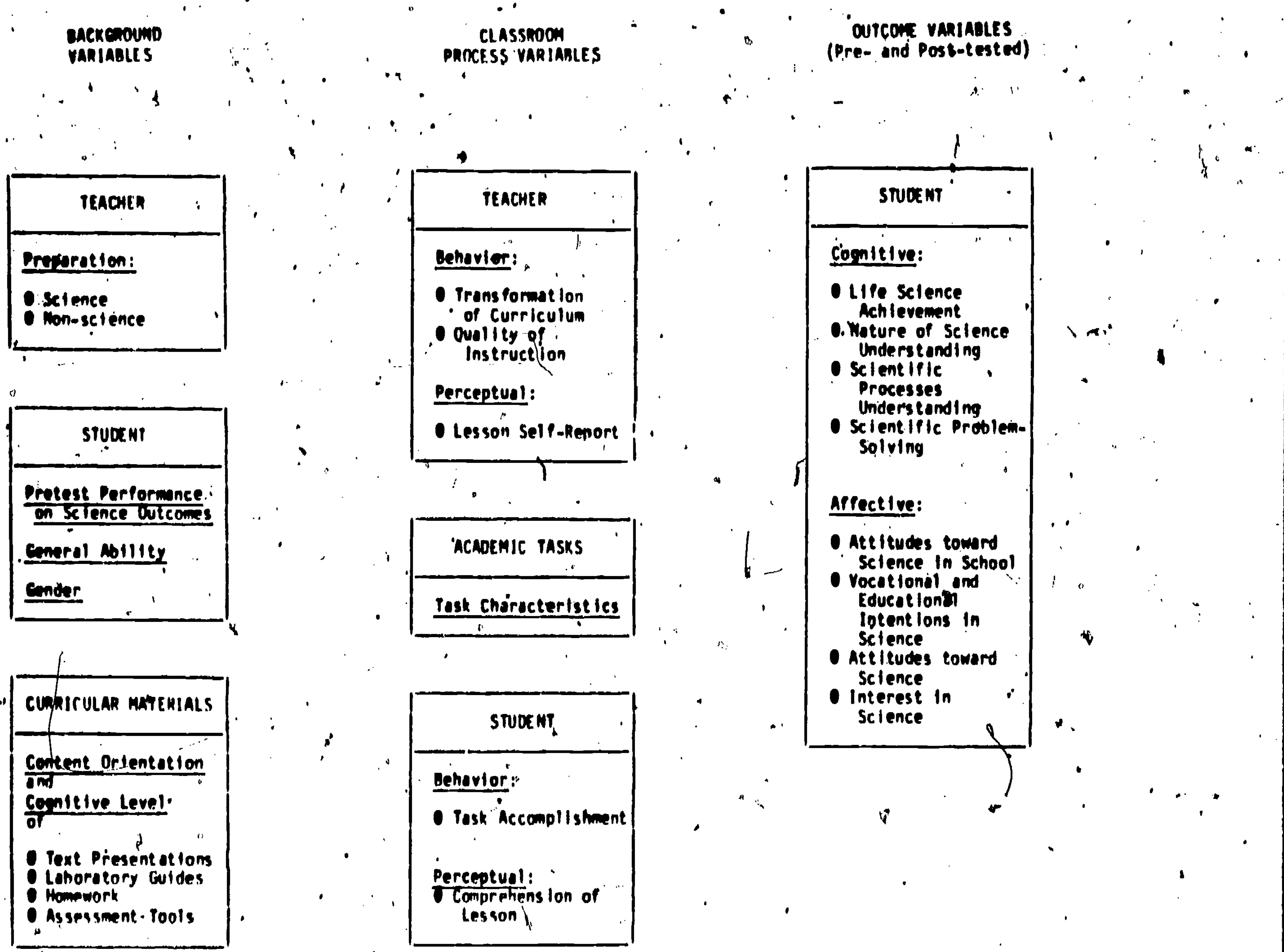

Figure 1. Framework for research design of intermediate school science instructional study.

For example, under the Outcome variables for students, outcomes were selected to cover as many of the components of scientific literacy as possible. While the first outcome, Life Science Achievement, refers to an assessment of students' knowledge of life science content, the remaining outcomes are linked to the other areas of scientific literacy. Figure 2 shows how three major sets of instruments--the curriculum content analysis, the class observation records, and the student pre- and post-surveys of outcomes--represent the scientific literacy components.

[Insert Figure 2 about here]

Method

Sample

Eleven teachers and the students from one of their life science classes participated in the study. All the classes were 7th grade and ran for the entire school year. Seven of the teachers were employed in the Salt Lake City area, while the remaining four were employed in the San Francisco Bay area. Selection of teachers was based on geographic convenience and, in some cases, on district recommendations about schools that had an interest in science. All teachers volunteered to participate. The smaller number of teachers in California was attributable to the fact that a full year of 7th grade life science was not as common there as it was in Utah.

Table 2 summarizes the background characteristics of participating teachers. The table indicates that four of the eleven teachers were female. Three of the teachers had a masters degree,

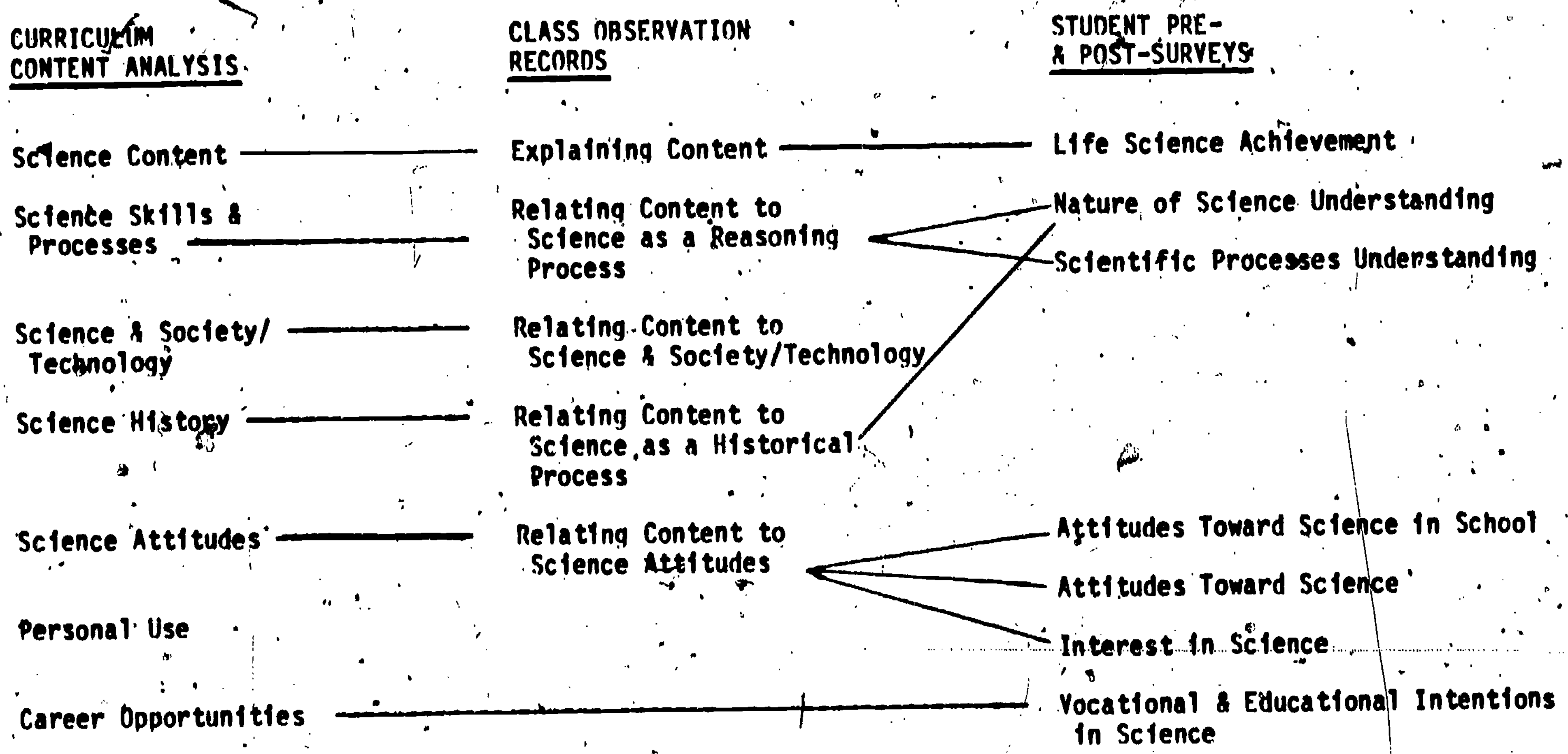

Figure 2

Components of Scientific Literacy Represented Across Three Different Measures in Study and all but two teachers had some specialization (major or minor) in the field of science. The general teaching experience of the sample ranged widely from 1 to 24 years, with an average of 13.3 years. Initial class sizes ranged from 24 to 32 students, with an average of 28.6.

[Insert Table 2 about here]

Data Collection and Measures

Figure 3 summarizes the data collection timeline for the study. As shown, besides the student pre- and post-tests, an introductory interview with each teacher, and familiarization visits to classes, the data collection focused on observing each teacher instructing his or her class on two life science topics, one in late Winter and one in Spring. Selection of the two topics for each teacher was based on four criteria: 1) that the topics be part of the teacher's normal plan; 2) that each topic last at least 5 days; 3) that the two topics represent a contrast either in level of organization (micro vs. macro) or obvious linkage to the different components of scientific literacy; and 4) that commonality across teachers in the topics be maximized.

[Insert Figure 3 about here]

Table 3 presents a summary of the topic titles and their duration for the eleven teachers. The table indicates several topics common to three or more teachers (cell structures and genetics; protists; ecology; and human organs and systems). The days spent teaching the first topic ranged from 5 to 12, with an average of

Table 2

Characteristics of Participating Teachers and Classes

TCHR ID	SCHOOL ID*	TCHR GENDER	HIGHEST DEGREE	DEGREE SPECIALIZATION	TOTAL YRS TCHNG	INITIAL CLASS SIZE
1	1	F	Bachelor's	Biology	5	32
2	1	F	Bachelor's	Biology	14	29
3	2	M	Master's	Zoology	24	29
4	2	F	Bachelor's	Physical Ed. (Botany Minor)	7	32
5	3	M	Bachelor's	Biology	15	30
6	3	M	Bachelor's	Mathematics & Elem. Ed.	1	24
7	4	M	Bachelor's	Science	15	28
8	5	M	Master's	P.E. (Life Science Minor)	17	24
9	6	M	Master's	Physical Ed. (Sci. Minor)	23	29
10	6	M	Bachelor's	Biology	10	29
11	7	F	Bachelor's	Soc. Science	15	29

*Note. School characteristics are as follows: School 1 has grades 7-9 with 1164 students; School 2 has grades 7-9 with 602 students; School 3 has grades 7-9 with 1532 students; School 4 has grades 6-8 with 535 students; School 5 has grades 7-8 with 492 students; School 6 has grades 6-8 with 700 students; and School 7 has grades 7-8 with 917 students.

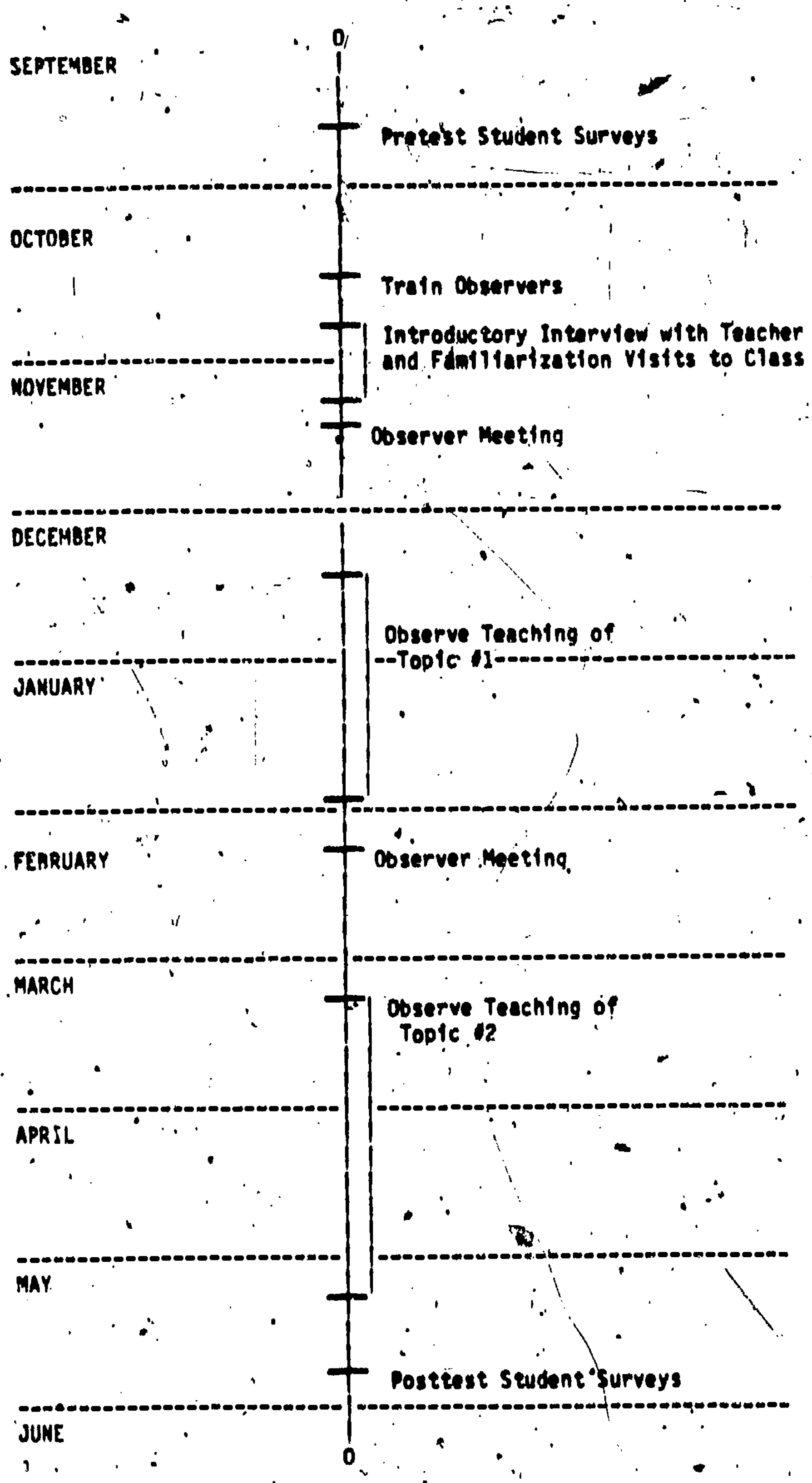

Figure 3. Timeline for the Intermediate Science Study.

8.2. For the second topic, the days ranged from 4 to 10, with an average of 7.7.

[Insert Table 3 about here]

For each selected topic, the same observer visited the class every day the teacher covered the topic so that the development of content and progression of tasks was captured. For each set of observations of a topic, there were several forms of data collection:

1) First, teachers completed a questionnaire beforehand about their intended approach and goals; after the topic was completed, teachers were interviewed and asked to give their own reflections on possible strengths and weaknesses of the topic session.

2) Second, in addition to making an audiotape of each observation visit, the observer completed three items on each day: a) a detailed narrative record of class events and the teacher's verbatim instruction; b) a summary of the activities and tasks for the day; and c) a higher-inference instrument for recording actual time use and rating the teacher's instructional approach with regard to the components of scientific literacy and more generic teaching skills.

3) Third, all students in the class were administered a survey at the end of one observation day and asked to indicate their memory of and attitudes toward the instruction that took place that day; furthermore, six students from each class were interviewed in greater detail about the topic and their science class at the end of the topic session.

4) Fourth, all curriculum materials used during the topic session were collected and analyzed.

Eight observers collected data for the study. Five of the

Table 3

Topic Subject Matter and Duration in Eleven Classes

TEACHER	SUBJECT MATTER OF FIRST TOPIC	DAYS SPENT TEACHING 1ST TOPIC	SUBJECT MATTER OF SECOND TOPIC	DAYS SPENT TEACHING 2ND TOPIC
1	Genetics	10	Ecology	9
2	Protists	8	Digestive Systems	10
3	Sponges and Coelenterates	7	Human Systems	10
4	Protists	9	Human Organs and Systems	8
5	Protists	7	Genetics	7
6	Bacteria and Viruses	7	Birds and Mammals	4
7	Ecology	10	Genetics	8
8	Protists	5	Human Digestive System	7
9	Cell Structure and Function	10	Human Circulatory System	6
10	Cell Division and Genetics	12	Human Circulatory & Skeletal Systems	9
11	Ecology	5	Bacteria and Viruses	7

observers had Ph.D.s in education and the remaining three were graduate students. Observers were recruited based on their skills in classroom observation and knowledge of science.

Initial Results on Teacher Time Use

This paper will now present some initial results that come from the higher-inference form completed by observers on each day of their class visits. Two items on this higher-inference form are of particular interest. These two items appear in Figure 4. The first item, Item 1, asks observers to estimate the amount of time, both allocated and actual, devoted to each of nine different possible instructional modes. The first six modes (seatwork, recitation, group discussion, demonstration, laboratory exercises, and surrogate instruction) refer to ways of communicating appropriate <u>academic</u> subject matter. The remaining three modes (nonacademic instruction, procedures, and other) encompass the kinds of activities and behaviors that are sometimes necessary but nonetheless take away from academic time. In Item 1, a distinction is made between allocated minutes and actual minutes. "Allocated" minutes refers to the official amount of time allocated to the mode, while "actual" minutes refers to the amount of time that is truly spent in the mode, after any "slippage" (e.g., procedures, interruptions) is taken into account.

[Insert Figure 4 About Here]

The second item of interest, Item 4, asks observers to estimate the amount of the teacher's academic presentation time that is

1. Estimate the percent of actual (not allocated) time devoted to the following:

	Mode	Allocated Minutes	Actual Minutes	Actual % of Time
Academic	Seatwork	____	____	____
	Recitation	____	____	____
	Group Discussion	____	____	____
	Demonstration	____	____	____
	Laboratory Exercises	____	____	____
	Surrogate Instruction	____	____	____
	Nonacademic Instruction	____	____	____
	Procedures	____	____	____
	Other: Transitions, Interruptions, Waste Time	____	____	____
	TOTAL (time between bells)	____		100%

4. Estimate the percent of teacher academic presentation time (recitation and demonstration) devoted to the following science emphases:

Science Emphasis	Minutes	% of Time	Linkage to Content	No Linkage
Explaining Content	____	____		
Relating to Science as a Social Historical Process	____	____	____	____
Relating to Science as a Reasoning Process	____	____	____	____
Relating Science and Society/ Technology	____	____	____	____
Positive Attitudes Towards Science	____	____	____	____
TOTAL RECITATION AND DEMONSTRATION TIME	____	100%		

Figure 4. Two items on time use.

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devoted to five major components of scientific literacy: 1) explaining content; 2) relating to science as a social historical process; 3) relating to science as a reasoning process; 4) relating to science and society/technology; and 5) positive attitudes toward science. Here, academic presentation time refers to the sum of the actual recitation and demonstration time given in the first item. Item 4 focuses on the use of the scientific literacy components in this very specific context because the study was primarily interested in how the teacher makes use of scientific literacy when he or she is communicating with the entire class (as defined here, recitation and demonstration necessarily involve the entire class). It should be noted that observers were instructed to code only very explicit instances of teacher use of the last four components. Here the logic was that in order for the references to scientific literacy perspectives to be salient to students, they at least would have to be salient to observers.

The collation of data for the second topic is currently underway; thus, only the findings on time use collected during the observation of the first topic are reported here. [A final report on the entire study will be available on December 1, 1984.] As indicated, these data were computed on each day of observation during the first topic. Here, for each teacher, averages across the number of observation days will be reported.

Table 4 presents the average percents of class time across the nine modes for each teacher. The top number in each box is the average, while the number(s) in parentheses represent the highest and lowest percentages in the range for each teacher. The total average across all teachers is presented in the column furthest to the right. Looking at the total average, it is striking that recitation was the most predominant mode, outdistancing its runner up--seatwork--by over 10 percent. Thus, it appears that life science teachers in this sample were spending on average over one-quarter of the available class time (31%) reciting academic information to the whole class. Looking at individual teacher averages for recitation, there is some variation. While recitation was the predominant mode for 8 of the 11 teachers, one teacher (2) made virtually no use of recitation. Two other teachers (3 and 5) used recitation to some extent, but allocated even more time to seatwork.

[Insert Table 4 about here]

The second most predominate mode, as indicated by the total average, was seatwork. Here, students spent an average of 20.4 percent of their class time doing assigned seatwork. Variation across classes is great, however. One teacher (9) apparently gave no seatwork, while two others (7 & 10) made minimal use of this mode. The remaining teachers generally used seatwork to a moderate extent, excepting one teacher (2), who used it over 53 percent of the time.

Looking at the other academic modes, laboratory exercises was the third most common mode. Here, the overall average was 13.4 percent. Translated into daily terms, this means that students spent approximately 1 out of every 7 days doing a lab. Again, there is some noteworthy variation among teachers. Teachers 3 and 11 had no lab during the first topic, and Teacher 6 had one short lab.

The remaining academic modes--group discussion, demonstration, and surrogate instruction--occurred relatively infrequently or not at all.

Table 4. Average Percent of Class Time Use During Observations of Topic 1

TEACHER:	1 N=10*	2 N=8	3 N=7	4 N=9	5 N=7	6 N=7	7 N=10	8 N=5	9 N=10	10 N=11	11 N=4	TOTAL AVERAGE
Seatwork	24.3 (4-68)	53.6 (44-58)	34.7 (24-70	15.8 (12-62)	22.1 (15.5-47)	16.5 (11-44.4)	2.5 (7-9)	20.2 (16-42)		5.0 (4-16)	29.5 (17-63)	20.4
Recitation	27.3 (3-77)	2.3 (18)	17.2 (2-66)	29.4 (4-85)	12.1 (7-31)	37.9 (11-78)	38.4 (9-82)	40.0 (13-68)	44.5 (7-88)	49.3 (16-78)	40.5 (8-69)	30.8
Group Discussion												0.0
Demonstration				1.0 (4)	0.3 (2)	2.3 (16)	11.9 (5-89)	0.4 (2)				1.4
Laboratory Exercises	11.9 (11-52)	18.8 (18-24)		23.1 (24-66)	15.0 (47-58)	4.8 (33.3)	18.8 (16-56)	17.8 (9-51)	21.0 (18-58)	15.8 (51-67)		13.4
Surrogate Instruction	5.5 (8-27)	9.9 (8-12)		7.1 (20-24)	4.4 (31)	6.0 (20-22)	7.3 (10-32)		3.3 (33)	2.0 (22)	11.0 (44)	5.1
Nonacademic Instruction	1.5 (4-11)	2.5 (20)	4.0 (12-16)	2.2 (20)	3.1 (22)	3.1 (22)	1.1 (11)	5.2 (2-22)	2.5 (25)	2.4 (4-22)	4.3 (17)	2.9
Procedures	17.4 (4-47)	3.8 (2-10)	8.9 (4-20)	14.8 (5-30)	11.1 (4-24)	8.5 (2-22)	5.8 (2-13)	10.8 (4-27)	12.6 (2-26)	11.9 (2-31)	7.3 (4-15)	10.3
Other: Transitions, Interruptions, Waste Time	12.0 (2-28)	9.25 (4-20)	32.5 (12-62)	6.7 (2-10)	31.9 (7-69)	20.9 (6-40)	13.6 (7-22)	5.4 (4-7)	16.1 (9-23)	13.7 (19-20)	7.5 (4-10)	15.4

*Note: The given N's are the number of days for which data were collected.

(0.0, 1.4, and 6.4 percent, respectively). Of these, surrogate instruction was used with some regularity by most teachers. Narrative detail indicates the form of surrogate instruction usually was films, videotapes, or filmstrips. The demonstration mode was used by only a small group of teachers, and when it was used, the time apparently was brief. It is noteworthy that the two teachers who did not use labs also did not use demonstration. Finally, there were no instances where teachers used group discussion. While teachers did use question-and-answer sessions frequently (this was coded under recitation), they apparently did not take this idea further to the extent of letting their students have considerable input into the discussion ideas and selection of participants (the distinguishing feature of our definition of discussion).

Turning to the last three modes, nonacademic instruction was the least predominant. The presence of this mode at all was largely attributable to the fact that administration time for this study's student survey was coded under this category. On the other hand, the procedures and "other" modes had substantial overall percentages (10.3 and 15.4, respectively). In fact, the "other" mode is the third most predominant when all nine modes are considered. While some unproductive "other" time is inevitable in every class, the teachers with average percentages exceeding 20 (Teachers 3, 5, & 6) may have had serious difficulties with classroom management or allowed a lot of "free time" to occur. Because the procedure mode encompasses teachers' directions to students about assignments and use of materials, all teachers had some time in this mode. Relative to other modes, the variation across teachers is not that great, ranging from 3.8 percent for Teacher 2 to 17.4 percent for Teacher 1."

In sum, it appears that for this sample of life science classes, teachers carried out academic instruction largely through means of recitation, seatwork, and laboratory exercises--in that order--followed by a fairly consistent use of audiovisual materials (surrogate instruction). These data can be compared to those from the Goodlad, et. al. "Study of Schooling". As reported in Sirotnik (1983), science at the junior high level involved 23.6% recitation, 20.1% seatwork, 15.6% lab, and 8% audiovisual. These figures are remarkably close to those presented here, falling within three percentage points, except in the case of recitation, which received about seven percent more time in this study. Looking at Sirotnik's time use data across all subject areas at the junior high level, it is the presence of laboratory (or what is referred to as "psychomotor/physical practice or performance") that distinguishes science from the other basic subjects of English, mathematics, and social studies.

Table 5 presents the results for the percent of academic presentation time that teachers devoted to the five components of scientific literacy. For convenience, the first component is referred to as the "explaining" component while the other four components are termed "relating" components. The top number in each box is the percent, while the botton number in parentheses indicates the actual number of minutes used. (The actual minutes vary widely across teachers not only because teachers devoted different proportions of time to academic presentation, but also because the number of days per topic ranged from 5 to 12.) What is immediately salient here is the low incidence of percent time in components of scientific literacy other than explaining content. There were three teachers (2, 5, and 8) who devoted 100% of their academic presentation time to explaining content only. Three other teachers (3, 6, and 7) had no more than 1 percent of their academic presentation time devoted to any of the relating components. Four other teachers (4, 9, 10, and 11) had relatively small percentages for relating components ranging from 3 to 6. Only one teacher, Teacher 1, had a relatively substantial percentage of time devoted to the relating components--a total of 14 percent.

[Insert Table 5 about here]

At this point, it is worth pausing to consider just what Teacher 1 was doing so differently from other teachers. The narrative records for this teacher indicate that she began her 10-day unit on the topic of "Genetics" by talking about people's ideas of spontaneous generation prior to the 1800's and Louis Pasteur's experiments that discredited these ideas. In the course of this historical overview, the teacher also made explicit reference to scientific experiments and their properties, including hypothesis formation. In short, most of the time devoted to relating components was accumulated during this one presentation on the first topic day and coded under relating to science as a social historical process and relating to science as a reasoning process. There were five other days during the topic where this teacher made brief use of some relating components. The most notable of these was Day 5, when the teacher spent three minutes asking students to hypothesize how planaria regenerate, and this was coded under relating to

Table 5. Average Percent of Teacher Academic Presentation Time Devoted to Five Components of Scientific Literacy During the First Topic.

TEACHER:	1 N=10*	2 N=8	3 N=7	4 N=9	5 N=7	6 N=7	7 N=10	8 N=5	9 N=10	10 N=11	11 N=4	TOTAL AVERAGE
Explaining Content	86 (112)	100 (9)	99 (59.5)	95 (127)	100 (39)	99 (110)	99 (225.3)	100 (90)	94 (146)	98 (245.8)	95 (74.5)	96.8
Relating to Science as a Social Historical Process	7 (8.5)		1 (0.5)	1 (2)						2 (3.8)	1 (.5)	1.1
Relating to Science as a Reasoning Process	5 (7.0)			4 (5)			1 (1)			<1 (.5)	4 (3)	1.4
Relating to Science and Society/Tech						1 (1)			1 (2)			0.2
Positive Attitudes Towards Science	2 (2.5)								5 (8)			0.6

*Note: The given N's are the number of days for which data were collected.

science as a reasoning process. There were four days during the topic when the teacher did nothing in areas other than explaining content. Also, it should be noted that this teacher never did any relating of science to society and technology. What is important about this example is that the kind of relating this teacher did sounds so unremarkable-- and yet this teacher was quite atypical in this sample. It also should be noted that just because this teacher spent a relatively large amount of time going beyond content, this gives no indication of the quality of her relating to other areas of scientific literacy. The quality of time use for scientific literacy is an independent issue being considered in this study. Teacher 1, in fact, was generally rated by the observer as doing a "moderately effective"--meaning "average"--job of using the scientific literacy components.

While all the data from this study are still not summarized, initial results from the first topic observations on teachers' use of the components of scientific literacy present a bleak picture. If our sample is at all representative--or even if it represents teachers that tend toward being better than average (which is likely with a sample of volunteers)--it appears that seventh grade life science teachers rarely or never go beyond explaining content by trying to relate the content to meaningful concepts--or if they do, they may not do it especially well. Explanations for this state of affairs can only be speculative now. One possibility is that teachers may be aware of the relating components of scientific literacy but feel they are unable to find the time to use them. There is some evidence for this in the case studies reported by Olson and Russell (1983), where teachers cited time pressure as a major factor in preventing them from addressing the relationship between science and society. Of course, one retort to this is the position that the amount of time spent addressing the relating components of scientific literacy need not be very great nor need all the components be addressed--increments of one minute on one component would appear to be important given these data. Also, it seems that the amount of nonacademic time (procedural or "other") being spent by most teachers (see Table 4) could be trimmed to permit more time for addressing scientific literacy.

Another possible explanation for the bleak results is that many teachers may simply not have a framework of scientific literacy in their minds that approximates that held by the scientific community at large. Indirect evidence on this possibility comes from interviews with 40 science teachers at the high school level (Guthrie, Leventhal, Mergendoller, & Kauchak, 1984). These data indicate that only a small percentage of teachers were unable to articulate a definition of scientific literacy given prompting. The remaining teachers articulated some reasonable definition either with or without prompting. This majority of teachers also cited time pressure to cover specified content as the reason they did not actually use the notions of scientific literacy in their classrooms. A study by Mallette (1980) also is applicable. Here, findings suggest that while teachers perceived a multidimensional definition of scientific literacy, they did not value the non-knowledge components of this definition as greatly as science educators. These works suggest, then, that there is an implementation chasm: most teachers seem aware of scientific literacy but for some reason do not insert it into their daily presentations. More research is needed to understand the nature of this failure, for "time pressure" alone does not seem to be a sufficient reason.

Conclusion

The initial results of this study indicate that the participating life science teachers generally used a typical pattern of academic modes of instruction, relying heavily on recitation, seatwork, and laboratory exercises. When teachers presented academic information to the entire class, largely through recitation, they rarely, if ever, made explicit reference to the historical, reasoning, social, or attitudinal implications of the subject matter. Given this prelude, several questions seem of particular interest for the final analyses. First, there is the question of whether the observation data from the second topic will yield patterns approximating those from the first. Second, it will be interesting to determine whether or not students' curriculum use and actual work assignments also reflect a lack of emphasis on the relating components of scientific literacy. Third, given a very low incidence of using relating components, it will be interesting to see whether even a minimal use of these components accounts for any differences in student outcomes among teachers. Whatever the answers, we feel the final results of this study will provide important guidance for improving the current state of life science instruction at the intermediate level.

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