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ABSTRACT

An evaluation of the elementary school science programing of KCTS-TV in Seattle took the form of a survey and an experiment. First, a survey of classroom teachers to determine the utilization of televised science instruction showed that KCTS's programs were being widely used and were considered to be both appropriate for the grade one to four level and effective in teaching science. Second, an experiment was devised to test the effect of televised science instruction on student achievement and teacher classroom behavior. Neither pupils nor teachers using television achieved significantly better than controls, but patterns of teaching and of asking questions appeared to alter with television use. Recommendations for changes and further research are made. (RB)

KCTS TELEVISION SCIENCE

AN EVALUATION

REPORT

- TO -

KCTS-TV, CHANNEL 9, SEATTLE

AND

COOPERATING SCHOOL DISTRICTS

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PREFACE

This report is the result of an analysis and evaluation of the elementary school science programming of KCTS-TV, Channel 9, Seattle. It is written in the hope that it will be of use to the television station and its personnel; to those districts using or considering the use of televised science instruction as a part of their elementary school curriculum; and to the Science Advisory Committee of KCTS-TV as it continues in its on-going responsibilities for planning and evaluating science instruction via educational television for the schools of the area.

The findings are divided into two parts. The first consists of the results of a survey concerning the utilization of televised science instruction in relation to several factors and its perceived effectiveness by classroom teachers. The second part involves the effect of televised science instruction on student achievement and teacher classroom behavior. The conclusions and recommendations are those of the investigators based on the statistical analysis of the data collected, as well as opinions formed during the investigation.

This study and report would not be possible were it not for the help, support, and cooperation of numerous persons and groups. First, the school districts participating in the 1969-70 broadcast program financially supported the project through a supplementary assessment to their regular support

levels. Four of these districts--Edmonds, Highline, Seattle, and Shoreline participated further by providing the classrooms and teachers which were a part of the experimental study. Appreciated were the contributions by the district science coordinators or their designates--Mr. John McAdam, Mr. Charles Hardy, Mr. John Putnam, and Mr. Jerry Bergloff--without whose efforts this project would have been impossible.

Special thanks must go to the fifty-four classroom teachers who volunteered to participate in this research effort. Their willingness to take tests and answer questionnaires, allow classroom visits, and to audio-tape all of their science instruction provided the necessary data from which this study resulted.

The cooperation of the Channel 9 personnel--Miss June Dilworth, the studio teachers, and the Science Advisory Committee were important to the conduct of the investigation.

Most especially however, it was the hard work, both physical and mental, of my two research assistants, Mr. Paul C. Beisenherz and Mr. Jerry L. Tucker that made this evaluation possible. The long hours that they put into this effort resulted in the report that follows, While, as principal investigator, I was responsible for overseeing the effort (and am responsible for any of its shortcomings), it was these two men who really did the work behind this report. It is hoped that through the earning of their doctorates as a result of this study, they will find additional compensation for their superb contributions. It is they who deserve the

thanks and rewards.

To the reader who wishes to delve further into this investigation, the dissertations upon which this report is based can be found in the University of Washington Library.

Seattle
August, 1971

Roger G. Olstad
Professor, Science Education

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Chapter 1

INTRODUCTION

The goals of science instruction in the elementary school are numerous and diverse, but the most widely recognized cultural imperative in the last decade has been the development of the individual's powers of ". . . recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, and deducing and inferring [Educational Policies Commission, 1961]." Virtually all the new elementary school science programs (e.g. AAAS, SCIS, ESS, etc.) have projected a unique combination of conceptual and process elements in their rationale and instructional materials. In most cases, Renner and Ragan's (1968) five essential experiences--observation, measurement, experimentation, interpretation, and prediction--summarize these processes.

The majority of these federally funded school science projects developed as a reaction to sterile, product-centered curricula which promoted science in terms of what Schwab (1961) called "a rhetoric of conclusions." The projects tended to be more flexible, creative, and student-centered than conventional text programs. Evaluation of instructional outcomes of these new programs has been a difficult task. It has been especially difficult to test how well children

hypothesize, plan ways of testing these hypotheses and interpret data because "evaluative criteria to be meaningful, must be in terms of specific behavior changes which are sought [Kuslan and Stone, 1968]."

One major elementary school science curriculum project, the American Association for the Advancement of Science's *Science--A Process Approach (S--APA)*, has utilized a task analytic, behavioral approach to develop, implement, and evaluate its instructional materials. Both the processes and effectiveness of *Science--A Process Approach* have been well established and validated through extensive field testing (Walbesser, 1963, 1965). The influence of the AAAS model for science education has permeated all educational levels (Livermore, 1964; Ayers, 1969; Norris, 1969; and AAAS, 1970).

In summarizing the objectives and potential influence of science education in the elementary school, Kessen (1964) reminded us that:

> Science is more than a body of facts, a collection of principles, and a set of machines for measurement; it is a structured and directed way of asking and answering questions . . . . The procedures of scientific enquiry, learned not as a cannon of rules but as ways of finding answers, can be applied without limit. The well-taught child will approach human behavior and social structure and the claims of authority with the same spirit of alert skepticism that he adopts toward scientific theories. It is here that the future citizen who will not become a scientist will learn that science is not memory or magic but rather a disciplined form of human curiosity.

Since 1966, the Seattle educational television facility (KCTS-TV, Channel 9) has developed and broadcast weekly

elementary school science programs with this objective in mind, basing its curriculum, in part, on the AAAS process approach. Programs for grades one and two, "First Look at Science" and "Second Look at Science" were organized around five units: Observation, Measurement, Classification, Interpretation, and Prediction. The third and fourth grade series, "Developing Science Concepts" and "Continuing Science Concepts" were designed to use the science processes--introduced in grades one and two--to develop the basic science concepts of matter, energy, change, continuity, and interdependence (Odman and Gilman, 1969).

Although the KCTS elementary science programs were organized and taught by a team of four experienced teachers knowledgeable in the conceptual and process components of science, the effectiveness of this mediated instruction in enhancing the scientific literacy of elementary teachers and children remains unknown. Informal feedback was obtained from participating classroom teachers utilizing the series during formative and trial phases of each grade-level program, but "hard" experimental evidence of effectiveness is non-existent.

Past research on instructional television has not been particularly helpful either, as Chu and Schramm pointed out in 1967:

> . . . we have hundreds of comparisons, usually involving on the one hand the best a system can put together in teachers, visual resources, and careful preparation, all presented on the television screen, and on the other hand, often ordinary class-

> room practice, ordinary teachers, and ordinary teaching aids . . . yet the predominant finding is no significant difference.

The key to the continual findings of "non-significant differences" in comparative effectiveness television research may be in our conception of instructional television as something considerably different from ordinary classroom teaching and in research's failure to determine the influence of television broadcasts in terms of their integration into the total classroom experience by the teacher.

In the elementary school the most important individual in the student's environment is the teacher. How the teacher selects, interprets, and extends television lessons will determine to a large degree, the quality of learning and the degree to which the objectives of television instruction are achieved. "The most important research on instructional television now . . . is research in the total process of which television is a part [Schramm, 1962]."

For the present study, a number of questions merit investigation:

1. What is the effect of the KCTS elementary school science programs on teacher and student competence in basic science processes?
2. What is the effect of instruction in science processes via television on teacher classroom behavior?
3. What is the relationship of teacher background and competence in science processes to their behavior

in utilizing the television science programs?

4. Under what conditions does television instruction in science produce the greatest gains in teacher and student process achievement and teacher classroom behavior related to science processes?

Purpose of the Study

Phase I of the project consisted of the preparation, dissemination, and analysis of responses to a 68-item KCTS "Elementary Science Survey" sent to all teachers in 28 districts in the State of Washington participating in KCTS programming. A 65 percent return (N = 2005) provided needed information on the utilization and *perceived* effectiveness of KCTS-TV science, and served as base-line data for Phase II of the project.

In the autumn of 1969, the second phase was initiated to experimentally determine the effectiveness of the KCTS-TV science programs in the schools. This investigation was concerned with the effect of KCTS-TV science, grades 1-4, on classroom teacher process questioning and teacher and student process skill achievement; and on the quality of teacher questions as they relate to a proposed model of science instruction. Fifty-four teachers and 1500 students from four metropolitan Seattle school districts representing grades 1-4 constituted the population.

Implications of the Study

This study should provide information from which curricular decisions may be made by KCTS-TV to maximize the influence of science instruction via television for developing crucial inquiry processes of elementary school children and their teachers. More importantly however, new avenues for research on the evaluation of process skill development in children, the uses of questions in science instructions, and the role of television for inservice teacher education will also be opened.

Chapter 2

UTILIZATION AND EVALUATION SURVEY

Licensed and operated by the University of Washington, educational television station KCTS-TV began its broadcast schedule in 1955 as a joint venture with other educational institutions in the Pacific Northwest. It presently offers some 40 separate television series to elementary and secondary schools throughout central and western Washington. Programs related to art, language arts, music, mathematics, and science are included in the KCTS curriculum. Approximately 66 school districts participate each year in KCTS programming through direct financial support and by representation on various KCTS curriculum advisory committees such as the Science Advisory Committee.

KCTS Science Series, Grades 1-4

Beginning in 1966, KCTS began a sequential development of four distinct science series, grades 1-4. Teachers from local districts were interviewed for the positions of television (studio) teachers by the Science Advisory Committee. Four teachers with elementary school teaching experience and an interest in science teaching were selected by the committee.

Under the guidance of the committee, these teachers

were responsible for developing the scope and sequence of each science series, preparing scripts, necessary visuals, and for teaching component lessons. In all cases, the lessons were taught by a team of at least two of the four studio teachers. Within each grade level series, 15-minute weekly broadcasts were programmed for the entire school year. Each lesson was broadcast three times during the week for which it was scheduled in order to provide flexibility in its usage by classroom teachers. The lessons from each series were organized around five basic units. Selected process skills--observation, measurement, interpretation, generalization, and prediction--as identified by the American Association for the Advancement of Science (AAAS) *Science--A Process Approach* formed the primary emphasis in grades one and two. A conceptual schemes approach, as typified by the textbook series, *Concepts in Science* (Harcourt, Brace and World) was utilized by grades three and four. Units on matter, energy, change, continuity, and interdependence provided the structure for these grades.

During the 1966-1967 broadcast period, each of the above units was preceded by a special in-service broadcast which outlined the major concepts, method of instruction, and suggested follow-up activities for use during the unit. Due to lack of teacher interest, these in-service lessons were discontinued after the second year of their use.

The format of each regular TV science lesson typically includes the following elements:

1. Problematic situations presented through demonstrations, slides, and other visuals designed to introduce, develop, and extend key concepts and processes emphasized in the lessons.
2. Questioning for soliciting active student and teacher response to the demonstrations and problems presented. A period of silence followed most studio teacher questions, thus facilitating classroom participation.
3. Suggestions for follow-up activities related to the main concepts and processes developed in current and subsequent lessons, thus providing continuity within the unit.

A *Teacher's Guide* was developed by the TV teachers to accompany each series. The guide identified key objectives, appropriate classroom materials, and supplementary activities (Investigations This Week) that could be used by the classroom teacher to extend and reinforce concepts and process skills emphasized in the lesson.

Television Science Phase I Evaluation

In the spring of 1969, the KCTS-TV Science Advisory Committee initiated a two-phased evaluation of the effectiveness of TV science in the schools, grades 1-4, under the direction of Dr. Roger G. Olstad of the College of Education

at the University of Washington. Financial support for the project was provided by KCTS from a supplementary assessment of three cents per pupil in each district participating in the 1969-1970 broadcast program. Field work was carried out by Mr. Paul C. Beisenherz and Mr. Jerry L. Tucker, research assistants in science education. These investigators worked closely with television representatives and science coordinators in participating school districts.

Procedure

Phase I of the evaluation consisted of a survey to determine the degree of utilization of TV science in the KCTS broadcast area. A questionnaire was developed by the investigators that focused on utilization, technical quality of programming, pedagogical design of broadcasts, perceived effectiveness of TV science instruction, and the background and experience of teachers as related to science instruction.

During April, 1969, questionnaires were distributed to all teachers, grades 1-4, within each participating school district through either the district television representative or superintendent's office. Approximately 65% (N = 2005) of the teachers sampled returned completed questionnaires.

Data were coded, and processed through a Bio-Med 02D program at the University of Washington Computer Center. Summaries of responses to all 68 items, and correlations between selected variables in the questionnaire were obtained.

The number of questionnaires returned from each district participating in this survey are presented in Table 2.1.

Results

The summary data obtained were classified into five main areas: teacher background, organization of science instruction, responsibility for teaching science, utilization of the KCTS science series, and perceived effectiveness of televised science. Tables 2.2-2.6 summarize these findings.

Teacher Background Factors. Teachers responding to the Phase I survey were generally evenly distributed across the four grade levels and the five levels of teaching experience surveyed. The grade level distribution (Table 2.2) varied between 28.6% at grade one to 22.1% at grade four. A noticeable difference (11.9%) was observed in the number of teachers found in the 11-15 years of experience category. Approximately 90% of all teachers reported having earned no more than 15 credits in either the physical or life sciences. Table 2.2 summarizes data concerning teacher factors.

Organization of Science Instruction. In assessing the existing organization of science instruction in the viewing area, it was found that even though 120 teachers reported using the new elementary school science programs (e.g. AAAS, SCIS, ESS, etc.) most were utilizing either text-based curricula, district produced units, or self-generated teaching

Table 2.1

Number of Questionnaires Returned from
Each District Participating
in the Phase I Survey

District	Number Returned	District	Number Returned
Anacortes	27	North Kitsap	7
Auburn	86	Northshore	85
Bremerton	32	Pasco	55
Burlington	27	Raymond	7
Edmonds	282	Renton	119
Enumclaw	33	Richland	59
Ephrata	11	Seattle	578
Federal Way	117	Shoreline	105
Highline	262	Snoqualmie	21
Issaquah	52	South Central	27
Lake Washington	76	South Kitsap	50
Lower Snoqualmie	3	Tahoma	14
Mercer Island	40	West Valley	20
Napavine	2	Zillah	8

Total N = 2005

Table 2.2

Teacher Background Factors

Background Factors	Number of Responses	Percent of Responses
a. Grade Level (Item 3)		
1	618	28.6
2	554	25.6
3	514	23.7
4	479	22.1
Total	2165	100.0
b. Years Teaching Experience (Item 5)		
< 3	526	24.0
3-5	487	22.3
6-10	377	17.2
11-15	260	11.9
>15	539	24.6
Total	2189	100.0
c. Credits Earned in Physical Sciences (Item 6A)		
< 6	898	43.7
15	940	45.7
30	161	7.8
45	30	1.5
>45	27	1.3
Total	2056	100.0
d. Credits Earned in Life Sciences (Item 6B)		
< 6	1194	61.6
15	609	31.4
30	99	5.1
45	22	1.1
>45	16	.8
Total	1940	100.0

materials, as indicated in Table 2.3. Self-generated materials appeared to be the most common method of organizing for science instruction. Only 2.3% reported teaching no formal science at all.

Of those teaching science, 70% devoted from one-half hour to two hours weekly in providing formal science experience for their pupils.

Responsibility for Science Instruction. Data found in Table 2.4 revealed that nearly all (94.8%) of the science instruction in elementary schools was provided by the individual teacher in a self-contained classroom. Team teaching and the use of science specialists and district science coordinators in presenting science lessons was minimal. However, approximately 50% of the teachers reported to have had some contact with a district science specialist. Most of this assistance (60%) was provided through either planned workshops or science materials distributed to individual classrooms.

Utilization of KCTS Television, Grades 1-4. Table 2.5 shows that approximately equal proportions of teachers (16.6% to 22%) viewed three or less of the televised series--science, art, music, etc. Twenty percent reported that they had utilized more than three series during the 1968-1969 school year. In terms of the televised science series, grades 1-4, data in Table 2.5 indicated that a greater proportion of grades one and two classrooms utilized the science series during the 1968-1969 school year.

Table 2.3

Organization of Science Instruction

Variable	Number of Responses	Percent of Responses
a. Usage of Various Programs in Elementary Science (Items 7, 8)		
Text Programs	2308	92.7
AAAS	78	3.1
ESS	29	1.2
SCIS	11	.4
MINNEMAST	2	.1
Other	62	2.5
Total . . .	2490	100.0
b. Local Development of Science Materials (Item 9)		
District Kits	630	25.2
Self-Generated Units .	1581	63.4
No Special Unit . . .	228	9.1
No Science	58	2.3
Total . . .	2497	100.0
c. Amount of Time Spent with Organized and Planned Science Instruction per Week (Item 14)		
One-half Hour or Less	326	15.3
One-half to 1 Hour . .	713	33.5
1 to 2 Hours	774	36.4
2 to 3 Hours	261	12.3
Over 3 Hours	55	2.5
Total	2129	100.0

Table 2.4

Responsibility for Science Instruction

Variable	Number of Responses	Percent of Responses
a. Assignment of Responsibility for Science Instruction in Particular Elementary School (Item 12)		
Self-Contained	2051	94.8
Team Member	58	2.7
Special Science Teacher	39	1.8
District Specialist .	10	.5
Other	5	.2
Total . . .	2163	100.0
b. Perceived Assistance Provided by Science Specialist (Item 11)		
Class Demonstration .	86	8.0
Individual Conference	108	10.0
Workshops	236	21.9
Visitation	104	9.7
Materials	413	38.4
Other	129	12.0
Total . . .	1076	100.0

Table 2.5

Utilization of KCTS Television, Grades 1-4

Variable	Number of Responses	Percent of Responses
a. Usage of All KCTS-TV Elementary School Series (Item 13)		
Number of Series Used		
None	354	16.6
1	413	19.4
2	463	21.7
3	472	22.1
4	269	12.6
5	163	7.6
Total . . .	2134	100.0
b. Usage of KCTS-TV Science Series, Grades 1-4 (Item 18) During the 1968-1969 School Year		
Grade Level Series		
1	370	32.4
2	337	29.5
3	233	20.4
4	202	17.7
Total . . .	1142	100.0

Perceived Effectiveness of the Televised Science Instruction. One of the most crucial questions addressed by this survey was the degree to which KCTS-TV science was thought to be effective by teachers utilizing it in their classrooms. Of the 1057 teachers reported to have watched one of the series during the 1968-1969 school year, nearly 80% indicated that the level of TV lesson difficulty was satisfactory as compared with the ability of their pupils (see Table 2.6). Only about 10% felt the lessons were overly difficult. Data provided in Table 2.6 indicated that KCTS science was believed to be ineffective in meeting the individual teacher's own instructional objectives by 9.5% of the respondents. Yet over 80% felt KCTS-TV science had stimulated and interested them in teaching science in general.

Although over 50% of the teachers presently using the TV science series believed the KCTS series moderately improved their science content background and skills in teaching science, 25% felt that very little improvement in these areas could be attributed to the televised science series.

Correlational Data

Prior to this survey, the investigators suspected that certain positive relationships existed between the amount of time spent with TV science, proportion of broadcasts used, usage of TV Guide, availability of classroom materials to supplement TV science, and other key factors such as teacher background, ability level of pupils, perceived effectiveness,

Table 2.6

Perceived Effectiveness of the Televised Science Instruction

Variable	Number of Responses	Percent of Responses
a. Level of Difficulty of KCTS Science Lessons When Compared to Ability Level of Pupils (Item 25)		
TV Lessons Difficult .	111	10.5
Lessons Satisfactory .	825	78.1
Lessons Too Easy . .	53	5.0
Uncertain	68	6.4
Total . . .	1057	100.0
b. Effectiveness of KCTS Science Series in Meeting Instructional Objectives of the Classroom Teacher (Item 26)		
Ineffective	102	9.5
Satisfactory	685	63.9
Highly Effective . . .	144	13.4
Uncertain	141	13.2
Total . . .	1072	100.0
c. Degree to Which KCTS Science Series Stimulated and Interested the Classroom Teacher in Teaching Science (Item 27)		
Very Little	177	16.3
Moderate	672	61.8
Highly	204	18.7
Uncertain	35	3.2
Total . . .	1088	100.0

Table 2.6 (continued)

Variable	Number of Responses	Percent of Responses
d. Degree to Which KCTS Science Series Developed and Improved the Classroom Teacher's Skills in Teaching Science (Item 28)		
Very Little	256	23.8
Moderate	635	58.9
Highly	129	11.9
Uncertain	58	5.4
Total . . .	1078	100.0
e. Degree to Which KCTS Science Series Improved the Classroom Teacher's Knowledge Background in Science (Item 29)		
Significantly Improved	144	13.4
Somewhat Improved . .	608	56.6
Little Improvement . .	271	25.2
Uncertain	51	4.8
Total . . .	1074	100.0

and the use of science specialists within the schools. Table 2.7 consists of the variables selected for correlation, the number of cases involved in the correlation, and the coefficients obtained in each case.

Statistical tests of significance for these correlations, also reported in Table 2.7, were determined through the use of Fisher's z transformation (Weiner, 1962). Confidence limits were established for each "r" distribution at the .01 level and in cases where calculated confidence intervals included zero, correlations were considered non-significant. As can be seen, a number of factors correlated significantly, thus providing the investigators an indication of potential key factors in the use of KCTS-TV programming. Of the 24 correlations found in Table 2.7, 15 were significant at the .01 level.

These data suggested that teachers reporting to spend the greatest amount of time with "planned" science instruction, devoted most of that time to KCTS-TV science (.14), used the KCTS *Teacher's Guide* frequently (.22), and provided regular television follow-up experiences for their students (.15). This use of KCTS-TV science was also significantly and positively related to the degree teachers felt KCTS-TV science was effective in meeting the teacher's own instructional objectives (.26) and improving their interest (.21), teaching skills (.16), and background information (.10) for teaching science.

It was concluded from these correlations, that

Table 2.7

Correlations Between Selected Variables
in the KCTS Phase I Survey

Variable	Variable	Cases	"r"
1. Proportion of Total Science Instruction Devoted to TV Science	Grade Level	2016	-.159*
	Age of Teacher	2012	.139*
	Years Teaching Experience	2036	.133*
	Credits Physical Sciences	1913	.009
	Credits Life Sciences	1815	.004
	Use Science Specialist	1995	.011
	Time in "Planned" Science	2035	.140*
2. Proportion of TV Science Broadcasts Used	Amount of TV Guide	1029	.222*
	Parts of TV Lesson Used	1037	.149*
	Number Children Viewing	830	.029
	Ability Level of Children	1008	.063
	Difficulty of TV Compared to Children's Ability	948	.100*
	Effectiveness of TV Meeting Teacher Objectives	890	.259*
	Effectiveness of TV: Teacher Interest	1012	.206*
	Effectiveness of TV: Teacher Skills	980	.161*
	Effectiveness of TV: Teacher Knowledge	982	.098*
3. Proportion of Time TV Guide Used	Number Children Viewing	815	.079
	Ability Level	1001	.038
	Difficulty of TV Compared to Children's Ability	942	.015
	Effectiveness of TV Meeting Teacher Objectives	884	.157*
	Effectiveness of TV: Teacher Interest	996	.267*
	Effectiveness of TV: Teacher Skills	970	.276*
	Effectiveness of TV: Teacher Knowledge	978	.156*
4. Lack of Materials for TV Science	Use of Science Specialist	293	.027

*significant .01 level

elementary school teachers' perceptions of KCTS-TV science's effectiveness were directly related to the degree they utilized this form of instruction in their classrooms.

Conclusions

It would appear from the KCTS Elementary School Science Survey that the experience and educational background in science of the 2005 teachers responding to the Phase I survey were consistent with that reported in the literature (Victor, 1961; Dunfee, 1967). It is also evident that few of the teachers were formally involved with such "new" curricular programs in elementary school science as the AAAS, ESS, or SCIS.

This survey pointed out that not only were the KCTS science programs being used by a sizeable proportion of the teachers sampled, but they were also perceived to be generally effective and appropriate to science objectives held by these teachers. Of the relatively high proportion of teachers (42%) using the KCTS-TV science series, grades 1-4, during the 1969-1970 school year, 57% reported watching all or nearly all of the weekly broadcasts. A majority also reported that KCTS-TV science had stimulated and interested them in teaching science, improved their skills in teaching science, and upgraded their science background knowledge.

Correlations between selected teacher background factors and KCTS effectiveness, as perceived by the classroom teachers, indicated that, in general, older, more experienced

teachers of first and second grade children were more likely to use KCTS-TV science. Younger, less experienced teachers teaching third and fourth graders watched television science the least.

Although these significant correlations indicated the existence of important relationships between television utilization and the teachers' perceptions of its effectiveness in the classroom, no causal relationships could be ascertained from this phase of the KCTS-TV science evaluation.

As a result of this survey and the desire of the KCTS Science Advisory Committee to obtain more substantial evidence of the impact of the science series in the classroom, a Phase II research study was designed to assess the effectiveness of the televised science instruction under more controlled conditions.

Chapter 3

THE EXPERIMENTAL STUDY

Introduction

Throughout the past century, numerous science educators have reiterated the importance of improving the individual's "ways of knowing." The last decade has seen the emergence of several new elementary school science curricula devoted to this task. The most prominent of these, *Science--A Process Approach (S--APA)*, Science Curriculum Improvement Study (SCIS), and the Elementary Science Study (ESS), have each presented unique combinations of conceptual and process elements in their rationale and materials. One common thread, an unmistakable emphasis on developing childrens' proficiency in the processes used by scientists to generate new knowledge--observation, measurement, experimentation, interpretation, prediction, etc.,--has been common to all of these programs.

In reviewing past research related to this investigation, the literature in five major areas was examined: instructional television, classroom questioning behavior, science process skill development, strategies of instruction, and the nature of the scientific enterprise.

From a review of the literature on science processes it was found that process skills and strategies of

instruction inherent in the new elementary school science programs (AAAS: *S--APA*, SCIS, and ESS) appeared to be generally comparable to those described by Robinson (1968) as used by scientists in verifying new constructs, and analogous to those implicit in the three stages of Piagetian equilibration. A number of studies reviewed demonstrated the efficacy of these curricula in enhancing several dimensions of intellectual development.

The literature on instructional television indicated that most efforts to assess the effectiveness of television instruction had been descriptive. Results generated from many "comparative effectiveness" designs have been frequently uninterpretable because of faulty designs or the use of an inappropriate conception of television effectiveness research--the failure to examine the way television was integrated into the classroom by the teacher. Of the three major generalizations to emerge from research on the use of TV instruction in elementary school science, the most pertinent finding was that television had been more effective when the television lessons were supplemented by good preview and follow-up experiences in the classroom. Although some research had demonstrated the influence of the type of preview and follow-up instruction on achievement and interest, few investigators have studied the quality of these integrative efforts as indicated by teacher questioning behavior.

Since questioning has long been considered one of the most important dimensions of teaching, the contributions of

past research in this area were reviewed with the potential application such research might have to the problem of teacher utilization of television science instruction. Three generalizations emerged:

1. Over time, and across all grade levels, teachers have tended to ask very high proportions of questions requiring little more than recall operations.
2. While specific lesson content has often influenced the type of questions teachers ask, considerable individual variation in questioning skill has been found between teachers.
3. Direct training in questioning and the use of AAAS: *S--APA*, SCIS, and ESS materials by teachers have proven effective in reducing the inordinately high proportions of recall questions in the classroom.

Even though research in questioning has been on the upswing since 1950, few studies have assessed the science questions teachers ask, the strategies used in questioning in science, or the quality of questioning employed as teachers integrate mediated science instruction into their regular program.

Because of similarities between scripts found in the KCTS science series and the "new" elementary school science programs, it appeared reasonable to expect similar differences in questioning behavior from both studio (TV) and classroom teachers using the TV science series.

It was hoped that an experimentally controlled investigation would provide crucial information on the manner in which classroom teachers integrate television science lessons into their classrooms. The most viable and potentially significant direction for this study appeared to be the assessment of KCTS-TV science effectiveness on classroom verbal behavior through an analysis of the questioning strategies studio teachers and classroom teachers followed in science.

Research Hypotheses

Based on the review of the literature and a thorough study of KCTS-TV science programming, the following 14 research hypotheses were investigated:

1. The four treatment groups and the four grade levels within each treatment group will not differ significantly in the mean gain scores on the "Teacher Process Test," the "Teacher Content Test," and the *Test on Understanding Science (TOUS)*.

2. The four treatment groups and the four grade levels within each treatment group will not differ significantly in the mean gain scores on the "Picture Test for Science Processes, Grades 1 and 2," the "Picture Test for Science Processes, Grades 3 and 4," and the "Science Concept Test, Grades 3 and 4."

3. On the basis of the lessons selected involving televised science instruction, scripts of television lessons directed to pupils in each of the four grade levels will not differ significantly in the proportion of the types of questions asked in each of the four phases of the instructional strategy (Exploration, Invention, Discovery, and Review).

4. On the basis of the lessons selected during the treatment period, the four treatment groups will not differ significantly in the proportion of

questions asked in each of the six categories of the modified Gallagher-Aschner system.

5. On the basis of the lessons selected from grades three and four involving televised science instruction, the three treatment groups utilizing TV science instruction will not differ significantly in the proportion of the types of questions asked in each of the four phases of the instructional strategy (Exploration, Invention, Discovery, and Reveiw).

6. On the basis of the lessons selected from the treatment period, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the Science Process Questions Inventory (SPQI).

7. On the basis of the lessons selected during the treatment period, the four treatment groups will not differ significantly in the proportion of the types of questions asked in each of the three categories of science lessons (Pre-TV, Post-TV, and Non-TV).

8. On the basis of the lessons selected from the treatment period, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the SPQI in each of the contexts in which they are asked; Pre-TV, TV, Post-TV, and Non-TV.

9. On the basis of the analysis of lessons from the *Mystery Powders* unit, the four treatment groups will not differ significantly in the proportion of questions asked in each of the six categories of the modified Gallagher-Aschner system.

10. On the basis of lessons from the post-treatment *Mystery Powders* unit, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the SPQI.

11. On the basis of the lessons analyzed, there will be no significant differences among treatment groups between the proportion of the types of questions asked by the classroom teachers during the treatment period and the proportion of the types of questions asked by the classroom teachers during the *Mystery Powders* unit.

12. On the basis of the lessons selected for analysis, there will be no significant differences between the question types utilized by teachers in the four treatment groups during the treatment period and the questions asked during the post-treatment period.

13. On the basis of the lessons selected during the treatment period, there will be no significant correlations between the proportion of the types of questions asked by the classroom teachers (as categorized with the Gallagher-Aschner system) in each of the four treatment groups *and* the following variables:
    a. Total number of years of teaching experience;
    b. Total number of semester hours in science;
    c. Gain scores on the "Teacher Process Test;"
    d. Gain scores on the "Teacher Content Test;"
    e. Gain scores on the *Test on Understanding Science (TOUS);*
    f. Mean gain scores on the "Picture Test for Science Processes, Grades 1 and 2, and Grades 3 and 4;"
    g. Mean gain scores on the "Science Concept Test, Grades 3 and 4."

14. On the basis of the lessons selected from the treatment period, there will be no significant correlations between the proportion of process questions used by the classroom teachers (as categorized with the SPQI) in the four treatment groups *and* the following variables:
    a. Years of teaching experience;
    b. Number of college credits in science;
    c. Gain scores on the "Teacher Process Test," "Teacher Content Test," and *Test on Understanding Science (TOUS);*
    d. Mean gain scores of their students on the "Picture Tests for Science Processes, Grades 1 and 2, and Grades 3 and 4."

Design of the Study

The basic design selected for the KCTS Phase II evaluation was a factorial design which provided four treatment variables representing four degrees of utilization of TV science and Non-TV science, and four grade levels. The

selection of this design provided an opportunity to determine overall effects due to treatment, grade level, and interactions between treatment and grade level. The KCTS Phase II Time-table (page 32) summarizes the events of the investigation discussed below.

To determine the effectiveness of television science under various levels of utilization, 54 teachers volunteered to participate in the research project. These teachers and their intact classes were randomly assigned to the following treatment groups by grade level within each school district:

I. Television--Ideal Conditions. Teachers utilized television science instruction only, with prescribed sets of supplies necessary for preview and follow-up activities provided by the district coordinator.

II. Television--Regular Conditions, and District Science. Teachers utilized television science with materials and supplies normally available in their building, in addition to the district program. No provision was made by the district coordinator for special supplies necessary for supplementing television lessons.

III. Television--Regular Conditions Only. Teachers utilized television science with materials and supplies normally available in their building. No provision was made by the district coordinator for special supplies necessary for

Table 3.1

Timetable of Events for Phase II

	Dates				
	November 23-December 4	December 1-December 16	January 5-April 7	April 13-24 (Teachers) April 24-May 8 (Pupils)	April 27-May 1
	Sequence of Events				
Selection of Teachers and Pupils	Orientation of Teachers Assignment of Teachers to Treatment Groups Pre-Test Period: Teachers	Pre-Test Period: Pupils	Treatment Period	Post-Test Period: Teachers and Pupils	Post-Treatment Period
	Evaluative Measures				
	Teacher Process Test Teacher Content Test *Test on Understanding of Science (TOUS)*	Picture Test Science Proc.--Grades 1 & 2 Picture Test Science Proc.--Grades 3 & 4 Science Concept Test, Grades 3 & 4	Audio-Tape Recordings Made by All Teachers of Science Taught During Treatment Period	Same Tests Administered as in Pre-Test Periods: Teachers and Pupils Teacher Questionnaire Administered to all Teachers	Audio-Tape Recordings Made by All Teachers of All Lessons Taught During *Mystery Powders* Unit

supplementing television lessons.

IV. Regular District Science Only. No utilization of television science was permitted for any teacher in this group. These teachers taught science from the regular district science program. Materials were provided from district personnel, only on request from the teacher.

While Treatment Groups II and III utilized instructional television in classroom environments similar to those found in elementary school classrooms throughout the KCTS broadcast area which use television, Treatment Group I attempted to provide an environment conducive to maximum utilization of the televised science series.

In addition to the use of television, classroom teachers in Treatment Group II had the option of teaching additional "Non-TV" science. Treatment Group IV provided the extreme alternative to television science, and as such, provided a necessary component in the "comparative effectiveness" aspect of the design. For both Treatment Groups II and IV, environments were produced which provided some indication of the classroom teacher's interpretation and utilization of the school district's science program for his grade level.

During the treatment period from January 5-April 7, 1970, each of the 54 teachers taught science according to the parameters of the treatment groups to which he was randomly assigned. Teachers in Groups I, II, and III watched two KCTS-TV science units broadcast for their grade level:

Classification and *Interpretation* for grades one and two, and *Change* and *Continuity* for grades three and four. Group IV teachers taught regular lessons from the various district science curricula during this time.

In accordance with the pre-test, post-test design selected for the study, all teachers and students were tested for conceptual and process skill achievement prior to and following the treatment period with instruments designed for the study. Teacher understanding of the nature of science was also determined with the *Test on Understanding Science (TOUS)*.

To obtain the information needed from the analysis of the questioning behavior of the studio (TV) and classroom teachers, a multiple-category system was used. All questions asked by studio and classroom teachers were categorized into the following systems:

1. A modified Gallagher-Aschner system which included the categories, routine, memory, observation, convergent, divergent, and evaluative.
2. The Science Process Questions Inventory (SPQI) which included the categories of observation, measurement, classification, experimentation, prediction, recall, and miscellaneous.
3. The Science Lesson Category System (SLCS) which included the categories, Pre-TV, TV, Post-TV, and Non-TV.

Also, all questions asked by studio and grades three and four

classroom teachers utilizing TV science instruction, were categorized into the Instructional Strategy Category System (ISCS), a four-phased system (exploration, invention, discovery, and review) patterned after the instructional strategy found in the Science Curriculum Improvement Study (SCIS). The ISCS evolved from an attempt to identify a model instructional strategy consistent with both exemplary elementary school programs and the nature of the scientific enterprise.

Following the treatment period of 13 weeks, a modified ESS unit, *Mystery Powders*, was used by all teachers to determine the degree of transfer of teacher questioning behavior from the treatment period to the post-treatment period. Tapescripts of teacher questions analyzed for this unit represented a total sample. Each post-treatment question was categorized into both the Gallagher-Aschner system and the SPQI.

The high reliability coefficients obtained between the two investigators and between the investigators and an independent judge indicated that the category systems employed could be used reliably to code questions in this study.

Mean proportions of question types across grade levels, treatment groups, and instructional contexts during and between the treatment period and the post-treatment period, were analyzed. Levels of significance between these proportions were determined by use of Fattu's Nomograph.

During post-testing of teachers, each teacher also

completed a Phase II questionnaire which provided background information, reports of utilization of television programming and support materials during the treatment period, and teacher perceptions of the effectiveness of KCTS-TV science lessons with their students. The relationship of teacher background and teacher-student achievement data to quantitative measures of teacher questioning behavior during the treatment period were obtained by correlational techniques.

Findings and Conclusions

The analysis of concept and process achievement for teachers and pupils, the analysis of understanding the nature of the scientific enterprise, and the analysis of the questioning of teachers in the four treat ent groups are summarized as follows:

> Hypothesis 1. The four treatment groups and the four grade levels within each treatment group will not differ significantly in the mean gain scores on the "Teacher Process Test," the "Teacher Content Test," and the *Test on Understanding Science (TOUS)*.

On the "Teacher Content Test" and the "Teacher Process Test," no significant differences were found in mean gain scores between treatment groups and grade levels. It was concluded that, on the basis of the tests developed by the investigators, teachers using the televised science series achieved no better than teachers utilizing science instruction by other means.

On the *Test on Understanding Science (TOUS)*, significant

differences in means between Treatment Groups I and III, and II and III were found. Because of the particular contrasts found to be significantly different, it was concluded that some factor, probably not the utilization of TV science instruction, was in operation effecting changes in *TOUS* scores.

> Hypothesis 2. The four treatment groups and the four grade levels within each treatment group will not differ significantly in the mean gain scores on the "Picture Test for Science Processes, Grades 1 and 2," the "Picture Test for Science Processes, Grades 3 and 4," and the "Science Concept Test, Grades 3 and 4."

On the "Picture Test for Science Processes, Grades 1 and 2," the "Picture Test for Science Processes, Grades 3 and 4," the "Science Concept Test, Grades 3 and 4," the "Picture Test for Science Processes (TV Unit, Subtest), Grades 1 and 2," and the "Science Concept Test (TV Unit, Subtest), Grades 3 and 4," no significant differences were found in class mean gain scores between treatment groups and grade levels. It was concluded that, on the basis of the tests developed by the investigators, pupils viewing the televised science series achieved no better than pupils receiving science instruction by other means.

Lack of significance for investigator-constructed teacher and pupil tests was attributed, in part, to broadly referenced items included to avoid biasing results in favor of television instruction.

> Hypothesis 3. On the basis of the lessons selected involving televised science instruction, scripts of television lessons directed to pupils

> in each of the four grade levels will not differ significantly in the proportion of the types of questions asked in each of the four phases of the instructional strategy (Exploration, Invention, Discovery, and Review).

While the questioning behavior of studio (TV) teachers remained consistent across grade levels, wide variation in frequencies and proportions of question types existed within and between the four phases of the ISCS. Analysis of the variation in question types revealed, that in comparison to other question types, low proportions of memory and observation questions and high proportions of convergent questions were asked consistently across grade levels. Also found were very low proportions of questions seeking evaluation and divergent responses.

Using the ISCS, high proportions of convergent questions were asked during the exploration and discovery phases at all grade levels. It was concluded that studio (TV) teachers, in asking a significantly higher proportion of convergent questions, pursued different questioning strategies than classroom teachers reported in the literature. Also, it was concluded that TV lessons, especially in grades three and four did conform to the four-phase model instructional strategy patterned after the SCIS.

> Hypothesis 4. On the basis of the lessons selected during the treatment period, the four treatment groups will not differ significantly in the proportion of questions asked in each of the six categories of the modified Gallagher-Aschner system.

Analysis of questions using the Gallagher-Aschner system

revealed that classroom teachers were consistent in the proportions of routine, divergent, and evaluative questions asked across treatment groups and grade levels. Of significance was the finding of consistently high proportions of convergent questions relative to the proportions of questions in the memory category. In addition, it was found that Treatment Groups I and III (TV only) asked significantly higher proportions of convergent questions and a significantly lower proportion of memory questions. It was concluded that some factor, probably TV science instruction, affected classroom teacher questioning behavior in the convergent and memory categories. The finding drawn from Hypothesis 3 of a high proportion of convergent questions asked by studio (TV) teachers suggests the influence of the TV science series on classroom teacher behavior.

> Hypothesis 5. On the basis of the lessons selected from grades three and four involving televised science instruction, the three treatment groups utilizing TV science instruction will not differ significantly in the proportion of the types of questions asked in each of the four phases of the instructional strategy (Exploration, Invention, Discovery, and Review).

Using the Instructional Strategy Category System (ISCS) in the analysis of TV-related questions revealed that 63 percent of these questions asked by classroom teachers in grades three and four were categorized into the discovery phase. During this phase, significantly more convergent questions were asked by teachers in all three treatment groups as compared to other question types. In addition, significantly

higher mean proportions of observation questions were found in the discovery phase. Treatment Group II, which included TV and Non-TV instruction, differed from other treatment groups in the proportions of memory and convergent questions asked in the exploratory and discovery phases. This group asked consistently higher proportions of memory and lower proportions of convergent questions. With the high proportion of convergent questions found in the Post-TV period and the findings reported above, it was concluded that the TV broadcasts and/or the Teacher's Manual had an influence on teacher questioning behavior. In addition, it was concluded that the ISCS provided additional contextual information valuable in identifying teachers' utilization of the TV science series.

> Hypothesis 6. On the basis of the lessons selected from the treatment period, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the Science Process Questions Inventory (SPQI).

In using the SPQI to categorize questions from the treatment period, it was found that about one-third of the questions asked required children to recall information of a non-process nature, and another one-third were designed to elicit "interpretations". While significantly higher levels of recall questions were asked by non-television group teachers (Treatment Groups II and IV), teachers using television under "ideal conditions" (where materials were follow-up activities were provided) asked greater proportions of

observation, experimentation, classification, interpretation, and prediction questions. For classification questions, the other "TV only" group (Treatment III) was also significantly superior to non-television.

The fact that teachers using the district science program only asked observation questions at levels comparable to those in Treatment Group I and significantly greater than teachers in Treatment Groups II and III, emphasized two important things: (1) the observed variability in teacher questioning behavior across treatment groups during the study, and (2) the emphasis placed by several non-television treatment grade one and two teachers on observational skills in their lessons.

In comparing the question proportions of teachers in television groups with those asked by television teachers, it was found that classroom teachers in all three groups asked significantly higher levels of recall and miscellaneous (routine) questions than television teachers. Conversely, television teachers asked significantly greater frequencies of interpretation and prediction questions than all four treatment groups and significantly more classification questions than non-television groups II and IV. Since no statistically significant differences were found between the levels of classification questions asked in TV scripts and by teachers in the "TV only" groups (I and III), it was concluded that "TV only" teachers had been influenced to ask classification questions at levels comparable with the

KCTS-TV science programs.

> Hypothesis 7. On the basis of the lessons selected during the treatment period, the four treatment groups will not differ significantly in the proportion of the types of questions asked in each of the three categories of science lessons (Pre-TV, Post-TV, and Non-TV).

Analysis of questions using the Science Lesson Category System (SLCS) revealed that, of those questions related to TV science instruction, a significantly greater proportion (80 percent) of questions were asked during the Post-TV period in comparison with other periods of the SLCS. Also found was a high degree of variability among teachers in their use of certain question types and SLCS periods. During the Post-TV period, high proportions of convergent questions were asked by Treatment Groups I, II, and III. Also, a significantly higher proportion of observation questions was asked during the Post-TV period by teachers in Treatment Group I. In the Pre-TV period, it was observed that classroom teachers in Treatment Groups I, II, and III asked a significantly higher proportion of memory questions. Significant differences were found between the Post-TV and Non-TV periods in the mean proportions of memory and convergent question categories. It was concluded that TV science instruction affected classroom questioning behavior in terms of the high proportion of TV-related questions categorized as convergent. It was also concluded that differences in questioning patterns existed prior to and following the TV broadcast. Some factor, perhaps the suggested follow-up activities and/or materials

provided teachers in Treatment Group I, led to a higher proportion of observation questions in this treatment group. It was concluded that the SLCS was of considerable value in providing additional context to further analyze the strategies used by teachers in observing the utilization of the TV science series.

> Hypothesis 8. On the basis of the lessons selected from the treatment period, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the SPQI in each of the contexts in which they are asked; Pre-TV, TV, Post-TV, and Non-TV.

In comparing the relative emphasis of each treatment group's process questioning during Pre-TV, Post-TV, and Non-TV instruction, each treatment period question was coded into one of the three categories of the Science Lesson Category System (SLCS). Within each category, significant differences of question proportions between groups were determined. Findings indicated that "TV only" groups previewed television lessons with significantly greater proportions of observation and measurement questions than Non-TV groups, and all television groups followed up lessons with significantly higher proportions of observation, classification, measurement, and prediction questions than Non-TV group teachers. KCTS-TV science was considered to have a significant influence on the use of science process questions by teachers.

> Hypothesis 9. On the basis of the analysis of lessons from the *Mystery Powders* unit, the four treatment groups will not differ significantly in

the proportion of questions asked in each of the six categories of the modified Gallagher-Aschner system.

Using the Gallagher-Aschner system to analyze the post-treatment unit, *Mystery Powders*, consistently higher proportions of observation questions and lower proportions of memory questions across treatment groups and grade levels was found. Also revealed was significantly higher proportions of observation questions asked by Treatment Groups I and II. A significantly lower proportion of observation questions for Treatment Group IV, grades three and four was found. Inspection of *Mystery Powders* typescripts revealed a high degree of pupil involvement with materials from kits provided each teacher. While the use of the *Mystery Powders* unit resulted in high proportion of observation questions, this unit did not produce sufficient variability among question types in order to identify differences between treatment groups.

Hypothesis 10. On the basis of lessons from the post-treatment *Mystery Powders* unit, the four treatment groups will not differ significantly in the proportion of questions categorized by type with the SPQI.

As a measure of the influence of treatment conditions on teacher questioning during subsequent science teaching, each treatment group's question types for the post-treatment *Mystery Powders* unit were compared. While *Mystery Powders* was initially considered especially appropriate for testing Hypothesis 10, statistical differences obtained between treatment group question proportions were non-directional.

It was concluded that although television group teachers asked significantly higher proportions of certain process questions in using television science lessons, either this superiority of questioning did not transfer to *Mystery Powders* instruction, or it was masked by teacher variability. In either case, the nature of *Mystery Powders*, and the availability of materials for teaching it, significantly improved process questioning behaviors of teachers involved in the study.

> Hypothesis 11. On the basis of the lessons analyzed, there will be no significant differences among treatment groups between the proportion of the types of questions asked by the classroom teachers during the treatment period and the proportion of the types of questions asked by the classroom teachers during the *Mystery Powders* unit.

Using the Gallagher-Aschner system to measure transfer of questioning behavior from the treatment period to the post-treatment period, significant differences, consistent for all treatment groups, were found in three question types--memory, observation, and convergent categories. Teachers in Treatment Groups I, II, and III involved in the *Mystery Powders* unit asked significantly lower proportions of memory and convergent questions while asking significantly higher proportions of observation questions than they asked during the treatment period. For Treatment Group IV, no significant difference in the proportion of convergent questions between the treatment and post-treatment periods was found. It was concluded that TV instruction appeared to adversely affect

the proportion of convergent questions asked by teachers utilizing the post-treatment unit, *Mystery Powders*. This conclusion can partially be interpreted by an examination of the nature of the post-treatment unit and the differences existing between this unit and units found during the treatment period.

> Hypothesis 12. On the basis of the lessons selected for analysis, there will be no significant differences between the question types utilized by teachers in the four treatment groups during the treatment period and the questions asked during the post-treatment period.

Findings related to Hypothesis 12 also supported the conclusion that teacher questioning in the study was heavily dependent on the substantive content and level of concreteness of the lessons taught. Comparisons of proportions of each treatment group's questions types from the treatment period with those asked during *Mystery Powders* revealed two important things: (1) while recall, classification, and interpretation questions achieved significantly higher proportions during the treatment period; observation, experimentation, and prediction questions were found at consistently significant levels during *Mystery Powders;* and (2) the superior use of classification, prediction, measurement, and interpretation questions by "TV only" teachers under treatment period conditions was not present in their *Mystery Powders* teaching--again demonstrating the lack of transfer of questioning skills from the treatment period. During post-treatment instruction, all groups asked high levels of observation questions (ave. 44 per-

cent) and interpretation questions (ave. 27 percent) as well as lower but appreciable percentages of experimental (5 percent) and prediction (5 percent) questions. While no transfer effect was noted, the unit selected allowed the teachers to employ significantly greater proportions of science process questions.

> Hypothesis 13. On the basis of the lessons selected during the treatment period, there will be no significant correlations between the proportion of the types of questions asked by the classroom teachers (as categorized with the Gallagher-Aschner system) in each of the four treatment groups *and* the following variables:
> a. Total number of years of teaching experience;
> b. Total number of semester hours in science;
> c. Gain scores on the "Teacher Process Test;"
> d. Gain scores on the "Teacher Content Test;"
> e. Gain scores on the *Test on Understanding Science (TOUS)*;
> f. Mean gain scores on the "Picture Test for Science Processes, Grades 1 and 2, and Grades 3 and 4."

In identifying relationships between proportions of the six question types and selected variables, positive relationships (.28 to .36) were found between the proportion of observation questions asked by classroom teachers and pupil and teacher achievement gains. In addition, low relationships were found between question types (exclusive of the routine category) and the number of years teaching experience (-.16 to .10) and science background (-.09 to .13). It was concluded that the TV science series, to the extent it fostered observation behavior, was related to achievement gains in teachers and pupils. It was also concluded that, considering the experimental conditions under which the data was collected, there

is no relationship between the types of questions teachers ask and the number of years of teaching experience and science background which teachers possess. Caution must be imposed in the comparison of this conclusion with the literature. The heavy emphasis of the TV science series on certain question types, e.g. convergent questions, suggests a potential influence on these results.

> Hypothesis 14. On the basis of the lessons selected from the treatment period, there will be no significant correlations between the proportion of process questions used by the classroom teachers (as categorized with the SPQI) in the four treatment groups *and* the following variables:
> a. Years of teaching experience;
> b. Number of college credits in science;
> c. Gain scores on the "Teacher Process Test," "Teacher Content Test," and *Test on Understanding Science (TOUS)*;
> d. Mean gain scores of their students on the "Picture Tests for Science Processes, Grades 1 and 2, and Grades 3 and 4."

Based on statistical tests for significance of correlations between the variables selected for testing Hypothesis 14, no significant relationships were found between teacher background and teacher-student achievement, and teacher questioning behavior exhibited during the KCTS-TV Phase II investigation. It appears that none of these variables need be considered in selecting teachers to use KCTS television science.

With a curriculum containing a pre-planned script and a teacher's manual with suggested activities, teachers

utilizing TV science instruction asked a higher proportion of convergent and specific science process questions than teachers not using TV instruction. These questions were found, for the most part, in the Post-TV period and in the discovery phase of the model instructional strategy. During these periods, a higher proportion of observation and classification questions were also found.

Comparison of these findings with those proportions of questions asked during the Non-TV period indicated differences in questioning behavior between treatment groups using TV and Non-TV science instruction. It was concluded that these differences resulted from the influence of the TV science series.

As revealed by the multiple category systems used in this study, teacher variability in questioning behavior existed across treatment groups and grade levels. This finding was similar to findings of other researchers.

Recommendations

Research on the relationships between teacher behavior and the influence of particular curriculum innovations or specific aspects of the innovations has not been widespread. There are many questions still to be investigated concerning these relationships. This study has shown that while teacher questioning behavior was quite diverse, it was neither completely random nor completely self-directed, e.g. the KCTS-TV science series did seem to have an effect on the teacher's questioning behavior.

Based on the conclusions drawn from this study, implications and recommendations of two types are offered. These include action that may be taken by the KCTS Science Advisory Committee, KCTS-TV Channel 9, and school districts utilizing the elementary science TV series; and further needs for research in the areas of televised and non-televised science instruction and questioning behavior.

Recommendations for Practice

1. It is recommended that KCTS-TV science teachers responsible for developing television programs outline specific sets of objectives and outcomes for teachers and children using this form of science instruction. Not only would this facilitate the identification of appropriate classroom behavior for teachers, but it would also assist in future formative and summative evaluation of KCTS-TV programming.
2. In the development of a revised or new program effort on the part of the KCTS-TV staff, it is recommended that an on-going (formative) type of evaluation be implemented. Periodic evaluations should be made of the degree of correspondence between specific objectives and behaviors prescribed for TV utilization and teacher-student classroom interaction. The analysis of a small number of classroom teachers and how they teach

the *same* lessons might reveal new insights. From information gained, curriculum developers can then decide if modifications in the curriculum are necessary.

3. The use of the multiple category system in this study for the categorization of questions should prove invaluable in helping curriculum developers identify the emphasis of questions asked during the TV broadcast as well as the effectiveness of discussions and activities initiated during the TV broadcast or suggested in the teacher's manual.

The prescriptive strategies called for by Clegg (1971) and Gall (1971) could be included in the design of a televised science series in at least two ways:

4. Suggestions for possible activities to be initiated by the classroom teacher within different phases of the instructional strategy could be included in the teacher's guide. This guide should contain not only explicit procedures for performing the activities but, in addition, key questions to aid the teacher in eliciting desired pupil responses.
5. Inservice broadcasts, preceding the units to be taught could include objectives of the unit, appropriate procedures in the teaching of these objectives, and instruction in the use of appropriate questioning strategies. The last portion of the broadcast could be devoted to the teaching of one

of the activities using appropriate procedures and questioning strategies.

If the three-phase instructional strategy patterned after the SCIS is accepted by the curriculum developer as a viable model for science instruction, the following recommendations appear appropriate in the design of a TV science series:

6. One model might include the placement of each of the three phases--exploration, invention, and discovery--into the TV broadcast. This strategy was found consistently in the present science series, grades three and four. The low incidence of pre-television instruction observed during this study suggests that current and future KCTS-TV science programs be modified to increase the amount of Pre-TV instruction to facilitate greater exploration of television topics. In addition to activities presently suggested in the teacher's guide for Post-TV follow-up, explicit reference might be made of activities, strategies, and key questions to be used in an exploratory function prior to the TV broadcasts.

7. Another possible design might include the placement of the TV presentation in the exploration phase of the instructional strategy. In this role, the classroom teacher might be given the responsibility for the invention and discovery

roles. Again, the teacher's guide should contain explicit activities, strategies, and key questions for use during each phase of instruction.

The above suggestions provide two means of developing a televised science series within the framework of the model instructional strategy developed in this study. Given an instructional strategy consistent with learning theory and the nature of science, many different modes of interaction of studio and classroom teachers can be envisioned. Further development and evaluation will determine appropriate courses to follow.

Recommendations for Further Research

The following implications and recommendations for further research appear valid from the information collected in this study:

1. Continued efforts should be directed toward developing process measures similar to those used in this study. A few science process tests for elementary school children have been generated along the lines of AAAS competencies measures since the initiation of this study, but additional research should be done on developing and validating a population of items useful to both future research and classroom practice.
2. Analysis of verbal behavior, e.g. questioning behavior, considered appropriate in the measurement

of effectiveness of Non-TV science instruction appeared equally appropriate to this study of a televised science series. The systems comprising the multiple-category system reported in this study have much to recommend their use in future research efforts in science education. Coders were easily trained in the category systems used in the study, with high reliabilities being obtained. In addition, they appear equally appropriate in the analysis of TV or Non-TV science instruction and with either preservice or experienced teachers. The question-category systems can be used to determine levels of thinking, process skill emphasis, and the strategies used by a teacher in the teaching of a particular lesson or unit. Only the Science Lesson Category System (SLCS) was designed specifically for use in the analysis of TV questions.

The use of this means of evaluation of television and non-television instruction allowed the investigators to identify the emphasis of those questions asked by teachers (using the Gallagher-Aschner system and the SPQI) and the context and location of these questions in the cycle of instruction (using the SLCS and ISCS).

3. It is recommended that the analysis of teacher questions along a "process" dimension in science

be continued. This study showed that when questions eliciting the recall of processes performed in the classroom were coded within categories specifically designated for science processes, lower proportions of "recall" questions were found than have been customarily reported in the literature. Considering the central role played by processes of observing, classifying, experimenting, interpreting, predicting, etc. in many diverse fields of study, it is recommended that the Science Process Questions Inventory (SPQI) be applied to teacher-student interaction studies in other subject areas.

4. Since the SPQI categories appeared to be valid and reliable for coding questions asked by elementary teachers, it is recommended that the system be expanded to include provisions for recording student process questions and responses. Such an improved system would make it possible for science educators to analyze the "flow of classroom dialogue" as it relates to concept or process skill instruction.
5. It is also recommended that the SPQI be used in conjunction with the Instructional Strategy Category System (ISCS) in analyzing elementary preservice and inservice teacher questioning skills. In its consistency with selected model instructional strategies found in elementary school

science and the nature of the scientific enterprise, the ISCS has implications in its use in future research in science education. This system can be utilized by either individual teachers or groups of teachers in identifying the exploratory behavior elicited, strategies used in the invention of concepts, and the extent of reinforcement and application of the concepts to new situations. The combined uses of the SPQI and ISCS as a multidimensional system, would allow researchers to assess both the strategies and processes employed by teachers in developing science concepts. The paucity of research focusing on the diagnosis of general and specific questioning behavior in science, coupled with the efficacy of Taba's work in the social studies, suggests this approach as an important focus of future research in science education.

The utilization of these question-analysis systems in the on-going (formative) type of evaluation where an in-depth analysis of a small number of teachers teaching under carefully controlled conditions, appears to be a viable model of evaluation of a TV or Non-TV curriculum. This focus of evaluation appears at least as viable as the measure of achievement found in prior investigations in educational television.

Designs for research in instructional television that

include comparisons between teachers using televised instruction and non-televised instruction appear less appropriate to the model of formative evaluation suggested in this study. As the questioning behavior of teachers was found to vary substantially with the concepts taught, it is difficult to justify the comparison of TV and Non-TV instruction, especially when different content objectives are identified between the two groups.

While researchers in educational television have sought to provide experimental classroom groups of teachers randomly selected from the total population of teachers, this study suggests that only those teachers who favor the use of ETV in their classrooms should be chosen or allowed to volunteer for studies measuring effectiveness and utilization of TV instruction. While there was considerable variation among the 54 teachers participating in this study, teachers perceived by the investigators to be more enthusiastic in their involvement and utilization of TV science instruction tended to more nearly conform to the strategies suggested by the KCTS-TV science series. More observation, convergent, and specific process questions tended to be asked by these teachers reflecting perhaps an increased use of Post-TV discussion and activities. Also noted were slightly higher teacher gain scores and class mean gain scores on achievement tests from classrooms more highly involved with TV science.

As certain teachers will be, for various reasons, more

likely to view one or more TV programs during the school year, it appears more appropriate to involve *these* teachers in research efforts and to generalize any conclusions made to a population of teachers who also favor the use of ETV in their classrooms.

The analysis of classroom verbal behavior was limited to teacher questioning behavior and did not attempt to assess the effectiveness of the questioning behavior in terms of verbal or non-verbal responses of the children. Future studies might assess the possible relationship between certain aspects of the studio (TV) teacher's and/or classroom teacher's questioning behavior and pupil verbal or non-verbal performance.

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APPENDIX

ELEMENTARY SCHOOL SCIENCE SURVEY

UNIVERSITY OF WASHINGTON
KCTS SCIENCE ADVISORY COMMITTEE

Elementary School Science Survey

Directions: This survey is composed of two sections. Part I is to be completed by ALL respondents, while Part II need only be completed by teachers currently using KCTS TV Science. Part III provides an opportunity for you to comment informally. As your name does not appear on the survey, YOUR RESPONSES WILL BE COMPLETELY ANONYMOUS.

Part I. For ALL respondents:

1. District_____ 2. School_____

3. Grade Level:

_____ Grade 1

_____ Grade 2

_____ Grade 3

_____ Grade 4

4. Respondent's Age:

_____ 20-25

_____ 26-30

_____ 31-40

_____ 41-50

_____ Over 50

5. Number of years teaching experience

_____ 0-2

_____ 3-5

_____ 6-10

_____ 11-15

_____ Over 15

6. Approximate number of college credits in science:

A. Physical sciences (physics, chemistry, astronomy, earth science, etc.)

_____ About 6 quarter hours (4 semester hours)

_____ About 15 quarter hours (12 semester hours)

_____ About 30 quarter hours (20 semester hours)

_____ About 45 quarter hours (30 semester hours)

_____ Over 45 quarter hours (30 semester hours)

B. Life sciences (biology, botany, zoology, genetics, etc.)

_____ About 6 quarter hours (4 semester hours)

_____ About 15 quarter hours (12 semester hours)

_____ About 30 quarter hours (20 semester hours)

_____ About 45 quarter hours (30 semester hours)

_____ Over 45 quarter hours (30 semester hours)

Questions 7-8-9 are concerned with the science curriculum you are now using in teaching science. Check as many as are applicable:

7. Which of the following textbook programs, if any, are you using?

_____ None

_____ Harcourt-Brace (Brandwein, et.al.)

_____ Singer (MacCracken, et.al.)

_____ Silver-Burdett (Mallinson, et.al.)

_____ Harper-Row (Navarra, et.al.)

_____ Scott-Foresman (Beauchamp, et.al.)

_____ Ginn (Craig, et.al.)

_____ Allyn-Bacon (Tannenbaum, et.al.)

_____ D. C. Heath (Schneider, et.al.)

_____ American Book Company (Jacobson, et.al.)

_____ Other (specify): _____

8. Which of the following elementary science projects, if any, are you using?

_____ None

_____ AAAS

_____ ESS

_____ SCIS

_____ MINNEMAST

_____ Other (specify): _____

9. Which of the following additional means of teaching science, if any, are you using?

_____ District produced units

_____ Self generated units

_____ No special units

_____ Not now teaching science

10. Does your district employ a science specialist (supervisor, coordinator, consultant)?

_____ Yes

_____ No

_____ Uncertain

11. If you answered Yes to Number 10, how has this person assisted you? Check as many as are applicable:

_____ Individual conference

_____ Conduct workshop(s)

_____ Class visitation(s)

_____ Provided teaching material(s)

_____ Demonstration teaching in my class

_____ Other (specify): _____

12. Who is primarily responsible for the science teaching in your school?

_____ Myself, in a self-contained classroom

_____ Myself, as a member of a team

_____ Another teacher who specializes in teaching science

_____ The district science coordinator, consultant, etc.

_____ Other (specify): _____

13. Including science, how many different KCTS TV elementary school programs (i.e. Spanish, Music, Art, etc.) have you used regularly this year?

_____ None

_____ 1

_____ 2

_____ 3

_____ 4

_____ 5

14. How much time is spent by your pupils with <u>organized</u> and <u>planned</u> science instruction per week?

_____ 1/2 hour or less

_____ 1/2-1 hour

_____ 1-2 hours

_____ 2-3 hours

_____ Over 3 hours

15. How much of the planned science <u>time</u> is "taken up" by KCTS TV broadcasts and their suggested activities?

_____ None, or nearly none

_____ About 1/4

_____ About 1/2

_____ About 3/4

_____ All, or nearly all

16. If you have discontinued use of the current KCTS TV Science Series (i.e. "First Look at Science," "Second Look at Science," "Developing Science Concepts," and "Continuing Science Concepts"), which of the following reasons explain why? Check each of the items according to its importance to your decision to discontinue KCTS science. IF YOU HAVE <u>NEVER</u> USED TV SCIENCE, GO ON TO ITEM 17.

VERY Important	SOMEWHAT Important	NOT Important	
			--- Lesson content inappropriate for grade level
			--- Method by which lessons are presented is inappropriate
			--- Suggested activities "unworkable" with your pupils
			--- Personality and style of TV teacher(s)
			--- Poor picture and/or sound reception
			--- Inconvenient scheduling of programs
			--- Lack of necessary TV receiving and viewing facilities
			--- Lack of essential laboratory materials for "activities"
			--- Lack of information about KCTS TV Science, schedule, etc.
			--- Availability of "better" district or other programs
			--- Discouraged by district building policy
			--- Lack of confidence in ability to use the program effectively
			--- Other (specify): _____

17. If you have never used the current TV Science, which of the following reasons explain why? Again, check each item as to its importance in your having never used KCTS TV Science.

VERY Important	SOMEWHAT Important	NOT Important	
			--- Lesson content inappropriate for grade level
			--- Method by which lessons are presented is inappropriate
			--- Suggested activities "unworkable" with your pupils
			--- Poor picture and/or sound reception
			--- Inconvenient scheduling of programs
			--- Lack of necessary TV receiving and viewing facilities
			--- Lack of essential laboratory materials for "activities"
			--- Lack of information about KCTS TV Science, schedule, etc.
			--- Availability of "better" district or other programs
			--- Discouraged by district or building policy
			--- Lack of confidence in ability to use the program effectively
			--- Other teachers reported that TV science is a "waste of time"
			--- Other (specify): _____

IF YOU HAVE USED KCTS TV SCIENCE DURING THE 1968-69 SCHOOL YEAR, PROCEED TO PART II.

IF YOU HAVE NOT USED KCTS TV SCIENCE THIS SCHOOL YEAR, TURN TO PAGE 9 AND COMPLETE PART III.

Part II. Respondents using KCTS TV Science during the 1968-69 school year please answer the following questions.

18. What KCTS Science series do you currently use?

_____ First Look at Science (Grade 1)

_____ Second Look at Science (Grade 2)

_____ Developing Science Concepts (Grade 3)

_____ Continuing Science Concepts (Grade 4)

19. What proportion of the KCTS TV Science broadcasts to you use?

_____ about 1/4

_____ about 1/2

_____ about 3/4

_____ all, or nearly all

NOTE: If you answered "none, or nearly none", you have completed this portion of the questionnaire. Do not answer questions 20-31, but turn to page 9 and complete Part III.

20. How much do you use the KCTS TV Teacher's Guide to Science?

_____ with none, or nearly none of the broadcasts

_____ with about 1/4 of the broadcasts

_____ with about 1/2 of the broadcasts

_____ with about 3/4 of the broadcasts

_____ with all, or nearly all of the broadcasts

21. What portions of a typical TV Science lesson do you usually use?

_____ TV presentation only

_____ TV presentation with occasional follow activity from, or like those in the Teacher's Guide

_____ TV presentation with regular follow up activities from, or like those in the Teacher's Guide

22. If you do not use the KCTS Science Teacher's Guide, which of the following reasons apply? Check each item in the list as to its importance in your decision to not use the Guide.

VERY Important	SOMEWHAT Important	NOT Important	
			--- unfamiliar with the Guide
			--- lack of availability
			--- "suggested" pre and post activities are too structured (too demanding on the teacher)
			--- new vocabulary word lists are incomplete or lack continuity
			--- important questions and the time allowed for their discussion during the broadcasts are not outlined in the Guide
			--- do not have time for a sufficient number of the "suggested" post-broadcast activities
			--- Guide is not specific enough concerning evaluation of student outcomes of the TV lesson
			--- "suggested" pre and post activities need to be more prescriptive for the teacher
			--- do not have time to study the Guide prior to the broadcast
			--- would rather substitute my own methods

23. Number of children in your class (on your class roll) who view the KCTS TV Science broadcasts:

_____ 15-20

_____ 21-25

_____ 26-30

_____ 31-35

_____ over 35

24. Apparent ability level of class in terms of the mean I.Q.:

_____ low (below IQ of 85)

_____ average (IQ 86-114)

_____ high (above IQ of 115)

25. Level of KCTS Science lessons compared to the ability of your pupils:

_____ lessons too difficult or complex

_____ lessons satisfactory

_____ lessons too easy or simple

_____ uncertain of difficulty level

26. Effectiveness of KCTS TV Science in meeting your instructional objectives:

_____ ineffective

_____ satisfactory

_____ highly effective

_____ uncertain

27. Degree to which KCTS TV Science has stimulated and interested you in teaching science:

_____ very little

_____ moderately

_____ highly

_____ uncertain

28. Degree to which KCTS TV Science has developed and improved your <u>skills</u> in teaching science:

_____ very little

_____ moderately

_____ highly

_____ uncertain

29. Degree to which KCTS TV Science has improved your science knowledge background:

_____ significantly improved

_____ somewhat improved

_____ improved very little

_____ uncertain

30. How do you rate the quality and usefulness of KCTS TV Science in comparison to a composite of other KCTS TV elementary school programs you use? (i.e. Spanish, Music, Art, etc.)

_____ better than others

_____ about the same

_____ poorer than others

_____ unable to judge

Part III. Informal comments.

31. I think KCTS TV Science should be . . .

32. Teaching science is . . .

33. Children think KCTS TV Science is . . .

34. The biggest problem with KCTS TV Science is . . .

Thank you for completing this questionnaire, an integral part of the comprehensive evaluation of KCTS TV Elementary School Science Program. It will contribute to a better understanding of the function of educational television in elementary school science.