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Educational Television: "Let's Explore Science"

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This study provides a historical overview of the development of the instructional television as a tool within the context of science education. The technology was traced from its beginning as experiments in public service broadcasting by universities and television networks, though closed circuit, cable, and commercially produced science-related programming. The use of the technology as a teaching tool is examined in terms of the concept of scientific literacy and the means by which instructional television helped to accomplish the goals of scientific literacy.

KEY WORDS: Instructional television; science education; scientific literacy; history of education.

> In an era known as the age of science, it is appropriate that science itself should have developed television, a medium perfectly suited to the promulgation of scientific knowledge . . . Television, of all available media, is the ideal one for satisfying widespread public demand for science data. (Poole, 1950, p. 1)

Poole's ambitious objective was the production of science-related television programs. In the early days of television, his view was one of many competing models for the most effective use of television broadcasting in the science classroom. The uses of television in the science classroom are examined in this paper. The various approaches used to infuse television programming into the classroom are examined, along with a discussion of how the methods employed fit into the schemes of scientific literacy en vogue at the time.

BACKGROUND: TELEVISION AND THE PUBLIC

The telegraph's first public message was Morse's inspirational statement, "What hath God wrought?" The telephone commenced with Bell's urgent request, "Mr. Watson. Come here. I want you." Television commenced on a substantially different level of human expression: an image of Felix the Cat.

The invention of the television stems from investigations dating as far back as the 1870s, with many individuals providing discoveries and inventions which would then be employed by subsequent inventors (Roman, 1996). Experimental stations began broadcasts during the decade before the Second World War; the war effort and the Depression, however, precluded any large-scale broadcast efforts from getting underway.

With the end of hostilities, network television broadcasting began in earnest in the 1940s. The 1950s

> witnessed a surge in the popularity of television, while radio was treated like an overlooked cousin. Most of the popular radio programs and their stars moved to the "electronic canvas." (Roman, 1996, pp. 158–159)

Like the motion pictures of a generation previous, public adoption of televisions as a source of entertainment and information developed rapidly. Television audiences numbered in the millions by the early 1950s and left the motion pictures far behind in terms of viewership. Measuring the impact of television on motion pictures by film business profits, the blows suffered by films were quite cruel:

> In 1946, the American film business grossed $1,700,000,000, the peak box office year in the fifty-

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> year history of the American film industry. Twelve years later, in 1958, box-office receipts fell below a billion dollars; by 1962, receipts had fallen to $900,000,000, slightly more than half the 1946 gross. (Mast, 1981, p. 260)

With television pulling in so many individuals for entertainment purposes, the challenge to encourage its educational use was somewhat problematic; more programs were oriented toward entertainment than educational applications. Added to this were the different instructional formats television-based instruction offered for educational uses over the years: live broadcasts, taped broadcasts, closed-circuit, and satellite program feeds provided programming for science classrooms. This fact impacted people's perception of instructional television with the wide variety of instructional approaches that were used to reach students (Cambre, 1991).

> With so many possible variations, it is no wonder that there are often some misunderstandings about what ITV [instructional television] really is. The confusion is exacerbated by the multitude of delivery systems available to disseminate the television picture. The most common and cost effective transmission of the ITV signal is by satellite to the PBS stations, or to local cable companies or ITFS (Instructional Television Fixed Services) systems. . . . Few today expect the signal to be used live in the classroom. On the contrary, videotape has become the medium of choice for using ITV programming. Tapes may be recorded from the satellite signal or from intermediate distribution signals, or they may be purchased directly from distributors. (p. 268)

The challenges associated with the various approaches to information delivery informed much of the following narrative.

Educational Advocates

The educational possibilities offered by television were recognized almost from the beginning. Research into the most effective uses of television in the classroom began in earnest in the early 1950s. Refining the pedagogy continues to the present.

In the domain of science teaching, Crum (1971) examined a number of the issues associated with the effective use of television in the science classroom. As the producer and television teacher for the program *Community of Living Things,* he identified a number of factors that led to more effective use of instructional television in the science classroom. As both the teacher and the producer of the program, he used insights gained from both perspectives to inform his suggestions for infusing ITV into teaching.

Crum's (1971) main educational thrust in developing his programs was to develop student interest and involvement. A prime example was his use of observation sessions.

> "Observation sessions" are incorporated into the program. In these sessions the student observes film sequences without narration. This allows each student to formulate his own ideas about what he observes. It also provides a variation of the discovery or investigative approach while, as intended, directly involving him. (p. 39)

Crum had the advantage of being both a producer and teacher involved with instructional television. This allowed him to construct television learning activities from knowledge derived from two sets of experiences. As the instructional theory supporting the use of television developed, a more defined set of characteristics supporting ITV were developed.

Hawkridge and Robinson (1982) provided an answer to the question "What is educational television?" They identified four characteristics of educational broadcasting:

1. its programmes are arranged in series to assist cumulative learning;
2. they are explicitly planned in consultation with external educational advisers;
3. they are commonly accompanied by other kinds of learning materials, such as textbooks and study guides; and
4. there is some attempt made to evaluate the use of the broadcasts by teachers and students (p. 25).

These characteristics, in addition to the following definitions, helped to identify and make explicit the use of television in science education.

> *Educational television* [italics added] has come to mean many things to many people, as there is something educational in almost all forms of television broadcasting. *Instructional television* [italics added] is more specific in its meaning in that it is confined to the organized teaching-learning situation and is part of the formal instructional program of an institution of learning. (Smith, 1961, pp. 15–16)

Television's home in the classroom, whether organized along the dimensions described by Hawkridge and Robinson or less formally in the above "educational" sense, provided much fodder for experimentation and innovation during the last half of the twentieth century. It also provided another avenue for educators to promote the ideals of scientific literacy.

CLASSROOM APPLICATIONS OF TELEVISION

Hopes were high for the effective classroom use of television. The images and sound of the motion picture were combined with the immediacy of the radio to produce a technology that could reach into each classroom to promote science learning.

Television, because of the flexibility its hardware offered, also provided challenges to the initial groups of educators who sought the most effective means of infusing TV into classroom practice. Several models for the classroom use of the television came to pass.

Anticipating a number of the challenges of the use of television in the science classroom, Schreiber (1952) considered the similarities between the motion picture and television as instructional tools. He suggested that the educational issues related to television's use in schools were related to two areas:

1. The live (non-film) television program is an instantaneous reproduction of some, perhaps distant, event; whereas the motion picture may be a reproduction of the same event that is then projected for study at some later time.
2. The second difference, educationally, is one of flexibility in use. The live television program comes on only once and must be used then or not at all. It cannot be previewed, it cannot be adequately prepared for, it cannot be interrupted for questions, and it may come on at a completely unopportune [*sic*] time (pp. 626–627).

Schreiber (1952), previously quoted as an advocate of film as an appropriate tool in the science classroom, identified several challenges for the use of television as compared with motion pictures: the issue of using live broadcasts and the appropriateness of the event would likely drive the instructional decision to adjust the course schedule to accommodate a live broadcast. More likely, it would simply be taped!

Schreiber (1952) also argued a philosophical point as to whether the nature of the television broadcast as a "live" event was a significantly different experience from a recorded event as represented by a motion picture presentation in the classroom. This question remains to be answered, but with the convenience of taping available today, it is a question seldom ventured.

Elsewhere he argued financially against the expenditure of funds to create a network of education broadcasting stations. His primary objection at the time was that there was little educational evidence to support the development of this sort of infrastructure. Motion pictures, he argued, would accomplish the same ends with greater flexibility (Schreiber, 1952).

Contemporaries of Schreiber, Levenson and Stasheff (1952) argued as forcefully in favor of the infusion of television into the curriculum. One factor they suggested as a strength of broadcasting was its timeliness—technology "presents and interprets the event while it is still current and before it becomes history" (p. 5). The multicultural educators of the 1990's would laud the further advantages of educational broadcasting. Television offered an opportunity to examine issues in detail by

> provid[ing] the classroom with windows on the world, with magic carpets that transport pupils to different lands, to other sections of their own land, and to new and different climates of opinion and culture. (Levenson and Stasheff, 1952, p. 9)

Researchers at Fordham University, on behalf of the United States Army and Navy, carried out early investigations into the efficacy of television-based instruction. A number of general findings were based on these studies that supported the use of instructional television:

1. That television instruction is an effective means of training large numbers of reservists in widely separated groups. All grades of personnel made statistically significant gains on test scores for each of the programs.
2. That reservists not only learned from the television instruction, but they remembered most of what they learned when re-tested four or six weeks later.
3. That television instruction continues to be highly acceptable to the reservists after eight weekly sessions. . . .
4. The amount of gain on test items is related to the explicitness of the topics on which these items are based. . . .
5. The type of instructional treatment given a topic influences the amount of learning (Rock *et al.*, 1952, p. 48).

Similar findings were found in a study conducted for the Navy, with additional suggestions for improving teaching practice. In particular, the impact of television's production values—close-up images versus distance shots, narration versus dramatization, and ensuring that the images and the audio track complemented each other—were significant in terms of the perceived quality of the experience by the viewer and also in terms of the quality of the information gained (Rock *et al.*, 1954).

Several other findings emerged from the study. Although the experiment demonstrated the usefulness and functionality of instruction via television, several suggestions were made to improve the experience. First and foremost, the visual nature of television made it essential that more visual aids for instruction be incorporated into the learning experiences. In addition, the performance of the instructor in a television setting was found to be of concern. A suggestion that a screening board "select instructors who are free from peculiarities in speech or other annoying mannerisms" was offered with the desire to promote more effective instruction (Rock *et al.*, 1954).

These initial investigations into the instructional use of television provided early empirical support for the use of television as a teaching tool. The suggestion was made in the Army Report that selected channels be reserved exclusively for military use to allow for the efficient use of resources and ease of access to trainees. Rather than saving channels for the military, this suggestion was implemented on behalf of educational broadcasting for the general public.

In the nearly 50 years since Schreiber, Levenson, and Stasheff, and others, offered their thoughts about the value and purpose of educational television, a number of approaches have influenced classroom practice.

Beisenherz (1973) carried out an extensive study as to the use of locally produced science programs in the Seattle area and found further evidence supporting the infusion of instructional television into the science curriculum. In particular, he found that the use of television programs in science instruction influenced teachers to ask students a higher proportion of convergent questions than did the teachers in a control group. As this was part of the curriculum's goal—to develop increased use of questions at the higher end of a (modified) Gallagher-Aschner question system—the application of television as a useful tool in science instruction was given empirical support. His findings indicated that television could serve as a powerful tool for developing thinking skills among science students.

Klopfer (1980), drawing on several decades of experience, offered some thoughtful insights into the use of television in science education.

> Among the alternative forms for science education, the use of television as a medium of science instruction has a history of about two decades. The medium has now outgrown its infancy, and sophisticated programs dealing with science topics and science-related social issues are being produced with increasing frequency. The advent of convenient, affordable videotape and videodisk playback systems promises to make a powerful instructional alternative readily available, since viewing of televised programs is no longer restricted to times when they can be broadcast. Using the new tape or disk equipment, any group or individual could watch a series of personally selected science programs in television at any agreeable time. Via either playback systems or direct broadcast, televised science programs offer a means for expanding scientific literacy of the entire citizenry, not only students in schools. (p. 4)

Klopfer's positive and engaging vision for the use of television in science education contrasted with Schreiber's more skeptical view. Interestingly, as the technology developed, nearly all of Schreiber's objections to the use of television were addressed.

Removed from the speculations of science educators, the classroom use of the technology framed the investigation contained in this study. Different instructional approaches with different infrastructures competed for space within the available educational bandwidth. The motion picture, with a standard means of projection and a reliable set of software, found application quite rapidly in the science classroom. Unlike the motion picture, no approach to educational television has become the standard practice within the science classroom. Perhaps because there was no single dominant paradigm, educational television still remains a "sleeping giant" with untapped potential to influence teaching practice. Although the basic tools are the same—transmitter, monitor, program, and audience—the various arrangements using these components provided a range of possible classroom applications.

Standard commercial broadcasts, beginning on a widespread basis in the 1940s, provided a viable starting point.

Commercial Television Broadcasts

The original commercial broadcast networks were extensions of the existing radio networks. By the mid-1940s, a number of programs that could be considered "educational" were in place. As the networks defined "educational" differently, some questions arose with respect to the programs' instructional merit.

The ABC network defined their educational mission in this manner:

> We feel that television is educational when it presents 'the dance' as much as when it is offering a forum discussion or showing the United Nations. . . . We feel that news programs are educational. (Siepmann, 1952, p. 38)

CBS was also vague in describing the educational objectives of their programming, which they defined to include "the broad areas of programmes contributing to the cultural advance of the whole community" (Siepmann, 1952, p. 39). NBC offered the opinion that their educational aims were "to serve by television, and not to replace the home, the school, the church, the university" (Siepmann, 1952, p. 42). The Dumont Television network did not articulate their educational philosophy for Siepmann's study, but among the programs they identified as educational was the "Johns Hopkins Science Review." This award-winning program was the first program on commercial television devoted explicitly to the investigation of scientific matters. The program's creator, Lynn Poole, offered two reasons for producing the program.

> First, a large segment of the population is interested in the topic as evidenced by the numerous magazine and newspaper articles that appear on aspects of modern science. Second, if science education is to continue in a democracy, its high costs have to be met by general public support of research. (Cumming, 1954, p. 13)

These reasons connected directly to the idea of developing scientific literacy.

The commercial networks, despite their overwhelming presence in the television broadcast arena, offered little in terms of programming explicitly related to science education. The occasional news broadcast or, in particular, space launch during the 1960s was the most common use of network television in science teaching. The use of the programming relied exclusively on the desires and interests of the classroom teacher, as resource materials were not typically produced in support of educational use of commercial broadcasts.

This trend of limited science-infused broadcasting held throughout the 1990s, with few exceptions. Short-lived programs such as *Walter Cronkite's Universe* found homes (briefly) on commercial television, but their tenure was rarely long lived. In an interview with the producer of *Walter Cronkite's Universe,* the role of viewership as the basis for most commercial broadcasting decisions was described by Lewenstein (1987):

> CBS producer Johnathan Ward explained that *Universe* failed because "it wasn't successful enough at building an 'evening.' We attracted people who did not normally watch TV. They would watch us at 8:00, then switch over to PBS to watch the second half of *NOVA*. They didn't stay with CBS, which is the name of the game in commercial broadcasting." (p. 33)

With the level of viewership providing an essential element for the commercial broadcast of science-related television programming, the limited number of any educational programs—let alone science-related television programs—on network television has virtually excluded network-derived programming from having an influence on science teaching.

The viewership issue was even more critical than the tendency for viewers of science programs to change stations during their evening's viewing. Ward, drawing from the work of Jon Miller, further pointed out that the typical audience for science television programming was approximately 10 million (in 1984) and that these were in fact "the same viewers, hunting out science wherever it appears" (Lewenstein, 1987, p. 33). The audience appeared to be an extremely loyal one, but too small for network broadcasting.

Some efforts to rectify this situation came about during the late 1980s. A gathering of scientists and broadcasters, sponsored by the Scientists' Institute for Public Information gathered for a "Retreat on Science and Television." The key issues derived from this event were that scientists and broadcasters would likely profit from a greater intimacy and that the challenge of news broadcasting was to present scientific information in understandable ways in less than 2 minutes. Series of episodes related to scientific endeavor were apparently not among the issues discussed. A positive outcome emerging from the conference was the further development of a video archive that would allow better graphics to be used in television news programs to communicate scientific information to the viewers (Jerome, 1988).

As with the viewers described as "switching to public television" at the end of an interaction with commercial television, it is appropriate to do the same here and examine the use of television in educational and public television.

Educational and Public Television

By the early 1950s, the desire for educational use of television was given public hearing.

> A total of 137 witnesses, most of them distinguished representatives of America's educational establishment, had formally testified at two hearings concerning the potential of TV in America as an instrument of enlightenment, training, and civilization. One or two dissents were heard, mostly from commercial broadcasters like the Columbia Broadcasting System. But, in main, the testimony was offered *en bloc* that TV had potentials to revolutionize education. . . . (Gordon, 1971, p. 17)

As a consequence of this testimony, the Federal Communications Commission reserved in April 1952 162 Ultra High Frequency and 80 Very High Frequency channels for educational use.

In the ensuing years, a variety of instructional approaches have made use of these reserved frequencies. In the various approaches toward using television in the classroom, several aims were evident throughout the different efforts made to infuse television into instruction.

First and foremost was the belief that "television can improve the quality of instruction" (National Association of Educational Broadcasters [NAEB], 1959, p. 122). Another issue, sharing sentiments similar to that of Thomas Edison, was that instructional television would serve to make education more efficient, in terms of both costs and the use of instructional facilities (NAEB, 1959).

The first educational television station broadcasting in the United States was WOI-TV in Ames, Iowa, licensed to Iowa State College (now Iowa State University). The fact that this was the only television broadcasting station in central Iowa from 1950 until 1954, as well as its mission as an agent of progressive agriculture, had a significant effect on the type of broadcasting offered by WOI as compared to other educational stations (Caristi, 1997). The challenge experienced by WOI revolved around its position as a broadcast network affiliate with a strong educational mission. The profit/non-profit and commercial/educational tensions were quite taxing for the organization. The conflicts inherent in this situation continued until 1994, when the Iowa State Board of Regents sold the station.

WOI-TV's first foray into science education, excluding programming offered by the farm extension services, was the program *TV Schooltime.* Offered "30 minutes, 5 times a week during the school year [and] designed for in-school viewing by elementary and secondary schools" (Cumming, 1954, p. 50), it featured, from time to time, science-related program content. Science episodes were titled "Let's Explore Science" and the content ranged from life science investigations (a teacher and her students set up an aquarium) to simple topics in physical science (an investigation into the states of matter and its properties). In a program dealing solely with science content, WOI broadcast the series *Chemistry 101* during the fall quarter of 1955. Topics covered during this experiment into instructional television were those typically associated with a freshman course in college chemistry (Iowa State University, 1998).

Program Profile: TV Schooltime

Broadcast from 1952 though the mid-1970's, *TV Schooltime* was a long-running educational program produced and broadcast by WOI-TV. Aired each Thursday morning at 10:00 AM, the *Let's Explore Science* portion of the *TV Schooltime* series provided instruction in a variety of science topics for elementary students. In an informational report profiling the educational uses of television through WOI-TV, Davis (1953) offered several reasons why *TV Schooltime's* science programming was important. The ability to bring the specialist into small, rural classrooms was the key advantage of televised instruction, as well as bringing the "now" into the classroom—in the sense of the spontaneous events taking place outside and otherwise unreachable to the classroom. Bringing the classroom into the home life of the students was another advantage offered by televised instruction. Television, as a means of continued staff development, was another implicit purpose of its instructional application (Davis, 1953). To achieve the purposes Davis described, *Let's Explore Science* was developed in this manner:

> Elementary school children are interested in the world close at hand, and in the universe beyond. Often, however, the elementary school teacher feels that the lack of equipment and technical training make planning the science program difficult. To help the teachers of Iowa meet this problem, *Let's Explore Science* is presented. . . . It is hoped that, with the textbooks and selected references, these supplementary programs will help the teacher to plan an active science program which will capitalize on the scientific curiosity of youth. (Iowa Joint Committee on Educational Television, 1953, p. 45)

Supporting the teacher in his or her use of the program was a comprehensive teacher's guide. Each of the lessons was identified first with the broadcast date and then with specific information to support the use of the program in science teaching. The guides for each lesson were divided into three parts: Part I covered what to do before the lesson, commonly hands-on activities related to the content of the program, a reading from the teacher, or research on the topic through some suggested literature. Part II was the broadcast of the program itself, with the purpose of the broadcast lesson described in appropriate detail. Part III provided suggestions for continuing the activities developed both before and during the broadcast. The program was designed as a motivating tool for students to collect, organize, and create information. Additional activities were designed to help students connect the contents of the program with local industry, agriculture, and the needs of local communities.

Viewing sample episodes from the early years of the series demonstrated many of the instructional goals of the program and how they were to be implemented. In the inaugural episode from October, 1952, a teacher and three of her students constructed an aquarium. Each step in the process was designed as a hands-on activity for students to duplicate in their own classrooms. Questions asked by the television teacher and the answers provided by the television students helped to develop deeper understandings of the needs for a small ecosystem (Iowa Joint Committee on Educational Television, 1952a).

Broadcast later that same year, a follow-up episode with a different instructor focused on further exploring the needs of fish in the aquarium. A discussion of analogous situations and investigations with Cartesian divers, energy transfer, and a dissection helped to further develop student knowledge (Iowa Joint Committee on Educational Television, 1952b).

Teachers and community members responded favorably to the programming. These comments were representative of those received by the station:

> I am a mother and I wish to express my gratitude to WOI-TV for the program *TV Schooltime.* Our children, like many other Iowa youngsters, attend a small consolidated school. We realize that the supplementary classroom help which these schools are getting could not possibly be obtained in any other way.
>
> We feel that TV is able to give us something we could not otherwise get.
>
> At present we are using the series in Guidance, Science, and Art. On the day preceding the science program, the teachers use the study guide for their class activity work. The students show a keen interest in each program and look forward to them with a good deal of anticipation.
>
> Several times we have performed experiments at school that were referred to in the broadcast. Eleven and twelve-year-olds clapped their hands from pure gratification to see that the TV class had the same experiences that we did. (Davis, 1955, p. 10)

During the 1950s, viewership increased year by year. Some limited data were available in surviving progress reports produced by station WOI-TV. The increases in viewers recounted by the data in Table I quantitatively amplified the high regard the viewers shared immediately above.

With the costs of television production rising sharply, the *TV Schooltime* series started, during the mid-1960's, to accept programming from external sources. *Let's Explore Science* ceased production and broadcasting during the 1960s. Multiple programs replaced it in the classroom. Each of its two successors reflected the changing ideas of scientific literacy, which were coming to the fore in the 1960s. In 1967, the final locally produced science series was begun, *Iowa Television Science.* It was developed with the process skill orientation evident. Its program profile, stated:

> [*Iowa Television Science*] . . . has been developed upon the philosophy that science is more than just a collection of facts and a method. Each lesson constitutes a visual talking reference to help the children and the teacher understand the scientific method.
>
> Important course objectives will be to develop an inquiring mind and to develop the art of observation. Each broadcast will be open-ended to encourage teachers and pupils to search for answers in their own classroom situation. (Iowa Joint Committee on Educational Television, 1967, p. 3)

By the following year, no science programs were produced locally. *Iowa Television Science* ceased production after only 1 year. In its place, two new series supplied by a consortium of Midwestern educational broadcasters, *Adventures in Science* and *Exploring the World of Science,* were broadcast, serving the needs of K–2 students and grade 3–4 students, re-

Table I. Progress Report on TV Schooltime[a]

	1955	1956
Total number of classrooms	278	312
Total number of students	7485	8329

[a]Davis, J. H. (1956). *Progress Report on Iowa TV Schooltime*, WOI-TV, Iowa State College, Ames.

spectively (WOI-TV, 1968). The state's commitment to producing and disseminating science television broadcasting was also decreasing. Production of the teacher information manual, produced and distributed by the Iowa Joint Committee on Educational Television since the early 1950s, was discontinued. The task then fell upon WOI-TV to continue the process.

This background information on the two science programs was offered in the WOI-TV–published (1968) teacher guide:

> *Exploring the World of Science* is an exciting new science series which uses the inquiry approach to learning and allows students to observe, grasp concepts, and draw conclusions on their own.
>
> The lessons are designed to inspire learning, arouse curiosity, develop a deeper appreciation of nature, and encourage students to think in a scientific way.
>
> The open-end approach of teaching is used, encouraging students to investigate, inquire and experiment on their own, whether at school, at home, or in the out-of-doors. (p. 3)

Exploring the World of Science was very much influenced by the curriculum movements of the 1960's. The use of hands-on activities, complemented by the development of science process skill acquisition, was consistent with the best thinking in 1960's science education.

Adventures in Science, serving a younger audience, also reflected the perspectives present in the 1960's science curriculum movements. The focus on the process skills of science was in many ways a result of the broader conception of what should compose a science curriculum, with thinking skills recognized as an important complement to the content knowledge.

> This series is aimed at presenting basic science instruction in a meaningful and stimulating manner. Basically, the objectives of the course are to acquaint the students with the fundamental truths and specific subject matter of science. However, at the same time, it is to stimulate their interest and to motivate them to engage in a program of research and experimentation. And finally, to encourage "scientific thinking" based on logical and critical procedure. (Iowa Joint Committee on Educational Television, 1968, p. 5)

In February 1974, *TV Schooltime* ended its nearly 22-year run on WOI-TV. The establishment of a state network for educational television—which was running some of the same programs—had rendered the original broadcasting approach for *TV Schooltime* obsolete. The complete coverage offered by the Iowa Educational Broadcasting Network and the stresses of serving both educational and commercial needs as an affiliate of a commercial television network brought an end to this educational outreach to the people of Iowa.

Other Examples of Locally Produced Programming

Many of the early documents related to the instructional use of television had a certain "do it yourself" quality about them. That is, in addition to addressing many of the technical issues related to how a television camera works and issues related to how the television was to be infused into instruction, many of these volumes were replete with creating effective scripts and discussion of proper television production values (Cumming, 1954; Gordon, 1971; Levenson and Stasheff, 1952; Poole, 1950).

One example of a locally produced television program came from Indianapolis in 1957. The local educational station had been used to "inform the general public about changes and developments in the public schools" (Barth *et al.*, 1958, p. 202). Local interest called for an inquiry into the use of television in education. The objective was to test the viability of television as a means delivering content information to the students in several test sites.

> Consequently, in the spring of 1957, a series of television programs designed for viewing by certain school classes was written and produced. As part of the series, four selected junior high school groups viewed specially prepared lessons each week for two months. The purpose of this plan was to attempt to add to the factual knowledge of the junior high pupil in the area of science and, experimentally, to determine if any difference in the knowledge of science facts could be observed between pupils who observed the science lessons and those who did not. If any difference could be observed, the worth of this technique of television teaching would be demonstrated. (Barth *et al.*, 1958, p. 202)

Apparently the approach was worthwhile. Raw scores reported in the study showed that students in the television-viewing classroom averaged higher gains in content knowledge than did those in the non-television setting.

A similar approach was employed in the Des Moines, Iowa, public schools during the late 1950s and early 1960s. Each week, science lessons, among other topics, were broadcast for classroom viewing and instruction on school district station KDPS. One of the purposes behind the use of television was to

> enrich and supplement the child's experiences beyond what could be done efficiently and economically by the classroom teacher alone. (Montgomery, 1964, p. 110)

Sadly, following up on the experiences of station KDPS proved to be impossible by the 1990's. Station records had been lost and the current station director[3] expressed surprise that the station had ever served a purpose other than as a training facility for high school students interested in broadcasting.

Reflecting in a more general way on her experiences using television as an aid in the teaching of science, Hadd (1971) offered some significant insights into the teaching process as supplemented by television.

> The TV set will never replace the classroom teacher, but as an elementary teacher I am not a specialist, and I welcome help from the television teacher. Teaching with the use of TV is a cooperative venture, or it may be looked on as team teaching. . . .
>
> The TV teacher is a partner in my classroom. Every Tuesday afternoon he takes over part of my teaching assignment. He presents, explains, and demonstrates the major points in the lesson and stimulates student interest. My job is to clear up misunderstandings, make assignments, evaluate the students, and provide for group or individual activity. The success or failure of the TV teacher's efforts will depend heavily on my performance as a classroom teacher. He may do a superb job, but it will count for little if I fail in my half of the task. We must work as a team and support each other's efforts. (p. 11)

From the point of view of an elementary education director quoted by Hadd (1971), "In my opinion, the teacher who uses television to the best advantage uses her teacher's manual very carefully" (p. 11). The most effective uses of television in the science classroom came from effective planning and preparation, much of which could be derived from the teacher's manual.

As an advocate for instructional television, Hadd (1971) offered suggestions for individuals interested in duplicating her level of success. Regarding the physical operation of the television monitor, she advised warm-up time and alternative seating arrangements for students. To improve the pedagogy, she made suggestions to novice television science teachers regarding using the television teacher as a motivator and idea builder for the students, not as a substitute for the classroom teacher.

Public Broadcasting System

Owing to infrastructure needs, the cost, and the labor-intensive nature of the process, locally produced programming gradually evolved toward the development of the state, regional, and national broadcasting organizations. As costs rose, the need to cooperate grew (Cambre, 1991).[4]

Cambre (1991) and Middletown (1979) both characterized the growth and expansion of instructional television as something other than linear. Rather, it represented a process of "give and take" due to the desire for local control at one end and the economies of scale and improved production values at the other.

By the 1970's, a nation-wide system under the banner of the Public Broadcasting System (PBS) had emerged and subsumed some of the efforts of local and regional educational broadcasting agencies. Serving the classrooms and communities of America with a nationally organized system, PBS adopted an approach similar in appearance, though not practice, to the commercial networks.

Although many of the programs were still produced by local educational stations (in particular, flagship stations such as WGBH, KQED, and KCTS), the network approach allowed for a greater distribution of exemplary programs.

> The primary function of PBS was to help CPB [Corporation for Public Broadcasting] and the Ford Foundation develop suitable programs among the major production centers, which PBS would then distribute by interconnection. PBS was not to produce programs. . . . (Saettler, 1990, p. 378)

Science-related programs distributed by PBS ranged from *NOVA* to *Bill Nye the Science Guy. NOVA* is one of the longest running series shown on PBS. Produced by WGBH in Boston, it sought to provide insights into the creative processes and mysteries of science. *Bill Nye the Science Guy* sought to entertain and inform preadolescent through young adolescents. Created by and starring former engineer Bill Nye, *Bill Nye the Science Guy* offered insights for

[3]Springer, Bill (1998, March 12). Personal contact. Springer served as the station director for KDPS during the 1990's.

[4]Stated Cambre (1991): "One indicator of the imperative to cooperate is the continuously rising costs of production. Local productions in 1962 cost in the neighborhood of $165 per fifteen minute program. Today [1991] the estimate for high-quality ITV productions is approximately $3000 per minute" (p. 269).

children into the role of science in society. Through engaging visuals,[5] fast editing, and parodies of music videos, Nye attempted to make the world of science engaging for children. *NOVA*, by contrast, was intended for a more mature audience and served more as an instrument of information and enlightenment.

Other programs broadcast through PBS informed and entertained students as well. Unlike the *NOVA* and *Bill Nye* programs, which did not produce teacher support materials in conjunction with their broadcasts, a number of PBS-sponsored programs did recognize a need for materials to support classroom practice. Others, profiled below, offered teacher support materials to supplement the broadcasts.

Program Profile: 3-2-1 Contact

By the 1980's, the increasing sophistication of the young viewer led to increasingly sophisticated programming. The series *3-2-1 Contact* provided an engaging science education experience for children in the elementary grades. The goals of the program were stated as follows (''Television,'' 1980):

1. To help children experience the joy of scientific exploration and creativity and motivate them to pursue further scientific activities;
2. To help children become familiar with various styles of scientific thinking and to stimulate their learning skills so that they can learn to analyze important social issues related to science and technology; and
3. To help children—with special appeal to girls and minority children—to recognize science as a cooperative human endeavor open to their participation (p. 27).

The goals of the program were clearly consistent with the 1980's view of scientific literacy. Science was to be considered an endeavor for all children—as noted in goal three—and the promotion of thinking skills and evaluation skills represented an idea born with the progressives and institutionalized as part of the process skill-oriented curricula of the 1960's.

[5]Wilcox, Jim (1998, 31 March) Personal contact. Wilcox, a staff member in the Iowa State University Archives stated that many of the visual images used in *Bill Nye the Science Guy* episodes were repurposed from WOI-TV's *TV Schooltime* episodes. Apparently the images of students in 1950's dress with 1950's production values provide a nice contrast with the quick editing and dynamic animation to which contemporary students are accustomed.

> The conclusion of each episode featured a mystery involving the Bloodhound Gang, a collection of genial neighborhood half-pint detectives who use their powers of observation and logic to solve baffling crimes like the case of the 264-pound burglar. Behind their capers is the idea that information-gathering techniques and creative thinking strategies are tools for scientists and detectives alike. (Thomson, 1980, p. 8)

The use of the Bloodhound Gang as an engaging means of developing the notion of science as a process of argument and evaluation resonated strongly with the view of scientific literacy present during the 1980s. The Bloodhound Gang, applying the tools of the scientists, was able to find answers to questions through problem-solving techniques akin to that of the scientific method.

In addition to gathering interest with home viewing, the series was also designed to be used as part of a classroom science teaching experience. Consistent with the profile of educational broadcasting defined by Hawkridge and Robinson (1982), *3-2-1 Contact* provided teacher materials, arranged the episodes in sequence to enhance learning, and was developed with input from a panel of specialists.

To assist teachers in the use of the program, teacher resource guides were published in conjunction with each broadcast. Several years after the initial broadcast of the program, *Science and Children* (Santoro, 1983) offered an in-depth profile of the series and the applications it had found in science education. The opportunities for participating in scientific endeavor, regardless of gender or ethnicity—the science for all Americans theme—continued to be an important part of the program's message.

A study undertaken by Johnson (1984) suggested that the use of *3-2-1: Contact* as a tool for science teaching had significant positive effects on student learning. In particular, developing student interest in science curricula and in improving student knowledge of science concepts provided the prime areas for investigation.

> . . . the children learned and retained many scientific facts, and, surprisingly, some of the knowledge gained was of the most abstract type. For example, a central topic during the series' ''Flight Week'' is Bernoulli's theorem about how flight can occur. Both before and after watching the programs, students were asked to explain how a wing can keep a plane up in the air. Prior to viewing, less than 25 percent of the students provided answers that demonstrated mastery of the concept. Afterward, 60 percent understood the theory. (p. 38)

Tomecek (1993) reported similar success with his use of *3-2-1: Contact.* In his classes, he used the video materials as a means of setting up intellectual challenges and then examining them through the video episodes. Combined with a set of hands-on/minds-on classroom activities, the videos provided a natural link between the introduction of concepts and the investigation and analysis of the concepts.

Program Profile: Cosmos

Another series described as an ''antidote . . . to scientific illiteracy'' (Morrow, 1980, p. 25) was *Cosmos.* Morrow (1980) described the series in this way:

> Carl Sagan's labor of love is the enthralling epic everyone was hoping it would be. Heavy on astrophysics, but also embracing biology and culture, Cosmos takes viewers on a dual journey: through history, to the sources of scientific adventure, and through space, to its fabulous frontiers. Episodes include . . . ''Traveler's Tales'' which juxtaposes the Voyager saga with the nautical innovations of Enlightenment Holland, and ''The Backbone of Night'' in which Sagan's own quest to understand stars is charted from his Brooklyn boyhood to his recent experiences teaching children about the Milky Way. (p. 25)

Cosmos sought to entertain as well as enlighten. The historical thrust of the presentations placed the conduct of science into a context that was consistent with Science-Technology-Society (STS) perspectives on scientific literacy as the interaction of science and society.

Program Profile: Einstein's Universe

A highlight of late 1970s instructional television was the PBS special *Einstein's Universe.* Although the emphasis of scientific literacy by the 1970s offered a focus on process skills and problem-solving skills, the essential role of content knowledge in the sciences could not be denied. An area of particular sophistication was (and still is) Einstein's theory of relativity. To assist teachers in the use of the program, *Aviation/Space* magazine offered an overview of the program. It consisted not so much of a teacher's lesson guide, but rather an overview and clarification of the content of the program. The approach taken, in an effort to make the ideas comprehensible to the audience, was to feature a layman as the narrator. The actor Peter Ustinov narrated the program. Identifying with the majority of the audience, he was frequently challenged to simplify difficult ideas and language. To aid in understanding, appropriate animation and narrative were used to offer clarification of the concepts developed in the narrative (Carlson and Wald, 1979). It is important to realize, too, that the information was not ''dumbed down.'' Rather, it took what Carlson and Wald (1979) described as ''Einstein's great achievement'' (p. 29) and used his ''vocabulary to think about the universe in ways that let us measure its properties'' (p. 29).

Much like *Cosmos, Einstein's Universe,* emphasized the human element in scientific endeavors. This implicitly offered support of the idea that science was a pursuit that all people could engage in.

Program Profile: Search for Solutions

Search for Solutions was a series of programs designed for students in secondary schools to help in the development of science process skills. The episodes in the *Search for Solutions* series included ''Adaptation,'' ''Evidence,'' ''Patterns,'' and others. Each episode was designed to assist the student to appreciate the topic and its role in developing scientific understanding. Connections between concepts used in life and living (such as speech) were examined and used as a means of exploring how the patterns which make speech understandable were related to patterns in nature. The content of the episodes was engaging and thought provoking, with questions posed early in the episode revisited as more information was gathered. This was the intent of the series (Conover, 1980):

> The *Search for Solutions* program is about the process of science; the titles of the films are concepts and approaches to problem solving. The films illustrate how scientists . . . solve problems, which is the fun of science. (p. 1)

To support the use of the programs, a teacher guide was issued with each program aired. The contents of the teacher guide included instructional suggestions for using the programs and hands-on science activities to develop student interest in the activities. A feedback form was included to provide information to the producers as to what were the most valuable aspects of the issue.

Produced in the late 1970s and available from that point through the middle 1980s, the series was influenced by the need to address the use of science process skills as part of the programming. The project also addressed the more inclusive nature of the science education movements of the late 1980s, by including footage featuring scientists from under-represented groups such as women, minorities, and the disabled.

Search for Solutions also adapted to the changing technologies of the time. Broadcast on television as well as later produced for direct distribution via videotape, the *Search for Solutions* teacher's guide offered a wide range of activities to support the use of the program in the classroom. The issues of the *Search for Solutions: Teaching Notes* (Conover, 1984a, 1984b) provided information and activities to teachers that encouraged both hands-on science activities and opportunities to apply the process skills (which provided the title of each episode) in an engaging and student-friendly manner. Interviews with scientists provided a context for how professionals in the field created knowledge; the activities provided allowed opportunities for students to accomplish the same.

Engaging students through the programs extended to sponsoring contests in which students could engage in independent investigations. Using investigative skills identified and described in the programs, *Search for Solutions* provided a significant part of the process. One judge mentioned, when reflecting on the entries he examined: "good use of problem solving principles found in the films" (Conover, 1985, p. 2).

Program Profile: Scientific American Frontiers

The program *Scientific American Frontiers* was a series of special programs appearing on PBS during the 1990's. Each week, a series of short episodes revolving around a particular topic, provided a range of experiences for teachers to draw from to support their classroom practice. Teacher support materials included the right to use programs in perpetuity after taping and a teacher's guide issued in advance of each episode. Further support materials were available in the form of a toll-free telephone service and an Internet web site ("The Art of Science," 1998).

One of the interesting features regarding *Scientific American Frontiers* was its commitment to a cross-disciplinary look at topics examined in each episode. The February 1998 episode, for instance, included a segment on Benjamin Franklin's glass harmonica. Activities in the teacher's guide include not only science-related activities but also information to support learning in the fields of art, music, and technology. This view of learning and teaching was clearly consistent with the goals of both the *National Science Education Standards* and *Benchmarks for Scientific Literacy.* Both documents advocated placing science learning and teaching in a context that would capitalize on the potential for interdisciplinary teaching.

Other programs related to science education include the 1993 series *The Secret of Life.* Teacher support materials were available free by request. An accompanying article in *Science and Children* served to emphasize a number of the issues in the series related to the 1990s conception of scientific literacy. Besides the content knowledge related to topics in biology, the infusion of issues related to biotechnology connects strongly to STS issues. The role of technology to effect changes, both positive and negative, in contemporary society represented and important facet of the 1990s conception of scientific literacy (Foley, 1993).

State Broadcasting Systems

State broadcasting systems served the same purpose as the national Public Broadcasting System, though on a more regional level. No single model was adopted from state to state; variety was more common among their organizational approaches. The local systems were organized either by states, communities, or sometimes by single agencies. An early model of this approach was provided by Alabama (Saettler, 1990).

> The first state-wide educational television network was developed in Alabama in 1952. The purpose of the network was to raise the standard of instruction throughout the state, a goal most observers agreed was successfully achieved. Alabama's first instructional network utilized five television stations, offering classes on the elementary and secondary level to some 158,000 students. Taken all together, at least six hundred schools made use of instructional telecasts in Alabama. (p. 366)

Examples of programs supporting science education at the state level included such efforts as *General Science,* produced by the New Mexico state broadcasting system.

Program Profile: General Science

The use of a state broadcasting system to provide science instruction served a number of purposes. Having identified the problem of curriculum coordination among the teachers of Albuquerque, New

Mexico, the use of television was proposed as a means of holding instruction together.

The solution to Albuquerque's (and New Mexico's) difficulties with curriculum coordination was the development of the television series *General Science.* Eddy (1971) described television science teacher George Fischbeck and the goals of the program:

> The main goal of Fischbeck's approach is to stir the mind of youth to like science. Thus, it is Fischbeck's aim to get the attention and to hold his interest. It is important, Fischbeck believes, to reach the young for science early in life. (p. 623)

The approach taken with the Albuquerque project was to supplement the classroom experience via television, rather than to ''present the image of the master-teacher who presents brilliant TV program lessons'' (Eddy, 1971, p. 623). To make the connections with the classroom teacher more effective, a series of teacher's guides were prepared as part of the television curriculum. The guides helped the teachers and students to focus on the relevant material presented through the television monitor. Remarked Fischbeck:

> When the classroom teacher is on chemistry . . . we're on chemistry. But no teacher has to use us. We aren't usurping the teacher's right to teach–just helping out. (''People on the Way Up,'' 1962, p. 24)

During the program's first decade, it strengthened its focus on the process skills of science, reflecting in part the influence of the curriculum movements of the 1960's. In particular, the influence of *Science: A Process Approach*, developed through the auspices of the American Association for the Advancement of Science, was evident (Eddy, 1971).

The program also anticipated the inclusive nature of the scientific literacy issues of the 1990's. The need to involve children of color, rural youth, and other underrepresented populations was a concern during the 1960's as well. To exclude any students from an education in mathematics, science, and technology was unacceptable (American Association for the Advancement of Science, 1989). Through the television broadcasts, the lessons could reach

> people outside of large cities. Thus, the same program that is presented in Albuquerque on TV is also presented to Indian American students on the Navaho Reservation, Spanish American students in the mountain communities and other students in the small towns in the valleys of New Mexico. It has provided basic knowledge regardless of the student's background or his location. (Eddy, 1971, p. 627)

While Eddy described the population served in specific ethnic terms, the ideas he shared were reflected in the 1990s document, *Science for all Americans*, with the charge to open up the pursuit of science to underrepresented groups.

Closed-Circuit Approaches

With the lower production costs available during the late 1950s and early 1960s, a number of school districts adopted a model of instructional television (IT) that relied on coaxial cables to carry the signals rather than standard broadcast frequencies. In the interest of improving instruction across the curriculum, the use of closed-circuit television was identified as a means of improving content, instruction, and student knowledge.

For the purposes of this study, the closed-circuit approach included intra-school networks, school district networks, and also cable television. Cable TV has a much different connotation now than previously, related to its use as a commercial medium. This study examined cable TV as an extension of the hardware, rather than as a radical redevelopment of the programming presented.

Perhaps the best known use of a closed-circuit approach to the curriculum was the ambitious effort of the Hagerstown, Maryland, school district. Beyond simply developing science instruction, the school district's entire curriculum was impacted by the use of a closed circuit television network.

The system devised was most comprehensive. The IT system reached some 6000 students during the 1956–57 school year and achieved nearly 100% coverage of the district (some 18,000 students) by 1959–60 (Jamison, Klees, and Wells, 1978). By 1961, the broadcast schedule had assumed the dimensions defined in Table II. What may be inferred from the table is consistent with the comments offered by David (1963). Televised broadcasting of science brought about both more science instruction at the elemen-

Table II. Weekly Televised Instruction Time[a]

Grade	1/2	3	4	5	6	7/8	9/10	11
Science	20[b]	20	25	50	50	159	159	
	(1)[c]	(1)	(1)	(2)	(2)	(3)	(3)	
Optional courses								
Physics								90
Films								(3)

[a]Table data from David (1963).
[b]Minutes per week.
[c]Number of class periods per week.

tary grades and served to standardize the quality of the instruction. Investigations into student learning were also conducted as the programming expanded. Findings suggested that television instruction had a positive impact on student achievement.

The district's interest in using instructional television served several purposes. In a report (David, 1963) describing the district's use of televised instruction, a number of statements supporting the use of television to enhance science teaching emerged:

> Before television, the elementary science program varied greatly. Teachers with training and interest in science instruction developed rich programs. Others neglected all but the barest essentials. In the upper grades, where more teachers with college training in science were available, the program was probably most appropriate for average and above average students. (p. 59)

Following up on these issues, the project shared reactions from elementary teachers surveyed as to their thoughts on teaching science with television. Ninety-two percent of the teachers surveyed (out of a 99% return rate) preferred science with television, 4% did not care either way, and 4% thought the class would be better without the use of television. Their narrative comments helped elaborate the data collected (David, 1963):

> The studio teacher is able to bring to the classroom audio-visual aids, resource people, and instructional materials which would be almost impossible without television.
>
> The children get to see many visiting people who are experts.
>
> More experiments are performed than we could ever do in the classroom.
>
> The studio teacher devotes her full time to planning and organizing lessons which are excellent. No individual classroom teacher could possibly prepare a lesson as the studio teacher does with all the other subjects he must teach. (p. 61)

Further thoughts from the perspective of the teachers using television as part of their teaching gave more evidence to support the value they attributed to the use of television in their classrooms.

> I think television is wonderful for science.
>
> I don't like science very much but can truthfully say I have learned a lot from the television lessons. Please continue this work.
>
> It has stimulated much interest and caused children to attack research work with a desire to learn . . . I hope I never have to teach in a school where there is no television. (David, 1963, p. 61)

Teacher support of the televised science instruction was clearly high. Likewise, student opinions tended to support the use of television in the science curriculum. Their comments echoed those of the teachers (David, 1963).

- I like the experiments we can do with our television teacher.
- We learn new experiments which we can show our friends and do at home.
- Our teacher on television has all kinds of things we can't get for our classroom (p. 60).

Opinion often produces changes, but data assists in keeping them. One measure of the success of the television-based curriculum came from a group of sixth-grade science scores on the Stanford Intermediate Science Test. The findings suggested that there were definite advantages to the televised science programming in terms of improving test scores. The results are summarized in Table III.

Some methodological questions concerning the use of standardized test scores in the study were identified by Cuban (1986). The failure to control for socioeconomic status made it difficult to evaluate properly the impact of this technology on the learning of all students.

By the 1980s, after having struggled with funding problems during the 1960s and 1970s, the use of television as part of the district's overall teaching strategies had changed and found the use of taped broadcasts was the rule (Cuban, 1986).

Other school districts and individual institutions adopted the same approach as Hagerstown. In the early 1960s, the Anaheim, California, school district made a similar attempt to use closed-circuit television as a means of improving the quality of education of the district's students.

Another example of closed circuit applications of television included work in the early 1980s by Menis (1982). He addressed the use of a closed-circuit approach for simulating laboratory work in the science classroom. Conceived on a much smaller scale than the Hagerstown approach, Menis (1982) sought the same goals. Noting the rising costs of laboratory materials, he developed a closed-circuit television broadcast of laboratory experiences. In his study, he determined that, for the material covered, the outcomes for the experimental and control groups were essentially the same. While he shared his preference for the actual laboratory experience, he pointed out the economic advantages of applying the closed circuit television model to classroom practice.

Table III. Average Growth in Science Achievement in Grade Six by Three Ability Levels[a]

Ability level		Pupils receiving televised lessions		Pupils in conventional classrooms
111–140	201	Pupils	84	Pupils
	118	Average growth	117	Average growth
	15	Months' average growth	12	Month's average growth
90–110	527	Pupils	365	Pupils
	100	Average growth	100	Average growth
	14	Months' average growth	11	Months' average growth
57–89	155	Pupils	146	Pupils
	83	Average growth	83	Average growth
	13	Months' average growth	6	Months' average growth

[a]Adapted from David (1963).

Cable Television

Cable television used essentially the same technology as the closed-circuit classrooms, but on a much larger scale. As the availability of cable television broadcasts became more common, the idea of ''narrowcasting''—creating programs for the interests of a small audience—became prevalent. This allowed the cable channels to speak directly to a specific audience, rather than an enormous one, and allowed for some science education programs to be produced that did not necessarily depend on an audience numbering in the tens of millions to succeed.

In the middle 1980s, *Mr. Wizard* returned to the airwaves after nearly a 15-year hiatus. Broadcast on NBC from the 1950s to the middle 1960s, it originated from Chicago station WMAQ. The updated *Mr. Wizard* ran on the Nickelodeon cable network, a channel designed for children's programming. The purpose of his show was described in an interview with Don Herbert, a.k.a. "Mr. Wizard."

> For Herbert, becoming Mr. Wizard was just doing what came naturally. He wanted to be a performer and a writer and had always been interested in what he called ''Factual stuff–like science.'' When he sold his idea to Chicago television station WMAQ in 1951, it began as essentially a magic show. (The ''wizard'' implied magic, but the ''Mr.'' give it respectability.) ''My idea of doing science turned everybody off, so we used magic tricks to get people interested. Then we did the science behind the magic, like the egg in the milk bottle.'' (Cole, 1984, p. 38)

The format of the show was rather informal in both incarnations.

> The new *Mr. Wizard's World* covers a dozen subjects in a half hour whereas the old *Mr. Wizard* covered just one. It has a segment on computers, and, of course, is in color. Otherwise it has changed little. The child sidekicks are still challenged to slice a banana leaving the peel intact . . . , or lift a car with one hand, . . . or crush a can using that ''invisible giant,'' air pressure. (Cole, 1984, p. 38)

The program fit into the more ''educational'' type of science television, as it was not designed to support a particular curriculum. Of course, the impact on student development of scientific literacy was still present. During the 1980s, when employed as a high school physics teacher, students informed the author of this study on numerous occasions that a demonstration he had performed was something already demonstrated to better effect by Mr. Wizard.

The Discovery Channel, a cable network devoted to informational programming, also offered a series of programs designed specifically for classroom use. In addition to the programming—offered during the school day, but also available for taping to use at the teacher's convenience—they offered a set of support materials to use in conjunction with the programs, thus falling into more of an instructional than educational vein. The lesson plans were written to provide activities that supported the most current standards in science education. Other teacher support materials included references to on-line resources, questions for discussion, and ancillary reading materials.

Despite the variety of resources offered, reviewing some of the questions supporting the instruction tended to be convergent questions, addressing specific content of the programs, rather than using the information as a springboard to a deeper level of problem solving. Surprisingly, even the process skills orientation consistently advocated since the 1960's was not present.

Practices in the Late Twentieth Century: 1980s and Beyond

By the middle 1980s, with several decades of experience to draw from, the late twentieth century offered several approaches to the use of television in the classroom. One solution reflected the ability of teachers to control classroom practice and make an informed instructional use of the technology. The other approach reflected a "top down" use of the technology and its role in the teaching and learning of science.

Convergence with the Motion Picture

> Few today expect the signal to be used live in the classroom. On the contrary, videotape has become the medium of choice for using ITV programming. Tapes may be recorded from the satellite signal or from intermediate distribution signals, or they may be purchased directly from distributors. (Cambre, 1991, p. 268)

The statement above, composed in the early 1990's, underscored the most significant shift with respect to how ITV was utilized in the classroom. As discussed in the previous chapter, by the early 1940's the use of the motion picture in the classroom was a standard practice. It had attained a position comparable to the chalkboard in terms of being an accepted instructional tool. The changes in technology, however, changed the technology of choice from the motion picture to the videotape. The flexibility of usage described in the previous chapter allowed the videotaped motion picture to attain a position of preeminence in classroom practice. Not only was it a simple matter to use teacher-created videotapes, but the ability to bring recorded television images into the classroom eliminated the constraints imposed by inconvenient broadcast times. This convenience of access through taping was also helpful in using satellite broadcast signals in individual classrooms.

Satellite Broadcasts

Satellite broadcasts to individual schools were conceptually rooted in the aviation broadcasts of the early 1960s. Briefly, that approach used the advantage brought about by the airplane's altitude to broadcast instructional programs to the schools waiting below (Smith, 1961).

> The Midwest Council on Airborne Television Instruction was formed because of concern of educators in the Midwest, as in the rest of the country, with the challenge facing American education today—the challenge to provide sufficient quantity of educational opportunity for a fast-growing school population, along with increased quality of instruction, and to provide both quantity and quality within feasible costs. (p. ix)

The airborne approach allowed broadcasting to cover an extensive area, with signals reaching parts of six Midwestern states.

With the development and proliferation of communications satellites, a direct satellite link to the receivers located in a school became a reality. General-purpose satellite programming such as Whittle's *Channel One* brought satellite-fed programming to numerous schools throughout the United States by the 1990s. On a smaller scale, individual schools took advantage of an instructional television satellite link by the early 1980s. Though not as common as direct cable television's connections, some rural locations found them to be exactly the solution to their IT needs they had been seeking.

The satellite delivery approach served isolated communities such as Circleville, West Virginia. In an effort to augment instruction, the school district arranged for the purchase of a satellite dish antenna. For areas such as Circleville, surrounded by mountainous terrain, this provided the first opportunity to make use of educational television (Dickson, 1981). This link to the "outside world" made it possible for teachers to use existing educational curricula to supplement their classroom practices.

One source of instructional material for the sciences was NASA. The connection protocols and services offered by NASA were described in on-line documentation:

> NASA Television (NTV) is a resource designed to provide real-time coverage of Agency activities and missions as well as providing resource video to the news media, and educational programming to teachers, students and the general public. (Dunbar, 1998)

To assist teachers and students in the use of the programming offered by NASA, comprehensive lesson plans were available for classroom use. Due to the cost of postage, by the late 1990's the materials were made available for access through the Internet as well as through regular U.S. mail should the teacher elect to pay for the postage. Topics ranged from the history of space exploration through medical applications, weather observations, mathematics, and Newton's laws of motion (NASA Central Operation of Resources for Educators, 1998).

LINK TO SCIENTIFIC LITERACY

The birth of television as a consuming part of American culture began in the late 1940s with the economic expansion coming about at the end of the Second World War. The scientific literacy issues of the day were defined by the National Society for the Study of Education's (1947) *Forty-Sixth Yearbook.* No mention of television was made in that document. Technology was addressed in terms of the use of the motion picture and slide films.

It should be noted that early instructional approaches using television were similar to early approaches with the motion picture. In the Indianapolis experiment described by Barth *et al.* (1958), the focus of the television approach was on developing improved content knowledge. This was consistent with the goals of scientific literacy a generation earlier but included the use of a new technology to make the process more efficient.

The evolution of the programs associated with *TV Schooltime* helped to define the conceptions of scientific literacy from the early 1950's through the 1970's. Early episodes, based on viewing both the episodes and the teacher support materials, tended to focus on scientific knowledge and applications to the community. Given the largely rural Iowa audience of *TV Schooltime*, it even seemed to contain some elements of the Nature Study conception of scientific literacy. By the 1960's the focus of the program reflected clearly the science curriculum movements of that time. The role of problem solving and science process skills came to be an important part of both the desired curriculum and the content of instructional television programs.

The experiences of George Fischbeck and his *General Science* program helped to promote the 1960's view of scientific literacy. The early focus primarily on science content gave way to the broader view of science as having both content and process skill components. The evolution of *General Science* during the 1960s reflected this change in how science was conceived in education.

The *3-2-1: Contact* use of a problem-solving component to engage student interest was consistent also with the further development of the scientific literacy concept. Within a few years of the inaugural broadcast of *3-2-1: Contact,* the prevalent idea of scientific literacy expanded to include problem solving as a component of the purposes of science education.

A study of several science television programs available via broadcast television and cable during the 1990's led to some interesting perspectives on the role of science television programs and the goals of scientific literacy. The data gathered by Long and Steinke (1994) showed the contrasts that educational programming offered. One of the primary contemporary tenets of science education was that science is for all Americans, regardless of age, gender, or social class. In each of the shows profiled (*Bill Nye the Science Guy*, *Beakman's World*, *Mr. Wizard's World*, and *Newton's Apple*), activities were demonstrated for children to duplicate at home.

> There is evidence in the shows that science is intended for everyone, not just white males. In all shows, viewers are encouraged to try the at-home experiments, thus indicating that anyone can do science.
>
> People on the shows represent multiple ethnic groups and both genders. Furthermore, females and children of color play important roles in two programs, often explaining or presenting scientific information. (Long & Steinke, 1994, p. 22)

Though the overarching goals of scientific literacy were addressed, there were other aspects to the programs in conflict with the inclusion goal. These aspects tended to be in conflict with the process of science and had a tendency to reinforce stereotypes about the practice of science and of scientists.

The contemporary idea of science as a process of explanation and argument was not commonly presented in any of the programs. Drawn from their viewing of two programs, Long and Steinke (1994) presented this evidence:

> Another way that Beakman's all-knowing image is perpetuated to viewers is through the way that Liza and Josie introduce him to viewers. In one typical episode, Josie calls Beakman "the merchant of mentality," "the kaiser [*sic*] of chemistry," "the one, the only, the Beakman."
>
> Like Beakman, Mr. Wizard constantly displays his expertise though his explanations of science. Mr. Wizard always knows the answer, and Mr. Wizard is always right. As with Beakman, Mr. Wizard's expertise seems limitless. (p. 25)

Seemingly in contrast with the idea that science is for everyone, there was also a tendency for science to be presented as elite, eccentric, and antisocial. This was unfortunate, as the use of lab coats, fright wigs, and odd behavior sent strong messages to viewers as to not only the nature of science but also who was deemed able to engage in its practice.

In some instances, there was a tiered system present with respect to the role of females in the programs. An examination of the same series of programs undertaken for another study (Steinke & Long, 1995), found that only 35% of the scientists shown on the program were female; the entire number of females on the programs was 52% of the entire cast. Furthermore, of the remaining female characters, many were portrayed in subservient roles such as laboratory assistants and apprentices. Clearly, the days of truly appropriate science programming are yet to come. The children's science education programs profiled were helpful in developing process skill and content knowledge but also perpetuated a number of sex role stereotypes and misrepresentations of scientists as socially inept human beings.

SUMMARY

The use of the television as an instructional tool may best be described in Fischbeck's words: television wasn't replacing the teacher—but rather just ''helping out.'' Though television did not revolutionize the teaching of science as early advocates such as Poole (1950) had hoped, it did provide a useful tool for bringing the world to the classroom as had the motion picture in previous generations.

As with the use of the motion picture, literature surrounding the instructional use of television presented three distinct phases (King, 1999a, 1999b):

1. Development of interest and focus on the hardware.
2. Development of appropriate pedagogy, and
3. Dissemination of software as the use of technology enters a mature state.

Examples to support this view were evident throughout this study. Examples of the first phase included Poole's *Science Via Television*, *Planning for Schools with Television*, and *This Is Educational Television. Planning for Schools with Television*, in particular, highlighted the technical issues associated with the hardware and classroom arrangements needed to optimize television teaching.

The second phase of television infusion, development of the appropriate pedagogy, was exemplified by works such as Diamond's (1964) *A Guide to Instructional Television,* which detailed many of the important instructional issues related to the use of the television in the classroom. Many of the examples he used were designed to demonstrate the effective teaching of scientific principles via television. Many efforts during the 1950s and 1960s (see, for example, Levenson and Stasheff, 1952; Rock *et al.*, 1952; Rock *et al.*, 1954; and Smith, 1961) helped to develop and disseminate effective pedagogy for television instruction.

The final phase in the evolution of the television as a tool for science teaching—the dissemination of software—was more problematic than with the motion picture. The availability of useful science television programming was through either a locally produced set of materials (see *TV Schooltime*, Fischbeck's *General Science*, or the Hagerstown application) or through programs which were more ''educational'' than ''instructional'' (*NOVA*, *1-2-3: Contact*, or the *Scientific American Frontiers* series). Instructional applications were adapted on a case-by-case basis for science instruction by classroom teachers.

Though videotaping relieved the teacher from being held captive to the broadcast time slot, the limited availability of useful classroom materials has been the greatest deterrent to more liberal use of television in the classroom. Some children's educational programming, despite the attention given to scientific accuracy of content, tended to support unfortunate stereotypes.

A final area for reflection had to do with the challenge of balancing entertainment versus instruction, especially when applied to the commercial television and cable ventures that were not related to a particular curriculum. The advantages of showing a diverse group of young people engaging positively in science would be considered a virtue; the entertainment value of placing television scientists in lab coats and fright wigs sent a different message.

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