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ABSTRACT

This study reports one investigation to better understand teachers' perspectives about teaching Science, Technology, and Society (STS). The study examined five teachers' perceptions of STS topics taught or not taught in their local schools. These teachers completed a summer workshop or an academic year class on STS. The curricula in the two STS inservice educational experiences were very similar, and interpretive research strategies were used to describe and interpret the teachers' classroom practices of infusing STS into the science curriculum. Two principal assertions related the teachers' perspectives on job security to their STS curricular decisions and the teachers' perceptions as outsiders to increasing conformity to what they perceived to be the school's local culture and decreased teaching of controversial issues. Findings suggest that teacher education experiences must include opportunities for practitioners to consider the impact of their beliefs concerning their local school cultures on their STS teaching practices. Included are the five teachers' responses to an opinionnaire. (Contains 46 references.) (Author/DDR)

Teachers' Perspectives Of Teaching Science-Technology-Society In Local Cultures: A Socio-Cultural Analysis

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Abstract

The teaching of Science, Technology, and Society (STS) topics to school age children is generally advocated by the science education community as a critically needed infusion throughout the K-12 science education curriculum. In many instances, the STS initiative does not play a significant role in the science teaching of practicing teachers because of the perceived controversial nature of many topics. In this context, an exploration using a socio-cultural perspective to better understand teachers' perspectives about teaching STS was undertaken. The constructs of taboos (beliefs that constrain action by making those behaviors perceived as threatening by the members of the social group forbidden and improper for discussion) and noas (instructional topics that teachers generally perceived as not forbidden and as proper topics for discussion in local cultures) were employed in this study to investigate the perceptions of science teachers about controversial topics and curriculum infusion. Five teachers completed either a summer workshop or academic year class on STS. The curricula in the two STS in-service educational experiences were very similar. Interpretative research strategies were used to describe and interpret the teachers' classroom practices of infusing STS. Two principal assertions related the teachers' perspective on job security to their STS curricular decisions and the teachers' perceptions as outsiders to increasing conformity to what they perceived to be the school's local culture and decreased teaching of controversial issues. Teacher education experiences must include opportunities for practitioners to consider the impact of their beliefs concerning their local school cultures on their STS teaching practices.

Teachers' Perspectives of Teaching Science-Technology-Society In Local Cultures: A Socio-Cultural Analysis

Introduction

The teaching of Science, Technology, and Society (STS) topics to school age children is generally advocated by the science education community as a critically needed infusion throughout the K-12 science education curriculum (American Association for the Advancement of Science, 1993; Bybee, 1993; National Science Teachers Association, 1982; National Resources Council, 1996). Proponents believe that the study of STS, defined as socially relevant topics where science, technology, and society interface, (i.e., nuclear energy, population growth, environmental stresses) will encourage interest, critical and high-level thinking, problem-solving, as well as decision-making capacity and concerted action for a democratic system, in students (Zoller, Donn, Wild, & Beckett, 1991). Advocates of the STS movement have long argued that the change in the science curriculum is necessary for the future health of society and the environment (Bybee, 1994; National Science Teachers Association, 1982.) Many research studies have shown, however, that the infusion of STS in school curricula has been minimal and problematic (Ham & Adams, 1987; Rosenthal, 1984). After reviewing the STS literature, Bybee (1993) summed up the situation: "I can only conclude that STS is minimally represented in the actual science curriculum for the majority of students." (p. 137). For science educators, the challenge is to understand why this situation exists when science teachers regularly report that they support the STS initiative (Barman, Harshman, & Rusch, 1982; Bybee, 1993).

One potentially fruitful area to explore in understanding why the STS initiative does not play a significant role in the science teaching of practicing teachers is the cultural realm. Charron (1991) argued for a social-contexts frame of reference that values and solicits "participant perspectices relating to target phenomena" (p. 611) to provide insights into problematic areas of science education. Tobin (1991, p. 2), in referring to the general difficulty of changing teacher practices, also pointed in this direction when he stated:

> Because of the difficulty of changing practices to conform with a given referent, it is not surprising that change takes so much time. Actions do not take place in isolation from a culture, and as a consequence, changes of an individual might not be met with the approval of other participants in a culture. Indeed, some changes that are contemplated might be taboo in this culture.

Many of the topics inherent in STS education are acknowledged as controversial to the community-at-large and pose special problems for science teachers to teach in their local school districts. Ironically, the most relevant topics to students in a particular school are often perceived by science teachers in those schools as too controversial to teach. There is a paucity of research about topics science teachers perceive to be "frowned upon" or forbidden to teach in their communities and how teachers then act on these beliefs. Duffee and Aikenhead's study (1992) about decision making and teaching science through STS underscores the critical need for this type of information. They argued that only by determining what constitutes the full spectrum of teachers' human experience ("teacher practical knowledge" which includes an examination of past experiences, current teaching position, and a vision of how their teaching positions should be, p. 494) will curricular decision making by STS teachers be understood and more open to influence by STS advocates.

This study reports one investigation to better understand teachers' perspectives about teaching STS. It examines five teachers' perceptions of STS topics taught or not taught in their local schools. This research also explores a socio-cultural perspective in STS research and reports on the explanatory power of interpreting the practices of STS science teachers. It should be emphasized that this study is not intended as an evaluation of the teaching practices of the teachers who graciously participated in this study.

Theoretical Perspective

This interpretive study falls within a radical constructivist framework. Constructivism is defined and used in this paper to describe the epistemology where individuals construct meanings from experiences, and these experiences are evaluated by their fit or viability with their current and

previous understandings (von Glasersfeld, 1989, 1992). Radical constructivism posits that individuals can strive only to know models of the world and not an ontological reality (Roth, 1995).

Within the radical constructivist framework, this study takes an ethnomethodological perspective (Heap, 1990). Ethnomethodology is the perspective where individuals are situated within social structures in which they actively seek to bring order to their lives on a moment-by-moment basis by interacting with the social world. Through these interactions, individuals in a culture "organize their reasoning and actions and their interactions, as rational, recognizable, orderly events" (p. 20). The focus of this study was documenting participants' constructions of the beliefs they perceived within their schools' local cultures which influence their selection and instruction of STS topics.

In the larger context, this study contributes toward the emerging effort to conceptualize a cultural perspective for science education (Aikenhead, 1996), where all teaching and learning occurs within a culture. There are numerous definitions of culture promulgated by anthropologists; the preponderance of definitions fit in two general categories, a totalist view and a mentalist view (Vivelo, 1994). In the totalist view, culture is broadly defined as an adaptive mechanism consisting of the totality of tools, acts, thoughts, and institutions which serve to maintain a population. Weiss (1973) succinctly stated "culture is the generic term for all human nongenetic, or metabiological, phenomena" (p. 1396). This study does not purport to examine all phenomena that influence science teachers' enactment of STS teaching practices. Instead, it is limited to making some sense of the curricular impact of the participants' conceptual constructions of their local cultures (the totalist definition on culture is not used). The less comprehensive mentalist view of culture, in which culture is viewed as an ideational or conceptual system, better fit the nature of this study. In the mentalist view, culture is defined as a shared set of ideas, a "conceptual code" (Vivelo, 1994, p. 16), which individuals use to reflect upon themselves, the world, and as a heuristic for their actions. Culture is a system of thoughts, not objects. What guides individuals' lives within a culture is their conceptualization of appropriate behavior (Frake, 1964). In addition,

this research is further informed by Geertz (1973) who alerted the interpretive research community that only by focusing on the knowledge constructed in "local example[s] of the forms of human life is there hope of gaining insight in the practices "of the mind" (p. 16).

Researcher Perspectives

In an effort to move toward critical subjectivity (a consciousness of one's beliefs, values, and epistemologies) as researchers, we share our perspectives on conducting research. Our interests and expertise is in the use of interpretative research methodology (Alasuutari, 1995; Erickson, 1986; LeCompte, Millroy, & Priessle, 1992). The data we collected are interpreted through that methodological lens. As a consequence of Lakoff and Johnson's (1986) work on the concept of "experiential realism," we believe there is worth in interpreting the social context in which science teachers practice from the teachers' perspectives. This means that the experiences of participants in this study are thought to be constructed in an awareness of a community that maintains its own belief structure. McGinnis also is interested in pursuing Tobin's (1991) allusion to taboos in teaching practice as applied to STS education to see if that assists in explaining why the infusion of STS in the curriculum is minimal even though most teachers support it. Duffee & Aikenhead's (1992) heuristic model of teacher practical knowledge encouraged us to place emphasis on the teachers' perspectives of their past experiences, their present teaching positions, and their visions of exemplary STS pedagogy.

We also held the belief that case studies can reveal insights that relate both to the hypothesis-generation and hypothesis-testing domains (Brause & Mayher, 1991), particularly if additional case studies examine identical issues in similar contexts. As a result, the research design for this study consisted of two case studies conducted sequentially over a two-year period where there was an identical research interest in similar contexts. Both case studies were based on a socio-cultural research perspective to generate grounded theory (Glaser & Strauss, 1967). In the first case study the research design is the development of an explanatory framework. The second case study served to determine to what extent the interpretative assertions of the first case assisted in understanding an identical issue in similar contexts with different participants. McGinnis's role

as a researcher (Creswell, 1994) during the first case study was one of observer and participant (he led one workshop session in which the study participants were enrolled). His role during the second case study was as an observer. Simmons' role as a researcher in both of the case studies was as a co-data interpreter.

An Anthropological and Sociological Perspective Of Avoided and Accepted Topics Within a Culture

The disciplines of anthropology and sociology offer insight and understanding of topics of discourse which are avoided and accepted areas within a culture. The constructs of *taboo* and *noa* are used to refer to these instances, respectively.

Taboo

Taboo (variations: tabu, tapu, and tampuh) is a Polynesian word that originated from Sanskrit and meant a general priestly ban or a specific object which should not be touched (von Raum, 1973). Captain James Cook's 1771 Polynesian voyage introduced this term to the English language. In its original scholarly usage in anthropological field studies of homogeneous, native cultures, taboos were defined as behaviors dangerous both to the individuals who engaged in them and to others (Knipe & Bromely, 1984). The element that distinguished taboos from other prohibitions was an automatic punishment associated with them. Margaret Mead (1928) stated "Tabu may be defined as a negative sanction, a prohibition whose infringement results in an automatic penalty with human or superhuman mediation." Burriss (1931) also defined taboo as a feeling that certain objects, actions, or persons are, for some unknown reason, possessed of a mysterious power which makes them dangerous and should be avoided. The reason for the taboo is usually lost over time.

The taboo construct has been of great interest to many social science scholars. Geertz (1983) distinguished humans from other animals as a result of our social structure built around a taboo on incest. Durkheim distinguished taboo by its strictness and its categorical nature (von Raum, 1973). Sigmund Freud (1918) made the argument that taboos (defined as a series of restrictions which people impose upon themselves that are forbidden without any apparent reason

and which they do not think to question) expressed a fragment of psychic life which is not comprehensible to humans.

More current definitions of taboo have moved away from the notion of an automatic, supernatural punishment and now emphasize the socially agreed upon forbidden component. Radcliff-Brown (1953) led this change by defining taboo as a ritual prohibition--a belief that an infraction would result in an undesirable change in the ritual status of the transgressor through the actions of other members of the society. Schroeder (1984) made the argument that although taboos are generally thought of as irrational proscriptions (deeply ingrained traditions that once may have had reasonable meanings that have long since worn away leaving a residue of ritual behavior), some are rational, such as the silence rule in libraries. Voigt (1984) pointed out that taboos are the dark and scary side of a culture. The social aspect of taboo as describing behaviors which are universally forbidden within a given social group was furthered argued by Knipe and Bromely (1984).

Taboos constitute an effective way for social groups to identify threatening behaviors and, having identified them, establish grounds for controlling those behaviors and the misfortunes which will result. Fortes (1983) supported the social creation of taboos when he stated that they are simply examples of a special kind of rule which guide an individual's life every hour of the day in society. Rules convey the socially authorized and sanctioned norms for the conduct of social and personal life. Von Raum (1973) argued for taboos to be placed under the rubric of restraints (restraints being defined as a limitation of a person's freedom of action or a reduction in the individual's sphere of control), with avoidance and taboo making up the ends of a continuum. Finally, Shaw and Boone (1951) argued for the consideration of levels of taboos, allowing the word to be used for both the identification of minor forbidden behaviors and larger, more generally held societal restrictions of behavior (similar to the original meaning from Sanskrit).

The definition of taboo employed in this study is a hybrid of the more current socially constructed definitions. Taboos are beliefs that constrain action by making those behaviors perceived as threatening by the members of the social group forbidden and improper for

discussion. In other words, taboos are constructed by the social group to control behavior that threaten the culture's belief structures. By extension, the label of taboo was applied to STS topics which science teachers avoided teaching because of a perception of being forbidden. By excluding these topics from the science curriculum, those topics were evaluated to be improper for discussion in the classroom. In addition, the general ban on teaching a topic in the science curriculum perceived as threatening in local cultures was also labeled taboo.

Noa

Noa is a Polynesian word also introduced into English following Cook's voyage. It has the opposite meaning of taboo, i.e., things ordinary and generally accessible (Freud, 1918). It is a term that has not been extensively used in colloquial English or in anthropological or sociological research, although its semantic power to serve as a succinct antonym of taboo is apparent.

In this study, the noa in STS instruction was defined as those instructional topics that teachers generally perceived as not forbidden and as proper topics for discussion in local cultures. These topics were not perceived as threats to the local belief systems and held little controversial potential.

Method

Context

The first cohort of case study participants (n=2) completed an Eisenhower funded three-week summer STS inservice workshop conducted at a major state university in the Southeastern U. S. A. The second cohort of case study participants (n=3) completed a 5-credit academic class one year later at the same university. The curricula in the two in-service educational experiences were identical, including the field trip sites, and were primarily designed and taught by the same science educator. The workshop and the academic class experiences differed only in the extent that the less time constrained academic class allowed additional time for discussion of the STS topics.

Curricula of the STS Experiences. The summer STS inservice experience included an intensive two-week workshop held on a university campus and a subsequent one-week field-based directed study. Participants in the workshop received 3 in-service credits and a stipend. The

workshop provided fourteen upper elementary and secondary practicing teachers with an update in scientific knowledge about the environment on a global and local scale, an introduction to the theoretical framework underlying STS (focusing on the two approaches to STS, the social issues and the social aspects of science) and problem solving, and extensions of these ideas to classroom applications. The social issues STS approach (which "deals with specific topics or problems in science, technology, and society", Rosenthal, 1989, p. 581) served as the dominant STS approach in this introductory STS workshop. However, the social aspects of science STS approach (which uses the perspectives of other disciplines such as history and philosophy to study the interactions among science, technology, and society) was also promoted in discussions for further study as an enduring STS theoretical framework. Emphasis was placed on incorporating STS related goals and activities in the science curriculum. Special attention was focused on the design and implementation of effective teaching strategies (e.g., role playing and investigative labs) in relation to the featured environmental science topics. The one-week field-based component of the workshop provided teachers with opportunities to examine and apply first-hand the ideas from the workshop to selected sites in the state. The field trips were organized to help teachers relate the scientific update sessions to the development and practice of teaching skills and strategies appropriate for STS education. They were conducted to exemplify how teachers could locate, design, translate, and implement field-based activities with their students.

Specifically, the two-week campus workshop included a series of sessions that focused on an update of scientific knowledge in societal issues and current specific pedagogy related to STS issues and problem solving. Conceptually, the topic areas in science content and in science-specific pedagogy were approached from four perspectives: global, national, state and local. Participants were encouraged to reflect on how the issues at each level influenced their teaching practices. The science content sessions were led by three members of the science community (senior level university faculty in science departments and institutes). The 3 to 4 hour morning and afternoon time blocks allowed the teachers and the scientists to discuss trends in research and the implications of that research on society. Specific topics addressed in the science content update

sessions included global warming, acid rain, water pollution, soil erosion, endangered species, habitat degradation, and bioengineering. To enhance the involvement and interest of the participants, prior to each of the science update sessions, participants were invited to submit questions to each of the presenters on the science topics. These questions served to guide the scientists' presentations and discussions.

The campus workshop also featured content specific pedagogy sessions organized around the science content sessions. These sessions built upon the participants' repertoires of teaching strategies by engaging them in activities and experiences representative of various strategies and alternative models of learning. Teaching strategies modeled and emphasized in these 2 hour sessions included mediative, generative, and collaborative strategies (Costa, 1985). Cooperative learning and role playing were used extensively throughout these sessions. Specific topics included decision-making, issue analysis, cooperative learning strategies, and futuristic problem-solving. Constructivism served as a referent for the instructors and participants of the workshop (Tobin, Tippins, & Gallard, 1994). Learning was portrayed as "making sense of experience in terms of what is known" (p. 48) in a social context. The teacher participants were encouraged to view themselves as learners and to give meaning to the workshop experiences by personal reflection that connected extant knowledge with new knowledge constructions. Discussions centered on teaching actions the participants could employ in school to facilitate effective and meaningful learning experiences for their students. Organizing questions included "How can teachers help students identify local, regional, national, and international problems which influence their daily lives?" " How can teachers design and implement a learner-centered classroom through problem solving organizers?" "How can teachers empower students to make decisions and changes and become aware of the responsibilities that accompany those decisions?" and "How can teachers develop problem-solving frameworks and organizers for enhancing classroom teaching and student learning?".

Resources used in the pedagogy sessions included simulations, laboratory activities, and curricular resources (including Project Wild, Outdoor Biology Instructional Strategies, Project

Learning Tree, BSCS Science, Technology & Science Modules, SirS Critical Issues, and CEPUP).

The one-week field-based component of the workshop consisted of three specific excursions within the state. Participants traveled in minivans to the destinations and spent the nights in workshop provided lodgings. Three representative excursions were selected as exemplars of geographic sites that offered opportunities for exploration of STS issues. The first excursion was to an environmental center that featured a comprehensive environmental education program, the second to an operational nuclear reactor and weapons facility, and the third excursion was to a series of mines, a major pristine swamp, and a barrier island.

Participants

First year. Two teachers were participants in the first year of this two-year long study. They volunteered and agreed to be observed throughout the academic year as they implemented STS practices in their local schools. For purposes of confidentiality, both participants are given pseudonyms, "Ms. Shaw," and "Ms. Bird," respectively. Three teachers in the second year of this study voluntarily participated in the second offering of the STS inservice workshop offered as a quarter long academic class. They also agreed to write and submit for review STS curriculum units designed for their schools and to be observed during implementation of those units in the academic year. For purposes of confidentiality, these participants are given pseudonyms, "Ms. Star," "Mr. Bailey," and "Mr. Jefferson," respectively.

For the first phase of this study, we employed a combination of factors to select the two participants: proximity of the teachers' schools to the university; participants teaching in districts far from the university would limit the previous exposure to us or to the STS initiatives promoted in local school districts by our department; diversity in level of teaching experience (new to experienced); teachers' beliefs about science (this diversity would enhance the quality of the data collection and interpretation); participant interest and active involvement; and, lastly, focus on a very limited number of contexts to extract insights into teachers' STS practices. The selection of Ms. Shaw and Ms. Bird fulfilled all of the criteria.

Ms. Shaw is a White woman in her late 20's who teaches 4th grade. Before taking her present teaching position, she taught middle school science for 5 years in another school district. She is not tenured. Ms. Shaw lives in a neighboring county and commutes daily to work. From our researcher perspectives what initially impressed us about Ms. Shaw during the summer workshop was her lightheartedness and casual summer attire, shorts and tee shirts. In contrast, the other participants dressed in much more formal attire. Ms. Shaw also projected that she was a confident and successful experienced teacher.

Ms. Bird is a White woman, in her early 20's, who teaches 6th grade. This is her second year of teaching and the first year in her current school. She is not tenured. Ms. Bird lives outside of the county in which she teaches, and she commutes daily to her school. During the group discussions conducted in the summer workshop, we were impressed by Ms. Bird's comments. She was serious and consistently focused on her teaching role. She projected herself as a new teacher who wanted to improve her science teaching practice.

Second year. The second cohort was selected to widen the pool of participants' characteristics regarding demographics and school location. Of the six participants originally targeted for inclusion, three ultimately fully participated (the other three expressed interest but were unable to coordinate mutually convenient site visit dates with the researcher or to fully participate in data collection strategies).

Ms. Star is a White woman in her mid-40's who teaches 5th grade. This is her fifth year of teaching at her present school. She is tenured. Ms. Star is a long time resident in the community served by her elementary school.

Mr. Bailey is a White man in his early 50's who teaches 8th grade. This is his tenth year of teaching at his present school. Mr. Bailey is tenured and lives in an adjacent community.

Mr. Jefferson is a White man in his mid-30s who teaches 9th grade physical science and 10th grade biology. This is his third year of teaching at his present school. Mr. Jefferson is not tenured and lives outside of the community served by his high school.

We selected these participants based on: the school's geographical position in the state (different rural and suburban districts compared to the first case study participants); diversity in level of teaching experience (new and untenured to experienced and tenured) and in beliefs about science (the teaching practices of those participants who were both similar to and different from the first case study would assist us in determining the explanatory power of the emergent insights from the first case study); participant interest and active involvement; and, increase the sample of participants compared to the first case study (to determine if a greater number of sites within this social context offered additional insight into teachers' STS practices). The selection of Ms. Star, Mr. Bailey, and Mr. Jefferson fulfilled these criteria.

Sources of Data

During the first phase of the study, a variety of data collection methods were used. Throughout the summer STS workshop, McGinnis took field notes in the daily STS sessions conducted at the university. Both Ms. Bird and Ms. Shaw were observed as they participated in the workshop's activities. In instances in which McGinnis was not available to directly observe the participants, he talked with the faculty who were present and recorded their anecdotal observations of the participants. Upon completion of the summer STS workshop, Ms. Shaw and Ms. Bird completed a 17-item 5-scale Likert opinionnaire[1] (Likert, 1967) crafted for this study (refer to the Appendix). The purpose of administering the opinionnaire was to provide selective information on the participants' level of science and STS beliefs. In addition, Ms. Shaw and Ms. Bird gave responses to four open-ended survey questions during the last day of the workshop that related to STS issues and perceived barriers to teaching STS topics.

During the academic year, McGinnis made a site visit to each of the participants' classrooms and conducted a semi-structured, audio-taped interview in which the participants reflected on the summer STS workshop and on their subsequent STS teaching practices over the school year. Artifacts, including participant lesson plans, also were collected for analysis.

During the second phase of study, we employed artifact analysis, classroom observations, and individual interviews. McGinnis reviewed the STS lesson plans that the three participants

submitted to their course instructor during their STS course. In these lesson plans, the participants presented a STS classroom activity they intended to use in their practices. After their STS course, the participants were mailed a copy of the science and STS opinionnarie along with a copy of the open-ended four survey questions. McGinnis then visited each participant once during the spring quarter following this fall class. He observed them as they implemented their STS teacher-designed activities in their local cultures. McGinnis had no previous contact with them, since he had not participated in their course. All three participants were interviewed using a semi-structured protocol at the end of the site visits. These interviews were audiotaped and transcribed. Table 1 contains the semi-structured protocol used in this study.

[Insert Table 1 about here]

Data Analysis

Methodology. Data analysis in both sets of case studies was conducted within and across two levels. The first level data analysis focused on documenting the level of selective beliefs the participants held toward science and the teaching of STS. There was also an attempt to compare and contrast these findings among the participants. The second level data analysis was performed during the academic year following the STS experiences. It consisted of a review of both data collected during the academic school year and during the inservice STS experiences. In the second level of data analysis, the focus was first on identifying each participant's avoided (taboo) and taught (noa) STS topics, second on documenting how the participants perceived their local cultures, and third on using analytic induction (Glaser & Strauss, 1967) to generate analytic constructs that explained the participants' patterns of STS enactment. Both sets of analyses informed each other and contributed toward the findings and emergent understandings from the two-year study duration. Within each analysis, ongoing efforts to triangulate and to disconfirm data were performed.

During the second case study, the first level analyses were performed along with a new analysis. In the second level analyses, the focus was first on the identification of science topics that were avoided or accepted (guided by the emergent understandings from the first case study)

and second on documenting how the participants perceived their local cultures. The analysis was different from the first case study by seeking to make claims concerning the extent of the explanatory power from the analytic constructs of the first study to make sense of these teachers' STS practices in their local cultures.

Trustworthiness of the data. Criteria to enhance the trustworthiness of the data analysis was based on Lincoln and Guba (1989). During the first phase of this study, McGinnis was a regular observer of the workshop, a workshop presenter, and an interviewer. During the second phase of the study, McGinnis reviewed STS participant products, arranged for and made on-site classroom observations, and interviewed all the participants. He also engaged in continuous peer debriefings during this study and had regular conversations with the designer of the STS workshop that focused on the research efforts. He presented on-going research understandings of this phase of the study at three separate research association conferences (science teacher education, qualitative, and science education associations, respectively) with this same workshop designer. Throughout the first case study, and especially during the second case study, we revisited emergent insights relevant to the understanding of avoided and accepted STS topics.

The principal incentive of engaging in the second phase of this study was to refine the emergent understandings from the first phase of the study. This was performed by increasing the number of case study participants, broadening the range of participant selection criteria (such as holding tenure), and by continuously looking for evidence to support or dispute first phase emergent understandings. In particular, classroom observations of participant STS lessons were conducted to provide another valuable source of evidence. Both before and throughout the study we monitored our developing constructions. Through the overt act of identifying our research perspectives and intentions we documented our commitment to engage in progressive subjectivity.

During the second phase of the study we were particularly sensitive to hold the emergent understandings from the first phase of the study as provisional while at the same time employing them as a lens to better detect and understand manifestations of teachers' perceptions of their circumstances. We engaged in ongoing member checks by formally sharing our written

interpretations of the workshop and the participants' actions with both the workshop designer and the participants. In multiple instances McGinnis confirmed with the participants that we accurately documented their statements and conditions obtained from site visits and interviews that were transcribed. Throughout this process, we received no challenges to the interpretation of the detected avoided and accepted topics or to the participant perceptions of the local cultures in which they practiced. However, due to the perceived sensitive nature of the topic of the study, the participants' reiterated their desire for confidentiality and anonymity to protect them from possible administrative censure within their school districts.

Emergent Understandings

The First Case Study

Level One: The Inservice STS Workshop. Ms. Shaw responded to all 17 items on the end-of-the-workshop science and STS opinionnarie and impressed us by how many items on which she held strong positions (Table 1). In some instances she revealed some ambivalent beliefs. For example, she indicated that time should be taken away from other subjects for STS issues and then she also said that is not practical.

[Insert Table 1 about here]

Ms. Shaw responded to all open-ended items on the survey administered at the end of the workshop. Ms. Shaw's vision of the "ideal" STS teacher was one of a nurturing teacher who promoted student initiated problem-solving. Ms. Shaw's responses to the survey questions encouraged McGinnis to pursue topics with her that she perceived as controversial to teach in her community, especially since she did not indicate if she would teach any of them (see Table 2, question #4). In addition, based on Ms. Shaw's identification of "evolution" and "the Big Bang theory" as STS topics which would get her into trouble (see Table 2), we wondered if Ms. Shaw constructed a definition of an STS topic as any science topic that she perceived as controversial in her community. While controversial in some contexts, the STS topics Ms. Shaw identified (evolution and the Big Bang theory) are not generally recognized as STS topics and were not

identified as STS topics within the guidelines promoted by Zoller et al in the summer in-service workshop.

[Insert Table 2 about here]

Ms. Bird responded to all items on the end-of-the-workshop science and STS opinionnarie. The opinionnaire data suggested that she was not a participant who held many strongly opinionated stands in the select science beliefs included on the opinionnaire (see Table 1). In contrast with Ms. Shaw who identified seven "strongly believed" items and one "strongly does not believe" item, Ms. Bird did not identify any item in which she held a strong belief. Ms. Bird indicated that she held many ambivalent beliefs concerning STS instruction. For example, she agreed with Ms. Shaw that time should be devoted to the study of critical problems in schools but that it was just not practical.

Ms. Bird responded in detail to all open-ended items on the survey administered at the end of the workshop. Ms. Bird's vision of the "ideal" STS teacher was one of a student-centered teacher sensitive to her students who guided her students to draw their own conclusions. Ms. Bird stated on the open-ended survey that she held the belief that evolution was a STS topic (see Table 2). This puzzled us since the STS workshop had not identified evolution as a topic in the STS initiative. Ms. Bird's carefully thought out responses on the STS topics to be avoided encouraged us to pursue her perceptions of the impact of student age on curriculum selection. We were impressed by the several references she made of her students in items 1, 3, and 4.

Level Two. The Participants' Taboo and Noa STS Topics and Their Perceptions of Their Local Cultures. An analysis of the multiple data sources, including field notes, opinionnaire responses, and semi-structured, audiotaped and transcribed interviews contributed insights into Ms. Shaw's and Ms. Bird's perceptions of taboo and noa STS topics and their local cultures. What follows is a description of the participant science teachers' perceptions of taboo and noa STS topics and their local cultures. These descriptions acknowledge the power of the emic voice (the participants' words) to provide the reader a better understanding of how the participants tell the stories of their professional lives (Van Maanen, 1995). What follows is a theoretically imposed

framework (the etic voice) we constructed as researchers as a result of repeated analysis of all data of the teachers' STS teaching practices.

Taboo STS Topics

Ms. Shaw. Ms. Shaw, in describing her STS teaching practice in her community, identified the STS topics she perceived as too controversial for her to teach in her community and explained her reasons for not teaching them:

> I think there is so much that can be taught and there are some issues that fall in the gray area where you really won't get in trouble for teaching them. And those I would have no trouble doing. But I feel like the trouble that would be stirred up by hitting something extremely controversial would take away from...for me it would take away so much energy to try to defend, and the problems it would cause would take away from the intent, or the reason for teaching them. Like, I put down on here [opinionnaire]: Evolution, the Big Bang theory as opposed to the Biblical creation. (Ms. Shaw, interview)

In addition, Ms. Shaw also identified AIDS and sex education as taboo STS topics in her local culture. Her rationale for selecting these topics as inappropriate for her to teach was that she believed the school community had strong ties to the community churches, and she perceived the churches would object to those topics. She also asserted that from her perspective the age level of the students justified not teaching them those topics in elementary school. Interestingly, Ms. Shaw also perceived that there were additional taboo topics in her community that were unrelated to STS.

> Interviewer: If you intentionally wanted to put your job in jeopardy at the school you teach in presently, which topics in STS would you include in your curriculum?
>
> Ms. Shaw: You mean if I wanted to try to get them to fire me? Probably AIDS in 4th grade. I think they need to know it, but I do not think I need to take class time and teach a unit on it. And I think that would probably get several people upset. I do not think that is necessary, but.... And if I went at the evolution theory in 4th grade, this is a rural area and there are strong ties to the community churches, and I think that would probably cause...and if I wanted to teach sex education, but I really do not see that as being STS. I'll

tell you, *if I got into the county government and the way it is run* [italics added], but again that really is not science. (Ms. Shaw, interview)

Two STS topics that Ms. Shaw perceieved as taboo (an examination of the community's water supply and tree cutting by the county) were introduced in class by her students as topics meriting investigation. While Ms. Shaw did not overtly forbid student discussion of those issues in her science classes, she explained that she attempted to protect herself from community umbrage in two ways. First, she did not schedule these topics to be taught in her STS infusion curriculum. Second, when these topics were introduced into the classroom discourse by her students, she limited the class's response.

Ms. Shaw elaborated on these self-imposed restrictions on her STS teaching practices:

Ms. Shaw (S): When we were getting into the [school's] water samples, I was starting to get concerned. And when the kids wanted to know about this right here, the woods being cut down, the county was doing that! My employer was doing that [laughter] you know. And they were concerned because the county was clearing land right in front of the fire department, and they were burning it, you know! But luckily for me, it all worked out.

Interviewer: Which point would you have stopped them, if it got really uncomfortable to you?

S: [long pause] I think probably if I felt like the end would not have justified the means. I mean, like them writing letters or getting upset because of the cutting down of those trees, the trees were already gone, you see what I am saying, they would not have made a difference. (Ms. Shaw, interview)

Ms. Shaw explained that she identified community involvement in her science teaching practices as a potential classroom disruption.

Ms. Shaw: My topic selection is one based on limiting the potential for classroom disruption that is instigated by my students' actions taken to address controversial topics in my community (field note).

Ms. Shaw stated that she most valued the "end result" of investigations in science, defined by her as the scientific facts mastered by her students. When she believed a topic had the potential for "stirring up" the community too much, and from her perspective could impinge negatively on "my teaching practices and on my tenure evaluation," the topic was not taught. Her rationale for not teaching these taboo STS topics, which she described as "topics worthwhile for learners to investigate in other contexts outside of my own," was that her teaching time was limited and there were many other STS topics she could teach without generating negative community attention to her teaching practices.

Ms. Bird. Ms. Bird listed abortion and nuclear war on her open-ended survey as STS topics she perceived as taboo in her local culture. Ms. Bird explained that she had two criteria for identifying taboo STS topics that she would not teach. First, she evaluated topics for inclusion in her STS practices by what she perceieved was age appropriateness for her students. Second, she evaluated them by her perception of how controversial the topics were to local community members.

Ms. Bird explained her understanding of what made some topics developmentally inappropriate for STS instruction:

> I am not sure my 6th graders would be able to handle some of the discussion--like abortion. You have to watch how much detail you go into with 6th graders. I think nuclear war is something you could not go into much detail with children because for one thing, it would be up over their heads, the language. And two, you do not want to scare them. I know a lot of them got scared when [the US Armed Forces] went to Saudi Arabia and you had the Desert Storm and Desert Shield so you have to watch what you talked about. You do not want to scare them and make them paranoid. (Ms. Bird, interview)

A recurring theme, avoiding "making the students paranoid" due to their age, was pervasive throughout Ms. Bird's reflections on her STS practices. She explained that her personal educational history led her to hold this belief:

I guess I would have to think back whenever I was a kid in the 6th grade to help me decide on which STS topics to avoid. What would have bothered me? Talking about something that scared me. I remember this happened long before the 6th grade, but I do not know where I got this from, but we talked about the weather and tornadoes and for the longest time I was paranoid anytime a cloud came up. And this went on up until I was in the 5th or 6th grade and whenever a cloud would come up I would go to pieces because I thought a tornado was coming, and it was going to take me away. So you have to, no matter what age, you have to be careful how you discuss a topic with them. Because even now, we talked about, I noticed some of my children, we talked about, we haven't really gotten into space but they asked about it once in a while, they asked "Will a comet come and hit the Earth?" You have to be careful about how you talk to them. You talk to them about comets and meteors and dinosaurs--we talked about dinosaurs-- and how a comet, I believe it was a meteor, hit the Earth and they believe that might be one of the reasons dinosaurs became extinct. Well they were so afraid that one was going to come and hit the Earth and make humans extinct. So you have to be careful what you discuss with them! (Ms. Bird, interview).

Ms. Bird also identified getting "too involved" in investigating the local culture's resources, the water and the farmland, as taboo topics in her community. Getting "too involved" meant encouraging the students to take any form of concerted action outside of the classroom concerning these topics:

Interviewer: If you intentionally wanted to put your job in jeopardy at the school in which you teach, which STS topics would you include in your curriculum?

Ms. Bird: Well, it may be like I was talking about, jumping on the water situation. We have a problem here with the water [in the school building] in which the water turns brown or it is brown. And it might be if my children started investigating to find out it might cause a stir in the community and in the school. I would hope I would not lose my job over it, but that could be something. [Also] if we did something with the farm land, that might

cause some problems because you have the farmers and they might get into an uproar. (Ms. Bird, interview)

As an non-tenured teacher in her community, Ms. Bird was sensitive about teaching topics that she believed could impact negatively on her tenure review. STS topics that she perceived her local culture would frown upon or criticize were taboo for her to teach, due to her concern for job security. To avoid the perception that she advocated beliefs that she perceived as controversial required some finesse on her part when students introduced them into the class discourse. In one case of a student who decided he wanted to independently research abortion, Ms. Bird explained her strategy to protect herself from community umbrage:

Interviewer: Have you reacted to controversial topics brought up by your students?

Ms. Bird: I do have a little boy who wanted to do his science fair topic on abortion. But, that was his choice. And I asked him if he realized that was sort of a peculiar topic for a boy to be doing. And he said yes. And I said that I just want you to know that is your choice. And when his daddy came to pick him up, and I was talking to his daddy about his science fair topic choice, his daddy said, 'That is kind of a peculiar topic,' and I said, 'Yes sir, but I want you to know that was his choice, I did not suggest it. He came up with that topic on his own.' So, see, I didn't tell the little boy to do the topic. (Ms. Bird, interview)

Noa Topics

Ms. Shaw. On her open-ended survey, Mrs. Shaw identified the preservation of the environment and natural resources as STS topics that should be included in her STS curriculum. In reflecting on her STS teaching practice, she identified the study of whales and dolphins in her school's hinterland local culture as the two STS topics that she included in her curriculum. Ms. Shaw explained her thinking of how she selected appropriate STS topics:

Interviewer: How do you decide on which STS topics are appropriate to teach here at your school?

> Ms. Shaw: By how beneficial it would be to the child's life. Period. You know, whales really aren't on our topic. That is not really a unit that we have. But, that, I feel, will help foster that responsible citizen in all my kids, you know. So I have to rationalize it in my own mind as to my goal that I have for my kids. I want them to be well rounded, and I want them to take responsibility for their environment and for their world. Because we are leaving them a mess in the environment, and that is what I tell them all the time. (Ms. Shaw, interview)

However, even after she selected a noa STS topic, Ms. Shaw was cautious in how she could be perceived by her community as promoting any controversial position. As she related,

> [My students] want to get into the dolphin thing since they adopted a whale. They will keep us posted about the progress of our whale, the sightings. And we can chart them. And they want to do something about the dolphins. You know, I present them with information, and if they want to act on it independently, you know there is not anything I can do about that. And I make sure that I present them with facts; I do not give them my opinions. (Ms. Shaw, interview)

Ms. Bird. On her open-ended survey, Ms. Bird identified the study of solid waste recycling, habitat destruction, tropical rain forest deforestation, and saving energy as appropriate STS topics to include in her STS curriculum. In reflecting on her STS teaching practice, she identified pedagogical strategies she saw performed in the STS inservice workshop, such as utilizing guest speakers in science and incorporating manipulatives in small group cooperative learning experiences, as non-threatening ways to infuse her science curriculum with an STS initiative. Since her principal was a former science teacher who endorsed student-based activities, she perceived she would be supported by him (and enjoy an inferred immunity from community censure) by promoting student-based, hands-on, minds-on activities in STS areas that she did not anticipate as controversial. As she stated,

> I've been trying to figure out for the past two weeks where exactly I teach STS. I do not think of it as one particular subject--we stick it in where ever it becomes necessary. It is all

throughout our curriculum. We've played with earthworms. We work it in where ever we can. I've been trying to figure out some classroom guests we could have, so I need to get in touch with someone here and get someone in here to talk about the water. My principal likes a lot of hands-on. He was a science person, so he likes a lot of hands-on in the science area. (Ms. Bird, interview)

Teachers' Perceptions of Their Local Cultures

Ms. Shaw. Ms. Shaw's interview responses indicated that she believed it was important for her to understand the dominant beliefs in her local culture and to project to the community that she was sensitive to its concerns. She used her perception of the local culture to strategically moderate her STS teaching practices:

Ms. Shaw (S): This is a rural area and there are strong ties to the community churches.

Interviewer: Is this your community?

S: No. No, but that is a conscious effort I make every year [to solicit information on the community from community members]. During the summer, I send out letters to my kids that I am going to have before school starts. And I talk with my parents before school starts, and it just makes for a very easy year... And I also invite parents in a lot to spent days with us. So like I said, I have a real close tie with my parents and the class. (Ms. Shaw, interview)

Ms. Shaw further stated in conversations that she perceived "parents as my immediate assessors in my community" (field note). As a result, she consciously made a strong attempt to maintain "a real close tie with the parents" (field note) by initiating and maintaining contact with them through letters and open invitations to her classroom. Ms. Shaw perceived her local culture as one in which "my science teaching is under constant scrutiny" (field note). She noted that she attempted to protect herself from potential community censure by "keeping her classroom door open for visitors" and by labeling concepts which could be viewed as threatening to the community as "theories" (interview and field notes). She emphasized that by repeatedly stating to her students that she taught "facts not opinions" (interviews and field notes).

Ms. Bird. Likewise, Ms. Bird made an effort to understand her school's local culture and used that perception to help her construct an effective STS teaching practice that would not be easily vulnerable to criticism. As a life long resident in a neighboring county, she based her understanding of the school's local culture and her place in it on her understanding of her own local culture:

> Interviewer (I): Seeing as I do not know your county very well, could you tell me a few things about your county, your school situation and your curriculum?
>
> Ms. Bird (B): The school is a middle school, that is 6th through 8. I do not live here. From what I've seen, the community, the parents, they seem to be very supportive and interested in what is going on in their children's classrooms. Anything that we do that could be put in the paper, we let the parents know.
>
> I: In this community, how do most people make a living?
>
> B: [There is] one big logging industry. There are some other industries in [a neighboring town]. It is just a small town community.
>
> I: Thinking of your particular students, do you have some idea how their parents make a living?
>
> B: A lot of them work at [the local woods factory]. Some of them work at the bank; some of them are teachers. I have one little girl, her daddy is the preacher. And then I do have some children whose parents drive to [another county] to work.
>
> I: Why do you believe that the water situation possibly could cause your job to be put in jeopardy if you answered those [student] questions?
>
> B: Just for being an outsider. Cause, I know, in this area, it is like everybody knows everybody. Everybody is supposed to know everybody. And if you are not related to somebody, you are a nobody. And what you think does not matter because you weren't born here. (Ms. Bird, interview)

Ms. Bird perceived her students' parents as being interested in what happened in her class and often sent home reports of daily events in science. She knew where most of her students'

parents worked and made assumptions about what they believed. Ms. Bird stated that she thought of her school's local culture as similar to how she perceived her own neighboring home community, "a community that held strong religious views and was suspicious of those not born in the area" (field note).

Researcher Assertions

The construction of two analytical categories based on patterns from the data helped us make sense of what influenced teachers' STS teaching practices. Each analytic construct is represented and elaborated as an assertion.

Assertion One: From the teachers' perspective, their job security requires that their STS curricular decisions be informed by their construction of the teachers' local school cultures.

In this first phase of the study, both participants felt especially professionally vulnerable to administrative censure brought about by the local community's disapproval if they went against the local cultures' religious beliefs. Since they perceived that the STS initiative contained controversial topics, the teachers were especially careful to construct an understanding of what the "rules of conduct" (Collete, 1977) were in each school district. Rules of conduct is a theory developed in sociology and anthropology which describes how rules that govern an individual's behavior are created and enforced. Rules are agreed upon norms of conduct passed down generation to generation in a community. An individual's actions are evaluated by other members of the culture through consideration of whether or not the person knows the rules, and through consideration of whether or not the person's behavior corresponds with the rule. The identification of rules is performed through interpretation of actions of many members of a community. A recognized example of a special rule of conduct in most cultures is the incest taboo (Fortes, 1983).

Both teachers identified the dominant local cultures' religious systems as Christian fundamentalism in a Southern context. The two participants identified meaningful STS topics such as population education issues and any local societal issues as taboo topics in their classes. As a result, they excluded those topics in their STS teaching practices. Within the classroom science discourse they limited any expressed student interest in those taboo topics. When students

introduced those topics into the classroom discourse, the teachers' responded with brief comments that were clearly portrayed as defensible 'facts' endorsed by the scientific community. In particular, the teachers never encouraged students to take any type of community action on topics which the teachers perceived as taboo in the local cultures.

Identifying and teaching those STS topics that the local culture found non-threatening and interesting was considered supportive by the teachers in gaining and maintaining job security in the local cultures. From Ms. Shaw's perspective, the noas of teaching STS in her Southern local culture were studying whales and dolphins. From Ms. Bird's perspective, the noas of teaching STS in her Southern local culture were topics that added a hands-on component to the science curriculum, such as creating imaginary animals and viewing earthworms. Both teachers approached their visions of the "ideal" STS teacher by teaching topics which they perceived would not provoke community concern.

Assertion Two: Teachers' perceptions of themselves as outsiders to the local community increases their conformity to the school's local culture and decreases their teaching of controversial STS topics.

In both cases, the teachers identified themselves as outsiders to the communities in which they taught. As outsiders they believed it was imperative to avoid actions which did not abide with the norms and shared understandings that defined and maintained each community's local culture. In this way, they would be considered as successful teachers. Based on the data, the teachers' reluctance to teach controversial local STS topics was influenced by their perspective of "outsider" to the local cultures. This "outsider" status necessitated a high standard of conformity to the local culture. As outsiders, the participants interpreted that their STS practices would be held to a high standard of conformity to the local culture's beliefs, particularly religious ones. As a result, it was understandable from Ms. Shaw's and Ms. Bird's perspectives that they were reluctant to provoke attention toward their STS teaching practices by encouraging student interest in controversial, albeit educationally beneficial, community-relevant STS topics. Instead, they achieved success and believed they were fulfilling the aim of the STS workshop by infusing STS topics in their practice

(constructing an STS teaching practice that was characterized by indirectly influencing students' everyday lives in any substantive manner). Interestingly, their strength of science beliefs (strong in Ms. Shaw's case or moderate in Ms. Bird's case) did not influence this fundamental aspect of their STS curricular decision making in the local school context.

Second Phase of the Study

The insights from the first phase were employed as potential explanatory mechanisms for interpreting the STS infusion practices of teachers in other school cultures. The fundamental assertion that the teachers' STS practices were heavily influenced by their perception of the code of conduct in their local cultures was examined in different contexts. We hoped that further insights would emerge by examining the practices of science teachers with different attributes, such as membership in the local culture and tenure.

Level One: The STS Class. Ms. Star responded to all items on the science and STS opinionnaire. The opinionnaire data from Ms. Star revealed that she was similar to Ms. Bird who held few strongly opinionated stances on the selective science beliefs (see Table 4). She indicated that advances in science have done more harm than good, and scientific advances make our lives change too fast. She also believed the western world's technology will eventually solve the world's environmental problems. She indicated that she did not believe that teenagers should have the opportunity to learn various methods of birth control in school. Of all the participants, she was the only one who did not believe that teenagers should have this opportunity. We looked forward to hearing how she reconciled this belief with her other beliefs supporting the role of science in people's lives.

[Insert Table 4 about here]

Ms. Star responded to the items on the open-ended survey. Ms. Star's vision of the "ideal" STS teacher was one who placed an emphasis on students capacity to engage in critical analysis. Ms. Star's responses suggested that she looked at STS education as a way to promote critical thinking, moral reasoning, decision-making, and problem solving in her teaching practices. On item #4, she identified genetic engineering and abortion as STS topics she perceived her

community would frown upon teaching, but she did not indicate if she would teach them. As a community member of the local culture in which she taught, we looked forward to discussing the STS topics she believed would be both well received and frowned upon in her context.

[Insert Table 5 about here]

Mr. Bailey responded to all of items on the science and STS survey. The opinionnaire data suggested that he was similar to Ms. Shaw, holding many strongly opinionated stances in his science beliefs. Interestingly, his strongly held belief that nuclear power plants should be closed was not shared by the other participants. (see Table 4).

Mr. Bailey responded to all items on the open-ended survey. His vision of the "ideal" STS teacher was one who was characterized as inquisitive, creative and promoted hands-on instruction. His response to item #4 was direct; he asserted that he would not teach any topic that he perceived would jeopardize his job. We focused on this assertion to understand his thinking in this area.

Mr. Jefferson responded to all items on the science and STS opinionnaire, adding explanatory comments to several items. Mr. Jefferson held a wide range of science and STS level of beliefs (see Table 4). His strongest beliefs were linked to the issue of human population control Mr. Jefferson's responses also suggested that he did not believe that applied science (in agriculture or in technology) would solve existing environmental problems. Mr. Jefferson wrote that there were no STS issues that would be too controversial for him to teach in his school. We wondered what factors distinguished Mr. Jefferson in this regard.

Mr. Jefferson also responded to all items on the open-ended survey. His vision of the "ideal" STS teacher is one who is noncommittal to student comments, who never publicly states that his students' parents are wrong, and who uses hands-on activities. Mr. Jefferson's responses to the survey reinforced McGinnis's interest in talking with him about his perception of his local culture and to what extent that influenced his selection of STS topics. He indicated that while he did perceive topics his community found sensitive (e.g., conflicts with a literal reading of the Bible) he would not avoid any topic on that criterion alone. McGinnis was eager to discuss with

him how he perceived how his manner of teaching supported him in teaching controversial STS topics in his context.

Level Two. The Participants' Taboo and Noa STS Topics and Their Perception of Their Local Cultures. An analysis of the multiple data sources (opinionnaire responses, semi-structured, audiotaped and transcribed interviews, and classroom observations) led to insights into the perceptions of Ms. Star, Mr. Bailey, and Mr. Jefferson about taboo and noa STS topics in their local cultures. What follows is a description of the participants' taboo and noa STS topics, a description of their local cultures from the participants' perspectives, and researcher assertions concerning the explanatory power of insights from the first case study to inform similar contexts. Representative vignettes of teaching practices were included to help readers visualize how the participants constructed appropriate STS instruction in their contexts.

Taboo STS Topics

Ms. Star. Ms. Star identified genetic engineering and abortion as STS topics that were too controversial to teach in her school, particularly in her 5th grade science curriculum. In two separate conversations at her school, Ms. Star reiterated, elaborated upon, and added to these topics:

> After finishing teaching her 5th grade science class at the end of the day and dismissing her students for the day, Ms. Star and I talk. She brings up the controversial STS topics idea, which she remembers seeing on the opinionnaire, and she states that she had thought about this issue before taking the STS class. She states that she thinks in her context teaching sex education would be a problem. Also, she states that she probably would not do things on genetic engineering. (conversation with Ms. Star, field note)
>
> In a recorded interview, Ms. Shaw once again touched upon this issue.
>
> I (Interviewer): Which STS topics do you think might be frowned upon for you to teach in your teaching context?
>
> Ms. Star (S): [laughs] In this community abortion, genetic engineering, and sex education--the technology of it. Also, evolution. I would like to teach genetic engineering, although I

know that it would be up to me to justify it to my students' parents. Perhaps I could teach it within guidelines... I would deal with the parents ahead of time.

I: If you intentionally wanted to put your job in jeopardy at your school what STS topic(s) would you include in your curriculum?

S: Sexual contraception and abortion would do it. (Ms. Star, interview)

Mr. Bailey. Mr. Bailey defined taboo STS topics as topics his community frowned upon and ones he would not teach. He also wrote that he would not teach any topic he perceived would jeopardize his job by evoking censure from his community. Abortion methods and sex education were two STS topics he perceived as too controversial for him to teach in his high school biology curriculum. In a semi-structured interview, we discussed these statements:

Interviewer (I): Could you please elaborate on your statements concerning controversial STS topics that you make here in your opinionnaire? [He reads the comments on his opinionnaire]

Mr. Bailey (B): Somewhat. A couple of years ago I was talking about the theory of evolution and one kid had, as kids often do, had not listened like he should have listened. He went home and told his mom I had been teaching him about evolution, and she did not like it. She did not like it, and came and visited the principal. That was my first year teaching. So ever since then I have avoided stepping on someone else's toes while teaching science. Cases, such as God and the Big Bang, I begin by talking about theories. I talk about Stephen Hawkings and his idea of a God somewhere. And I tell students that science is going toward this idea of a G-O-D. I don't tell that is the way it is, and I am not telling them it is not the way it is. And that might be the chicken shit way out, I do not know. That is factual.

I: What would you do if one of your students brought up one of the topics you have identified as frowned upon?

B: If a kid asked me about the abortion pill, for example, I would tell him I didn't know enough about it to really discuss it with him in great detail. If he needed more information he could go to the library. (Mr. Bailey, interview)

Mr. Jefferson. Mr. Jefferson's responses on his opinnionaire and open-ended survey were inconsistent in his identification of STS topics he thought were too controversial for him to teach. On one item on the opinionnaire, he commented that "all science topics which conflicted with a literal reading of the Bible as STS topics I would not teach in my 8th grade earth science class." He also stated that from his perspective there was no sense in "going out in a blaze of glory" by teaching STS topics he identified as evoking censure from Christian fundamentalists in his community. However, on another item, he strongly disagreed that there were some STS issues that were too controversial to teach in his school. He added, " They must be handled carefully." Throughout the study, we found Mr. Jefferson's definition of taboo STS topics inconsistent and difficult to understand. In an indepth interview with him at school, Mr. Jefferson and McGinnis discussed his beliefs about taboo STS topics:

Interviewer (I): Did you ever consider the notion of potential controversial topics in STS before responding to the opinionnaire?

Mr. Jefferson (J): Yes. But, you see at this school, we do not worry about controversial topics. We decide to discuss it or teach it, as look as we are relatively careful about it. You know, we have discussed topics ranging from the Nude Dancing establishment they want to open up here to just about anything you want to talk about. You just have to be careful about how you do it.

I: What teaching techniques allow you to introduce controversial topics in your classroom? Specifically, what do you mean by saying you must do it in a "careful" manner?

J: The main thing is you got to be noncommittal. You know, everyone has the right to their opinion, this is how this group backs up their opinion, and I guess it is a case of my not wanting to install my values on these kids. I figure that is their parents' job. I think it makes parents upset when you try to do that. I remember one kid's mother who pulled him

out of our school because she disagreed with how we taught evolution. Anything we did, we were basically atheist. It was a shame the kid had to leave. You can discuss anything as long as you do not say if the kid is right or the parents are right. Because if the kid goes home and states that Mr. Jefferson says you are wrong you are going to run into problems.

I: Have you experienced any examples of students misinterpreting what you said in a controversial STS science topic?

J: Oh, it happens periodically. But you know, you work it out.

I: What STS topics in your context do you believe some people in community would frown upon?

J: OK. Earth science. Not a whole lot of things that would get you into trouble. Around here the only thing would be if you are teaching geology, pointing out that according to geologists things did not happen the way the Bible said they occurred. Other than that, you talk about oceans and you get into evolution and whether everybody came from the ocean. I tell the kids, "You do not have to believe it" this is the scientists' point of view.

I: Do your students ever ask you what you believe?

J: I tell them I have my beliefs, and they have their beliefs and they may match and they may not match.

I: Have any students brought up some controversial topics related to STS?

J: No. You know, earth science is not real controversial. Oceans, evolution could come up. Not much in Earth science. (Mr. Jefferson, interview)

This excerpt illustrated that Mr. Jefferson was able to both identify certain STS topics he believed were taboo by his community while simultaneously stating that he believed he could teach those same topics in context, if they were taught in a certain careful manner. Mr. Jefferson's construct of taboo STS topics was idiosyncratic compared with the other participants.

Noa STS Topics

Ms. Star. Ms. Star identified one specific topic, endangered species, and several broad categories, environmental issues, moral reasoning, decision making, and problem-solving, as STS

topics she believed would be supported by her community. She taught STS by focusing "on the technology sections in the students' science textbook, and by taking students on trips to sites associated with technology" (interview). The following vignette (field notes of Ms. Star teaching endangered species to her 5th grade class) exemplified her noa STS teaching practices:

> I arrive at Ms. Star's elementary school at 9:00 am and am met by Ms. Star at her classroom door. She announces to her students that their visitor has arrived. She asks if I have something to say to her class. I say no, I am here to observe what she and her students have done relating to STS. She shows me my desk in her class and begins her lesson by summarizing where they were in an STS investigation.
>
> Ms. Star states that she and her students recently visited a local dam. This was her students' first trip to a hydroelectric dam (she had anticipated taking them to the zoo but students told her that they had visited the zoo many times and were not interested. She thought of the dam since she had visited there during the STS class). At the dam, a guide told the students that fish could get caught in the flow. Students were concerned. Once they returned to school, they participated in a town council meeting. As a result, they decided to stop the dam. They were considering a petition. Ms. Moon decided they needed to have some knowledge/experience with fishing so she located an activity from Project Wild, "Net GAIN." Students had been working in groups to investigate the four areas of fishing evolution: harpoons, hooks, trapping, nets. Today they were presenting their posters then participating in a simulation of catching fish.
>
> Eight Student groups present their posters. One member of each group reads from a written document they prepared. Posters includes graphs of tons of fish caught, types of fishing lures, illustrations of harpoons striking fish, traps catching crustaceans, purse nets and gill nets holding fish, a trawler dragging a net. After each group presents their report and poster, Ms. Star gives a quick review. E.g., after the first group, she states, 'Joe has given us information. Let's see if technology has affected the fish population. Do you have enough information to answer that?' And, after the second group's report, she states,

'I learned a lot about fishing! I did not know it was so complicated.' And after the third group's report, she states, 'This makes a connection to killing whales. We have been taking about that.' And after the fifth group's report, she states, 'Can you look at their poster and see something added to the technique of fishing?' A student answers 'Boat?,' and Ms. Star responds, 'Yes! Now we can use big nets, make big catches, and make more money for profit. This way we can eat fish at Captain D's!' And after the sixth group's report, she states, 'This group made a conclusion [about gill nets]. They are still used, should they be?' And after the seventh group's report, she states, 'Remember all the fishing that goes on up in Canada that we have been talking about?' And after the last group's report, she states, 'This accounts for quite a bit of our fish catch.'

After all the reports are presented and she has made comments at the end of each, she states, 'Let's provide time for some questions.' After no students have questions she turns to me and asks if I had any reactions to their presentations. I said I didn't really have a reaction, but I would share a story. Students said 'Yes!' so I talked about the story I had heard on the radio (American Public Radio) during the drive to their school that focused on two countries' decision to resume hunting whales. I asked them which countries they thought had decided to resume hunting whales. Students guessed, 'Minnesota,' 'Arctic.' I say, 'Norway and Japan.' I ask if they felt they should be allowed to hunt the whales? Student comments I received were: 'Only fish in part of the world,' 'Only some for food.' I thanked them for their comments and their presentations.

Ms. Star invites me to stay for a follow-up activity involving a simulation of fishing. She has a large plastic container of mixed beans and other dried food (including rice) in front of the room . Student groups record data and report to the whole class. Ms. Star summarizes for the groups that the hand techniques catches more beans (fish). She also tries to make a connection between the size of the mesh and the size of the fish caught. She challenges students with this question, "Should we have to put certain fish back in the water? Various comments are made. Ms. Star hurriedly states that regulating agencies

investigate this. She then states that technology has changed which fish are able to be caught. Her final questions to the students before she dismisses them for recess are, 'Do you think new technology should be created? Who should use it?' (Ms. Star, observation)

Mr. Bailey. Mr. Bailey perceived a study of agriculture, communications, computers, and the environment as acceptable STS topics in the community. In a conversation at school, he perceived his community as mainly wanting him to involve "all his students in his science lessons" (field note). The following vignette (field notes of teaching a 10th grade biology class lesson) exemplified his version of STS infusion in his context:

I arrive at the school at 10:35 am. I am welcomed into Mr. Bailey's basic biology 10th grade class. He informs the class that the invited visitor from the university has arrived. He asks if I had anything to say to the students about STS and I say, 'No. But I am very interested to see what you are doing.' I sit in the back of the room which contains desks arranged in a large U, the open end toward the front of the class where three students stand. There are approximately 20 students in the room. Two White (girl) students assisted (by a White (boy) student who holds up a poster identified as "Jurassic Park" for the other students to see) present a project to the class and to their teacher. Mr. Bailey sits on top of a desk in the back of the room with a camera in his hand. The two students share where they decided to place buildings and dinosaurs on the fictional island named "Jurassic." Mr. Bailey's students seem generally interested in the proceedings, i.e. they look at the presenters and are not engaged in off-task discussions. Mr. Bailey asks the presenters, 'Why did you place the dinosaurs where you did?' One of the student presenters gives a reason related to safety of people in other areas of the island. Mr. Bailey listens to all responses without making an evaluative remark. He then thanks the presenters who return to their classroom seats. Mr. Bailey then encourages two other White girl students to present their poster projects to the class. They stand in front of the room and show a poster of an island with identified areas. They discuss placement of areas for a few minutes and then stop. Mr. Bailey asks, 'Why did you locate your generator where you

did? Any particular reason?' The student responds, 'I wanted it away from the dinosaurs.' Mr. Bailey responds, 'That is real neat. Real good.' The students return to their seats and the class ends. (Mr. Bailey, observation)

Mr. Jefferson. Mr. Jefferson's belief of community support of the linkage between technology and student career preparation permeated his STS teaching practices. He elaborated on how this direction influenced the STS teaching practices he viewed as appropriate at his school:

Interviewer (I): What STS are you teaching this year?

Mr. Jefferson (J): Not near as much as I should be doing. Basically, I am following the curriculum which is earth science. And as we study a unit we go into the type of jobs that may be related to, or might be required by, those type of jobs. The parents want us to make connections with technology. And we have been looking at the environmental aspect of everything. Right now we are doing something on pollution.

I: This year, have you attempted to infuse STS in any other ways in your science teaching?

J: Basically, when we do weather, we get into acid rain. We get into the types of people who predict weather. As far as actual societal issues, I haven't really done much with that. Cause just now I getting into the area of conservation and pollution--that is where we get into most of it. (Mr. Jefferson, interview)

The following vignette (field notes of an eighth grade earth science lesson he asked McGinnis to observe) exemplified the way he enacted his construction of appropriate STS instruction in context:

Mr. Jefferson begins class by telling his students to get in groups of three. There are 24 students in the class. He states they are going to do a science investigation. He writes on the board these two conditions to investigate:

1. Hold aluminum foil over candle flame and make observations.

2. Place small hole in upper end of straw.

The students work lockstep in groups as Mr. Jefferson gives them step-by-step directions. The students make observations about the soot that forms on the aluminum foil. Mr.

> Jefferson asks the class if there could be any practical use for the soot, if there are any jobs for them in that. Ideas elicited from the students include to make charcoal, to write with it, to use it as fertilizer, and to include it in paint. Mr. Jefferson asks where the soot would go if the aluminum were not there to stop it. Students call out, 'In the air!' 'Into clouds to make acid rain!' Mr. Jefferson asks, 'What does soot mean?' His students do not reply. After a few moments, he hands the dictionary he had next to him to a student. He states, 'I thought you would need this.' The student reads the definition of soot to the class. Mr. Jefferson emphasizes that carbon is in soot as the class ends. (Mr. Jefferson, observation)

Teachers' Perceptions of Their Local Cultures

Ms. Star. Ms. Star lived in the community in which she taught. She perceived her community, as well as herself, to be conservative on many important social issues, such as population control. She described her community as holding beliefs stemming from Christian fundamentalism. As a resident, Ms. Star believed that it was important for her to make curricular decisions that would be in accordance with the beliefs which guided most people in her local culture. While she depended fundamentally on her own "everyday construction of her local community's culture to guide her STS topic selection" (field note), Ms. Star strategically reached out to her students' parents to inform and confirm her perceptions before teaching a topic. She used this strategy in her interactions with her administration so that no "misunderstandings" (field note) would arise to problematize her teaching position.

Mr. Bailey. Mr. Bailey did not live in the community where he taught. During his first year of teaching, he assumed that the beliefs he held were in accordance with those held by the parents of his students. It was only after one of his 10th grade biology student's parents complained to the administration about his teaching of evolution that he was confronted with the realization that he needed to fully understand his school's local culture in order to teach successfully in his context. In an interview, Mr. Bailey expounded on this:

> We are in a strong religious environment here. You do something that goes against some of the teaching of the churches around here and you are in trouble. If you push evolution you

can get in trouble.... A couple of years ago I was talking about the theory of evolution and one kid had, as kids often do, had not listened like he should have listened. He went home and told his mom I had been teaching him about evolution and she did not like it. She did not like it and came and visited the principal. That was my first year teaching. So ever since then when I teach that topic I think about it and let them know theories and so forth. I try to be more clear on that. I don't tell that is the way it is and I am not telling them it is not the way it is. And that might be the chicken shit way out, I do not know. That is factual. (Mr. Bailey, interview)

Mr. Jefferson. Mr. Jefferson was not a member of the community in which he taught, but constructed a perspective of the local culture. He characterized the school as being situated in "the Bible belt" (interview). As he explained, this meant that a significant number of community members were guided by a literal reading of the Bible. Mr. Jefferson offered insight into how, as a tenured teacher, he ascertained information about the local culture and how he used that information in his STS curricular decision making:

Interviewer (I) : How do you gain access to information relating to what you believe your community would find controversial or taboo?

Mr. Jefferson (J): I use the time honored, bull in the china shop method. I teach what I think the kids are interested in and need to know about. And if I catch flak, I work at it from that point.

I: What about the teacher who looks at controversial topics as requiring too much energy to teach since there are always less volatile, good topics to teach?

J: But, those are the fun ones....You have to pick your battles. It's like the question that relates to choosing topics to jeopardize your job. If you want to go out in a blaze of glory, you can always pick something to cause problems with. But, it is not worth it. It is like once you have been in the school system for three years if you do not grab some little girl on the butt or something, they cannot get rid of you. (Mr. Jefferson, interview).

Researcher Assertions

In this phase, data from all sources were analyzed for insights to assist in making sense of the participants' STS teaching practices. Of particular interest were two analytical constructs which emerged from the first cohort of participants. These constructs provided insight into interpreting the STS teaching practices of other teachers who participated in a similar STS in-service experience. What follows is a discussion of how the two researcher assertions informed this second investigation of science teachers' STS practices.

Assertion One: From the teachers' perspective,job security required that their STS curricular decisions be informed by their construction of their school's local cultures.

Consistent with the first study, the three teachers in this second phase believed their job security necessitated basing their STS curricular decisions on their perception of their local cultures' belief systems. With two nontenured teachers, Ms. Star and Mr. Bailey, concern for job security was a dominant referent in their STS curricular planning. The tenured teacher, Mr. Jefferson, expressed more security in his teaching position, but also believed that violating the local culture's beliefs was an act that should be carefully evaluated as to its costs and benefits. In all cases, the participants perceived the local cultures as dominated by a Christian fundamentalism which made the teaching of STS topics (from their perspectives) that conflicted with a literal reading of the Bible (such as genetic engineering, population control, and evolution) problematic. With Ms. Star, this was sufficient justification not to teach those topics at all. In Mr. Bailey's case, he distanced himself from the topic of evolution by not emphasizing its fundamental explanatory role in biology. Instead, evolution became simply one theory among others that scientists espoused. Mr. Jefferson's rhetoric indicated he did not think his school community's local culture wielded maximum power in his STS curricular decision making; his curricular decisions indicated that he also elected not to provoke community umbrage by teaching STS topics which he perceived segments of his community found objectionable. Interestingly, all of the teachers demonstrated they were adept at identifying noa STS topics in their contexts (such as endangered species and a study of the environment) and at teaching in a manner that did not

confront parental beliefs in their local culture. Although constrained in their topic selection, they approached their vision of the ideal STS teacher in their teaching practices. Therefore, we concluded that this analytical construct held extensive power for interpreting the STS teaching practices of all participants in this study.

Assertion Two: Teachers' perception of themselves as outsiders to the school's local community increases their conformity to the school's local culture and decreases their teaching of controversial STS topics.

Two participants (Mr. Bailey and Mr. Jefferson) identified themselves as outsiders to the communities in which they taught. The other participant (Ms. Star) identified herself as a member of the community where she taught elementary school. Both outsiders, Mr. Bailey and Mr. Jefferson, made concerted efforts to construct a vision of their schools' local cultures. This was particularly apparent in Mr. Bailey's case. Mr. Bailey suffered a professionally painful experience during his first year of teaching when he assumed that the beliefs of students from the local culture were in accordance with his own beliefs. As a result, he was particularly sensitive to construct a vision of his school's local culture that gave him some insight into the code of conduct which community members used to scrutinize him. From that constructed vision, Mr. Bailey took his direction on which STS topics to avoid that violated the shared understandings of his school's community. Although Mr. Jefferson expressed an awareness of his school's local cultures rules of conduct, he professed that this vision was insufficient to determine his STS practices.

Ms. Star indicated that she was adept at eliciting information about her local culture which she used in her STS teaching practice. While confident that her everyday construction of her local culture was viable, she consistently made efforts to reaffirm her vision of its code of conduct with her community members before teaching STS topics. Since she perceived that she was in accordance with her community's norms and beliefs, her efforts to inform her students' parents of her teaching intentions was to avoid miscommunication that could result in misunderstandings.

While this analytical assertion has some explanatory power, it varied in degree by the circumstances and inclinations of the teacher participants. The teachers felt it was valuable to

construct some notion of their school's local culture to assist in their teaching practices. However, their reactions to their constructions in their STS curricular decision making was idiosyncratic and dependent on their experiences with the school's community, their perceptions of their personal power, and other undetermined variables.

Conclusions and Implications

Advocates of STS have long posited the argument that students benefit by becoming actively involved in local, relevant, and, oftentimes, controversial societal issues (Aikenhead, 1973). We assert that topics in local cultures which are perceived by teachers as defying subtle unwritten rules in their communities were not taught, even though teachers believed the topics worthy of inclusion in the curriculum. Instead, topics which were perceived as non-controversial but STS related were taught by teachers to fulfill their efforts to infuse STS into the curriculum. In some cases, this identification of topics was operationalized by practitioners to include non-controversial, low level, technology-related topics which did not correspond to the spirit of the STS movement.

Researchers such as Bradford, Rubba, and Harkness (1995) noted that college students constructed unanticipated misunderstandings of STS in classes purporting to teach STS. They suggested that this occurred because of a lack of sufficient focus and continuity. The study reported in this paper documented that practicing science teachers also constructed unanticipated understandings of STS after successfully completing an in-service STS experience. The central insight from this study was that practicing teachers construct their understandings of STS and make STS curricular decisions as a result of their perceptions of the belief structures that guide individuals' actions within their schools' local cultures rather than by their construction of the vision of STS as presented in well designed and taught STS classes or workshops. Therefore, more research is warranted to determine which STS topics are perceived by teachers in local cultures as problematic and how these constraints may be overcome.

In this study, the power of the socio-cultural perspective was demonstrably apparent. If we interpreted the teachers' STS teaching practices as a function of their beliefs about science or

their perspective of the worth of the STS initiative, we removed them from their contexts and diminished their power as informants of their situated practices. Extending value to the teachers' construction of their local cultures unwritten rules of conduct acknowledged them as possessing essential information needed for a deconstruction and interpretation of teaching *in situ*. This act promoted respect for the teacher as a professional practicing in a complex environment. It also necessitated a focus on listening to the teacher's construction of the "conceptual code" (Vivelo, 1994, p.16) undergirding the school's local culture. The use of a socio-cultural perspective also allowed the development of analysis schema that included anthropological and sociological constructs. In this study, the constructs taboo, noa, and local culture served as essential explanatory mechanisms for interpreting the STS teaching practices of the participants. These constructs are offered to other researchers interested in investigating similar STS issues in science education. This study also supported the teacher practical knowledge construct (Duffee & Aikenhead, 1994) as a powerful model to inform STS research.

Designers of workshops on STS should consider the findings from this study when constructing curricula and when interacting with practitioners. The discourse (Lemke, 1990) in the workshop must include overt consideration of the local cultures in which the practitioners practice. Using a strategy in which the participants publicly discuss the teaching of controversial STS topics in their contexts will assist them in the process of transforming their teacher practical knowledge. This enables teachers to reflect socially on their understandings of which topics fulfill the STS initiative and on the impact of their constuction of the beliefs in their school's local cultures on their STS practices. In many cases, this will involve a recognition and acceptance of their level of commitment to the STS movement while being aware of the implications of their curricular decisions in their schools' local cultures. For example, Mr. Bailey underscored the need for this type of strategy when reflecting upon his STS inservice experience:

> Mr. Bailey (B): When you are teaching about those type of topics in which people get upset, you cannot use the same methods that you use for everything else like alternative fuel sources. Big Bang, compute the probability of an Almighty God out there because

then some other kid will object. And you can't use a discrepant event which is effective for other topics. That would be an interesting STS inservice.

Interviewer (I): Do you have suggestions on how to incorporate your ideas into STS in-service experiences?

B: We didn't talk too much about stepping on toes. (Mr. Bailey, interview)

We strongly suggest that proponents and advocates of STS should recognize the need to influence beliefs in the local cultures to create environments in which teachers can safely practice STS education. How this can be accomplished will vary in different contexts, in keeping with the spirit of STS. Certainly, administrative commitment for supporting science practitioners in controversial curricular decisions is a prerequisite. Yet, administrative support does not exist in a vacuum and is itself influenced by forces in the larger socio-cultural environment. Science-technology-society education in any particular school clearly is influenced by the larger socio-cultural situation in which it is situated. Therefore, efforts should be made in all domains that bear on the individual science teacher's STS practice (personal, administrative, and cultural) if changes are to occur. Without more effort put into the larger socio-cultural realm, it is clear that STS education will be perceived as a worthwhile endeavor by science teachers, but will also be characterized by insurmountable constraints and potentially calamitous professional consequences if the constraints are ignored.

Limitations and Recommendations for Further Study

This study, while taking a cultural perspective, was not an ethnography in the sense of a long-term investigation in a local culture. Instead, the focus was limited to the perceptions of a relatively small number of participants who work in local cultures.

Additional questions which were generated in the course of this research include:

How are teachers successfully teaching taboo STS topics in their local cultures?

What strategies do teachers employ to protect themselves from community censure?

Are these strategies transferable to other teachers in different local cultures who are interested in enacting a spectrum of STS practices that range from non-controversial to controversial?

How are the teachers' perceptions of taboo and noa constructed? What is the role of the local culture in teachers' constructions of taboo and noa related to science instruction?
How do students in the local culture influence the taboo and noa of science teaching?
How can inservice experiences for science teachers assist teachers in examining and reflecting on their power as informants of changing their practice?
How are the various roles (teacher, student, administrator, parent, citizen) in the local culture woven into a conceptual code which forms the foundation for the local school culture?

Through studies which merge the perspectives of the insider (the emic) and the outsider (the etic), the science education community can build a stronger research base for informing practice. Research which draws upon the literature from anthropology and sociology can provide valuable insights into the complex environment and interpretations of teaching which occur not just in a teacher's classroom, but within the local culture of a community. The synthesis of these kinds of research studies will strengthen the theoretical base and practical knowledge of teachers and science teacher educators.

Footnotes

[1] The items included in the belief opinionnaire used in this study were based on items adapted from an unpublished STS instrument developed by Willard Jacobson, Teachers College, Columbia University.

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Table 1

Semi-Structured Interview Protocol

1. Had you thought about the issue of controversial topics in STS instruction before you answered those questions on your opinionnaire and survey? [If yes, please elaborate.]
2. As a result of the questions, how has your thinking concerning STS teaching been impacted?
3. Which topics do you anticipate might be frowned upon for you to teach as STS topics in your teaching context?

   [probe: Which of these topics would you teach anyway?
   Do you teach them in any way different from other topics?
   Have you ever received complaints about any topics relating to STS that you taught?
   Would you teach those topics again?]
4. How have you reacted to controversial topics brought up by your students?
5. If you intentionally wanted to put your job in jeopardy at your school, which potential topics in STS would you include in your curriculum?
6. Has your involvement with STS instruction (as a result of the workshop, further thinking, etc.) changed your thinking or viewpoint about what subjects might be too controversial or "taboo" to teach in your class?

   [If the participant asks what taboo means, say it refers to a topic in STS which they believe is considered by the local community to be forbidden to be discussed in the classroom.]
7. Does the school's local culture share your definition of what might be "taboo" STS topics to teach? [probe: If no, ask which ones differ and how.]
8. What did you do this year with your students relating to STS?
9. How did you do it?
10. Do you have any suggestions on how to improve the STS inservice experience?

Table 2

Ms. Shaw's and Ms. Bird's Selective Beliefs About Science

Level of Belief	Ms. Shaw	Ms. Bird
Strongly Believes	Item(s) # 1, 4, 8, 11, 15	no responses
Believes	Item(s) # 2, 6, 7, 14	Item(s) # 1, 3, 5, 6, 8, 10, 11, 13, 14
Neutral belief	Item # 9	Item(s) # 4, 7
Does not believe	Item(s) # 3, 5, 12	Item(s) # 2, 8, 9, 12, 15, 16, 17
Strongly does not believe	Item # 16	no responses

Note. Refer to the opinionnaire for the item statements.

Table 3

Ms. Shaw's and Ms. Bird's STS Understanding

Question/Statement	Ms. Shaw	Ms. Bird
1. What kind of working definition do you you hold of science-technology-society-education?	Where the teacher is the resource and guide in the class. The students are the implementors, searching for answers.	STS is the teaching and learning of science technology focusing on real-world problems extending beyond the classroom to the community to develop citizenship roles in students.
2. What topics do you believe should be included in a STS curriculum at your school?	The preservation of the environment and our natural resources.	Solid waste-recycling; habitat destruction; tropical rain forest deforestation; saving energy.
3. Envision the "ideal" STS teacher. Describe that teacher and how that teacher behaves.	The teacher is nurturing and supportive. Since the students investigate problems they choose--the teacher must be flexible.	The teacher would be flexible, sensitive to students concerns, and guide students to draw their own conclusions or solutions.
4. What STS topics do you anticipate would be frowned upon by your school administration or community if you taught them (taboo topics)? Would you teach them anyway--even if it meant you put your teaching job in jeopardy?	Evolution, The Big Bang, Aids (with 5th grade).	At the 6th grade level abortion and nuclear war would be frowned upon by school administration or community because of the age of the children. I would not teach them. However if the subject is brought up by the student it would be addressed and not ignored.

Table 4

Ms. Star's, Mr. Bailey's, and Ms. Jefferson's Selective Beliefs About Science

Level of Belief	Ms. Star	Mr. Bailey	Mr. Jefferson
Strongly Believes	No responses	Item(s) # 5, 10, 11, 12, 13	Item(s) # 10, 11
Believes	Item(s) # 2, 3, 4, 7, 10, 13, 15, 16, 17	Item(s) # 2, 8, 16	Item(s) # 1, 2, 3, 5, 6, 7, 8, 13, 15, 17
Neutral belief	Item # 5	Item(s) # 4, 7, 15	No responses.
Does not believe	Item # 1, 6, 8, 11, 14	Item(s) # 1, 2, 6, 8	Item(s) # 4, 14, 16
Strongly does not believe	No responses.	Item(s) # 14, 17	Item # 12

Note. Refer to the opinionnaire for the item statements.

Table 5

Ms. Star's, Mr. Bailey's, and Mr. Jefferson's STS Understanding

Question/Statement	Ms. Star	Mr. Bailey	Mr. Jefferson
1. What kind of working definition do you hold of science-technology-society-education?	The need to include the incorporate STS education in all areas of the curriculum (critical thinking and problem-solving skills).	Education designed to make students aware of more practical uses of and operations involved in modern day science related topics and decisions.	Helping kids to think about issues that affect their lives.
2. What topics do you believe should be included in a STS curriculum at your school?	Environmental issues; endangered species; moral reasoning; decision making; problem-solving.	Agriculture; communications; computers; environment.	Pollution, acid rain, cloud seeding, alien contact.
3. Envision the "ideal" STS teacher. Describe that teacher and how that teacher behaves.	The STS teacher looks for opportunities to challenge students to think critically and make judgments based on critical analysis.	Hands-on; inquisitive; creative.	The STS teacher is noncommittal to student comments on STS issues. The teacher never says the parents of students are wrong. Hands-on activities used.
4. What STS topics do you anticipate would be frowned upon by your school administration or community if you taught them (taboo topics)? Would you teach them anyway--even if it meant you put your teaching job in jeopardy?	Genetic engineering; abortion.	Abortion methods; sex education. I would not teach anything that I thought might jeopardize my job.	In earth science any statements that conflict with a literal reading of the Bible would be frowned upon by the community. There is no sense in going out in a "blaze of glory" by teaching certain topics. The teacher must pick the battle.

Appendix: Opinionnaire

DIRECTIONS: The following items are statements about science, technology, and society. Please indicate for each item if you:

Strongly agree (SA) Agree (A) Neutral (N) Disagree (D) Strongly Disagree (SD)

Also, if you wish, please indicate under each item your reasons for your response.

ITEMS

1. The fundamental driving force in science is curiosity concerning the natural, physical universe.

2. Scientific discoveries and technological inventions have, on balance, done more good than harm for human kind.

3. Scientific discoveries make our lives change too fast.

4. Because of the great needs and serious problems we face feeding the world's population, the rate of technological development should be increased in agriculture.

5. In dealing with environmental problems, we should heed the credo, "Nature knows best."

6. A return to a simpler life less dependent on technology would result in a better environment for all.

7. Life is better now than it was ninety years ago.

8. It would be better for us, our economy, and environment if society were less technological.

9. It would be better for us, our economy, and environment if less chemicals, such as those in fertilizers, insecticides, and herbicides were used in agriculture--even if that resulted in less production; rapid population growth is one of the major problems causing environmental degradation.

10. Rapid population growth is one of the major problems causing environmental degradation.

11. Teenage boys and girls should have the opportunity to learn various methods of birth control in school.

12. Nuclear power is such an awful danger to the environment that the United States should close down all nuclear reactors.

13. Critical societal problems affecting the environment should be studied in the schools even if it means less time and energy devoted to science, mathematics, English, music, and art.

14. Ideally, we should consider critical societal problems that affect the environment, but that this is just not practical in our schools of today.

15. Given the choice between maintaining my standard of living or using my resources to improve the environment, I choose to maintain my standard of living.

16. The western world's technology will eventually solve the world's environmental problems.

17. There are some science-technology--society issues that are too controversial to teach in my school.

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