Professional Development of Science Teachers: History of Reform and Contributions of the STS-Based Iowa Chautauqua Program

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Abstract

During the last quarter of a century, it became abundantly clear that the desired reforms in science teaching and learning could not be accomplished without significant professional development of in-service science teachers. Yet, there was a dearth of effective professional development models that could lead to the kind of instructional reforms desired. It was soon realized that professional development itself must undergo significant reform. New guidelines for professional development began to be developed in order to reform it. We trace the history of this reform and describe a model that emerged as an exemplar of the new guidelines. This model has been used extensively in the USA and in many other countries of the world. The characteristics of the model, research related to its effectiveness and impact, and its implementation around the world are presented.

Professional Development: Need and Role in Science Education Reform

> What lends urgency to professional development is its connection to reform and to the ambitious new goals for education that are to be extended to all students. Can professional development lead educational reform? (Sykes, 1996, p. 465)

This question, raised by Sykes, regarding the critical role of professional development in educational reform provides the foundation for this exploration of professional development as a reform mechanism and the contributions of an STS-based approach to the K-12 in-service science teachers professional development process. Given the increasing impact of science and technology in contemporary society, making science relevant to the lives of all students emerged as a key aspect of reform in science education during the final two decades of the 20th century (Hickman, 1982; Hurd, 1986, 1989, 1990, 1991, 1994, 1997; Kennedy, 1982; McCormack & Yager, 1989; Yager, 1984a, 1984b, 1998; Yager & Tweed, 1991). Several science education reform efforts around the world during that time, such as *Project 2061* in the USA (American Association for the Advancement of Science [AAAS], 1994) and *Science Education for the Future* in the UK (Millar & Osborne, 1998) reflected this common concern for science education that is relevant to the lives of all students. Achieving such reform that effectively addressed this common concern is a complicated task and cannot be accomplished simply by introducing new curricular materials or technological gadgetry into the classrooms. With the recommendations for reform grew a growing realization of the importance of ongoing professional development of in-service science teachers in order to achieve the vision of the desired reform. For example, the National Science Education Standards (NSES) developed in the USA (National Research Council, 1996) included a section devoted entirely to professional development standards. Long before the publication of NSES, Sparks (1983) noted: "Staff development offers one of the most promising roads to the improvement of instruction" (p. 65).

While the importance of professional development in bringing about science education reform became increasingly obvious, it also became evident that the traditional forms of professional development were severely limited in their capability to bring about the desired reform. Traditionally, professional development of teachers was packaged into an afternoon or a full day in-service session, which seemed to be designed as a quick-fix for teachers' inadequacies and incompetence (Guskey & Huberman, 1995; Huberman & Guskey, 1995; Kyle, 1995). This form of professional development came to be widely criticized as inadequate and inappropriate in the context of contemporary educational reform efforts, and as being out of step with current research about teacher learning (Darling-Hammond & McLaughlin, 1995; Fullan, 1995; Kyle, 1995; Lieberman, 1995; Lieberman & Miller, 1992; Little, 1993; Miles, 1995). The need for a new perspective on professional development of teachers emerged as a crucial first step in the reform process. For example, Fullan (1995) noted that "radical changes are required in how teachers learn and in their opportunities to learn" (p. 266) and Lieberman (1995) warned: "The conventional view of staff development as a transferable package of knowledge to be distributed to teachers in bite-sized pieces needs radical rethinking" (p. 592).

Making science relevant to the lives of students requires, among a variety of other factors, a classroom environment in which they can be actively involved in making meaning of the information within a relevant context. Teachers need to learn to create a suitable environment and employ strategies that encourage active questioning and identification of issues and answers by students. They need to be able to encourage students to challenge the information presented and discuss its personal relevance. These abilities cannot be developed through brief, "one-shot" in-service sessions traditionally regarded as professional development. They require carefully designed, sustained, professional development opportunities that actively involve teachers in the learning process. As Shanker (1996) noted, such professional development will be far more effective than the traditional practice:

> For professional development to be effective, it must offer serious intellectual content, take explicit account of the various contexts of teaching and experiences of teachers, offer support for informed dissent, be ongoing and embedded in the purposes and practices of schooling, help teachers to change within an environment that is often hostile to change, and involve teachers in defining the purposes and activities that take place in the name of professional development. (p. 223)

Therefore, reforming professional development from brief in-service sessions to comprehensive programs became essential to the broader science education reform efforts.

Effective Professional Development or Business as Usual?

The concern regarding teacher professional development worldwide was well expressed by an Australian teacher, as follows:

> Staff development days in education are still being called curriculum days—and they often just have a focus on the students and the curriculum in schools. ...They should focus on professional development for teachers because that's going to benefit the kids as well. (Ball, Jones, Pomeranz, & Symington, 1995, p.21)

Until recently, staff development for teachers was dominated by a "training" paradigm (Grant, 1997). Within this paradigm, professional development of teachers is characterized by terms such as "teacher training" and "in-service education." Staff development activities under this paradigm have traditionally been packaged into short-term, discrete, in-service sessions or workshops. Most of these workshops tend to follow a somewhat standard format whereby an outside expert (or consultant) "blows in, blows up, and blows out" while teachers are expected to passively receive whatever was “blown up” and try to make use of it in their instructional practice. They seldom ever see or hear from the expert again.

The training paradigm evolved concurrently with curriculum development projects of the 1960s and 1970s. The need to help schools and teachers adopt the new curricula legitimized the training format whereby "teachers were ‘trained’ to faithfully implement the various innovations" (Blunck, 1993, p. 23). Teachers were viewed as “vessels to be filled rather than lamps to be lit” (Blunck, 1993, p. 24). The major problem with the training paradigm was its view of teachers as passive recipients of knowledge and its prescription from the top down. The realization of the limitations of the “teacher training” model led to formal studies of in-service programs. For instance, Berman and McLaughlin (1978) studied federally-supported programs and found that the programs that made a lasting difference in schools were characterized by in-service activities that had a local focus, allowed teachers to experiment with and customize the innovation to suit the local context, had active support from the administrators, and involved extended opportunities and ongoing support for teachers to implement the innovations. Findings such as these stimulated new interest in the in-service education of teachers. New guidelines for effective in-service education were developed. For instance, exhaustive research undertaken by Evans (1986) led to a set of 22 guidelines.

In spite of the development of these guidelines, very few programs actually followed them in designing in-service activities (Liu, 1992). Even though staff development came to be viewed as a key aspect of school improvement efforts (Sparks & Loucks-Horsley, 1990), much of what was offered as professional development of teachers continued to follow the training paradigm and remained largely out of touch with the emerging guidelines. Miles (1995) paints a very sobering picture of a majority of professional development work that emanated from the training paradigm and dominated the educational arena:

> It’s everything that a learning environment shouldn’t be: radically under resourced, brief, not sustained, designed for “one size fits all,” imposed rather than owned, lacking any intellectual coherence, treated as a special add-on event rather than as part of a natural process, and trapped in the constraints of the bureaucratic system we have come to call “school.” In short, it’s pedagogically naive, a demeaning exercise that often leaves its participants more cynical and no more knowledgeable, skilled, or committed than before. (p. vii)

Training-based discrete workshops may be useful for delivering certain types of information such as methods for organizing portfolio assessment of students’ work (Little, 1993) or teaching specific skills such as the use of a particular computer software package (Grant, 1997). However, their usefulness as the dominant channel of professional development in diverse contexts has been widely criticized (Darling-Hammond & McLaughlin, 1995; Fullan, 1995; Kyle, 1995; Lieberman, 1995; Lieberman & Miller, 1992; Little, 1993; Miles, 1995; Sykes, 1996). Advances in research on adult learning (Wood & Thompson, 1980) and the change process (Fullan, 1993), coupled with identification of new needs for science education reform, stimulated new views about professional development of teachers and its role in improving education.

Professional development began to be recognized as an ongoing process of teacher growth rather than a series of discrete remedial events to fix their inadequacies (Kyle, 1995; Kyle & Sedotti, 1986), leading to the development of professional communities of learners (Little, 1993) and a pathway to producing new professional cultures in schools (Fullan, 1995). Within this new paradigm, teachers are regarded as sophisticated and responsible professionals rather than “mere functionaries handing out and collecting materials prepared by commercial or bureaucratic sources outside the classroom" (Renyi, 1996). Teachers are also being recognized as change agents whose equal partnership in defining and designing professional development activities is critical to the success of contemporary reform efforts. Based on the works of Sparks (1995), Little (1993), and Sykes (1996), the National Foundation for the Improvement of Education in the USA summarized the major aspects of shifting emphases in teacher professional development shown in Table 1 (from Renyi, 1996, p. xvi). The emphases in the right-hand column of Table 1 can also be regarded as a list of key elements that make professional development effective in the broader context of educational reform.

Table 1
Shifting Emphases in Teacher Professional Development

From	To
Isolated, individual learning	Learning both individually and in the context of groups, such as the whole school faculty and teacher networks interested in particular subjects
Fragmented, one-shot "training"	Coherent, long-range learning
District-level, one-size-fits-all programs	School-based learning tailored to the needs of all the students in the building
Bureaucratically convenient	Focused on student needs
Outside the workplace	Embedded in the job and closely related to both student and teacher needs
Experts telling teachers what to do	Teachers taking an active role in their own growth
Skills that can be used by everyone and therefore available in depth to no one	Involvement of all teachers and instructional leaders in developing new approaches to teaching based on their needs
Teachers as passive receivers	Teachers and administrators as active makers of their own learning
Adult learning as an add-on that is not essential to schooling	Adult learning as a fundamental way of teaching and a transformation of schooling
Measuring effectiveness by attendance at workshops	Measuring effectiveness by improvements in teaching and learning

Specific to science education, guidelines have emerged for the professional development of science teachers. Examples of these include Standards for Professional Development for Teachers of Science (National Research Council, 1996, Ch. 4, pp. 55-73) and the National Science Teachers Association's (NSTA) Position Statement on Professional Development in Science Education (NSTA, 1996). These guidelines embody a spirit of "change throughout the system" (National Research Council, 1996, p. 72). Accordingly, they encompass the shift in several areas of emphases in the professional development of science teachers shown in Table 2 (from National Research Council, 1996, p. 72). Collectively, the shift in emphases presented in Tables 1 and 2 reflects the changing conception of the role of professional development in educational reform as well as the role of teachers in the professional development and reform process.

Table 2
Shift in Emphases Encompassed by the Standards for Professional Development for Teachers of Science

Less emphasis on	More emphasis on
Transmission of teaching knowledge and skills by lectures	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators, consultants, and planners
Teacher as technician	Teacher as intellectual, reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher as target of change	Teacher as source and facilitator of change

The Iowa Chautauqua Program: An STS-Based Model of Exemplary Professional Development

Endorsed by the NSTA (1990-91), the Science-Technology-Society (STS) approach to both science instruction and professional development of science teachers provided the basis for designing the Iowa Chautauqua[1] Program (ICP) at the University of Iowa, Iowa City, Iowa, USA during the early 1980s. It soon emerged as an exemplary model of professional development for K-12 in-service science teachers. Its success in improving the teaching and learning of science in Iowa schools led to its recognition and validation in 1993 by the U.S. Department of Education as a model professional development program, worthy of dissemination through the Department's National Diffusion Network. Consequently, the ICP model has been emulated in several states in the USA and in several countries worldwide during the last decade (Dass & Yager, 1999). Some of the key elements of the program, which make ICP an exemplary model of professional development reform, include learning experiences based on research-compatible ideas and that actively involve teachers, an expectation from teachers to practice what they learn, feedback and follow-up support, and an on-going approach involving collaborative efforts. Central to these key elements is the STS approach to the teaching and learning of science; using real-life situations, questions, concerns, and problems as the context and starting points for studying science (Figure 1) or setting the content of science in the context of human experiences (Blunck & Yager, 1996). The key elements of the ICP model are now described.

CHAUTAUQUA LEADERSHIP CONFERENCE

LEAD TEACHERS MEET TO:

Plan Summer and Academic Year Workshops
Enhance Instructional Strategies and Leadership Skills
Refine Assessment Strategies

THREE-WEEK SUMMER WORKSHOPS

3-4 LEAD TEACHERS + UNIVERSITY STAFF + SCIENTISTS WORK WITH TEACHERS IN LOCAL/REGIONAL WORKSHOP SETTINGS

Teachers are introduced to constructivist instruction in a Science-Technology-Society (STS) context. Teachers:

- Participate in activities and field experiences that integrate concepts and principles from all major disciplines of school science.
- Make connections between science, technology, and society in the context of real-life experiences.
- Use local questions, problems, and issues to provide an organizing context for science instruction.
- Create a 5-day teaching module.

5-DAY CLASSROOM TEACHING TRIAL

Teachers involved in summer workshops teach and assess a 5-day module using constructivist principles in an STS context

Academic Year Workshop Series

3-4 LEAD TEACHERS + UNIVERSITY STAFF + SCIENTISTS WORK WITH SUMMER TEACHERS + NEW TEACHERS

Fall Short Course: 20-Hour Instructional Block
Defining techniques for developing teaching modules and assessing their effectiveness; selecting a tentative topic; practicing specific assessment tools in multiple domains of science.

Interim Project: Three- to Six-Month Interim Project
Developing a constructivist instructional module for a minimum of 20 days of instruction; developing a variety of authentic assessment strategies; administering pre-tests in multiple domains of science; teaching the module; communicating with regional staff, lead teachers, and central program staff.

Spring Short Course: 20-Hour Instructional Block
Discussing assessment results; analyzing experiences related to teaching the module; planning next steps for expanding constructivist and STS approaches; planning for professional leadership in local reform efforts.

Figure 1. The Iowa Chautauqua Program (ICP) of professional development.

Learning experiences. During the 3-week summer workshops of the ICP, teachers are involved in learning experiences that help them identify or generate specific issues that they would expect to explore in their science classes. The learning experiences include field trips and introduction of audio-visuals or other media reports of some current events. Issues potentially relevant to students are gleaned out of these experiences. After identifying the issues, teachers study research and other information and gather materials needed for treating the issues in their science classes in a Science-Technology-Society (STS) context. The first product of this exploration is a small, issue-based teaching module designed by each participant. In developing these modules, teachers are designing instruction compatible with research on effective teaching, their own teaching goals, and the issues involved. Throughout the workshops, teachers are actively involved in their own learning as they identify issues, develop teaching modules based on the STS approach, develop assessment plans to match their modules, and assess their current teaching practices in light of these approaches. Appendix A shows elements of the STS pedagogy embedded in the modules, and sample modules may be accessed from Dass (n.d.).

Expectation to practice. Following the summer workshop, participants of the ICP try out their modules in their classes during the early part of fall semester. Since the STS approach to science teaching and learning is not presented in an abstract fashion during the workshop and teachers personally design each module within the context of the realities of their own teaching situations, the use of these modules does not appear to be an extra add-on activity. Rather, it fits within the context of what they would normally be doing. This increases the chance of their actually practicing what they learned during the workshop. The modules and the instructional strategies belong to the teachers, not a phantom consultant long gone. Practicing and applying in classrooms what is learned during professional development activities are key ingredients of quality professional development if the goal is to bring about a change in teacher behavior (Joyce & Showers, 1980; Sparks, 1983).

Feedback and follow-up support. The ICP teachers are not left on their own after the summer workshop. Mentored by lead teachers from local teams, teachers receive feedback, encouragement, constructive criticism, and support as they try their first modules. In addition to the on-going support provided by lead teachers, follow-up workshops during fall and spring both support teachers and push them a bit to take risks in their classrooms. These workshops are designed to provide an opportunity to share, assess, and reflect upon the results of trying the first module. Teachers learn from their peers and are encouraged to continue the effort by refining the first module and designing a second, relatively larger, module whose trial results are discussed during the spring follow-up workshop. Thus, the series of workshops not only provides feedback on the first teaching trial but helps participants continue to practice what they have learned by way of designing and teaching new modules. And, in the process, they see other teachers trying new things as well. Teachers learn from each other as they share experiences and results of their practice. This form of feedback and follow-up support contributes toward the development of a community of learners. Feedback and follow-up support have been found critical in ensuring behavior change and are, therefore, identified as key features of quality professional development (Guskey, 1995; Joyce & Showers, 1980; Sparks, 1983; Wood & Thompson, 1980).

On-going approach with emphasis on collaboration. In order to bring about real change, teachers must be involved in long-term learning activities and should have the support of professional learning communities that include their colleagues, administrators, parents, and other community members (Darling-Hammond & McLaughlin, 1995; Guskey, 1995; Lieberman, 1995). Recognizing the need for long-term learning and ongoing support to change teaching practices, the ICP offers a full academic year program (involving summer, fall, and spring workshops) and promotes regular communication among participants and central staff through telephone conferences, meetings, e-mail, and a newsletter. Participants are encouraged to contribute articles for the newsletter about their experiences and accomplishments in the classroom. Each issue of the newsletter has several first person stances of participants' successes and limitations.

The ICP exemplifies high quality professional development in its emphasis on collaboration between teachers, administrators, parents, scientists, business and industry leaders, and other community members in improving science education for all students. One of the key elements of the ICP is to develop a network of professional learning communities. This is achieved by involving scientists and other community resources in the workshops, inviting administrators and parents to participate in the workshops, and encouraging teachers to develop partnerships with other teachers and community members as they design and teach issue-oriented modules.

The emphasis on the STS approach is ideally suited for helping teachers develop skills necessary to be able to design learning experiences that will make science relevant to their students. While achieving this goal, the ICP also provides opportunity for teachers to develop leadership qualities. Activities such as developing their own teaching modules, organizing local area workshops during summer, fall, and spring, and writing articles for the newsletter and other outlets all contribute to the development of professionalism, teacher leadership, and competence, as well as foster a sense of ownership of the program on the part of teachers. This implies that within a few years time in any given area, a cadre of local lead teachers will develop who can successfully design and implement professional development activities based upon the ICP model but tailored to meet the specific needs of local teachers as they change through time. This is a critical point for those seeking to develop effective professional development programs. Just as effective science education, viewed through the lens of STS, means relevance in terms of real-life experiences of students, effective professional development also means relevance in terms of the local teaching situations and realities of the teachers involved. The ICP model offers that relevance by involving teachers actively in developing the leadership to influence how science will be taught in their classes and schools.

Effects of the STS-based ICP Model: Teacher Growth in Multiple Domains

While engaging teachers in the STS approach to the teaching and learning of science, the ICP model of professional development offers opportunities for teacher growth in several domains. These include: leadership qualities, use of instructional approaches that connect science to real life, attitudes toward teaching, confidence and competence regarding science subject matter, ability to collaborate with other teachers, and integration of modern communication and information technology in instruction. The studies described below point to the effectiveness of the ICP model in helping teachers grow in these domains.

Liu's (1992) comparison of new ICP participants with non-ICP teachers revealed that by the end of the program, ICP teachers had significantly higher confidence levels to teach science, better understanding of the basic features of science, and more positive perspectives on teaching science. He also conducted a comparison of teaching behaviors in classes using the STS approach versus those using the “traditional” textbook approach. This comparison indicated that in the STS classes, teachers employed more elements of the student-oriented, constructivist teaching and learning principles as compared to what was going on in traditional classrooms.

Blunck (1993) studied the impact of ICP on “reculturing behaviors” of teachers that lead to a positive change in the culture of the school. The reculturing behaviors considered in this study relate particularly to change in teacher confidence so that they view their roles inside and outside the classrooms differently. These behaviors relate to teacher interaction with their peers, interaction with school administrators, interaction with parents, and interaction with field experts in the community. Blunck discovered that after participating in the ICP, teachers' confidence increased significantly to involve other teachers, school administrators, parents, and experts in the community as they implemented the STS approach in their classes. They also showed increased confidence with respect to dealing with differing opinions from those inside and outside the school and with respect to working with others on projects to improve their science programs. This increased confidence to effect change, both within one's own classroom and in the school as a whole, positioned ICP teachers to influence real educational reform and enhance the quality of science education in their schools.

Using a combination of quantitative and qualitative methods, Dass (2005) studied professional growth of a group of teachers participating in an ICP-based program in Florida, USA. This study led to the following conclusions:

1. The Chautauqua program helped teachers develop leadership skills in the areas of mentoring, coordinating teamwork, sharing their work at professional meetings, and taking roles of responsibility within the program.
2. Chautauqua teachers learned to focus more on student questions and concerns. They learned to value prior conceptions and knowledge levels of students and developed instructional activities, which took into account students' prior knowledge levels. In general, Chautauqua teachers grew in their understanding and use of constructivist pedagogy.
3. Chautauqua teachers developed a markedly positive attitude toward teaching in general and toward teaching science in particular. They demonstrated a new excitement and enthusiasm toward their profession.
4. Chautauqua teachers became more confident about teaching science. Elementary teachers in particular reported spending more time on science activities and integrating science topics more with other areas of the curriculum.
5. Chautauqua teachers collaborated more with their peers and administrators in improving instructional practices. They also utilized resources available in the local community more than they did formerly. These collaborations enhanced the quality of their instructional activities and made learning experiences more meaningful for their students.
6. Chautauqua teachers integrated more of the available technological resources than they did formerly in their instruction. This also enhanced the quality of activities and helped students explore avenues of learning otherwise inaccessible to them.

As evident from these results, the STS-based ICP model has contributed significantly to the reform of professional development and, in turn, to the reform of the teaching and learning of science in K-12 classrooms. However, it must also be noted that in order to be successful, a comprehensive program of professional development must provide for ownership of the reform by teachers and the school community at large. Also, other demands on teacher time, such as various administrative duties, must be taken into consideration. These issues of ownership and other time demands may make it difficult for professional development to be effective. Applying the Concerns Based Adoption Model (Hall, 1979; Hall, Wallace, & Dossett, 1973), Dass (2001) investigated what made the adoption and implementation of ICP successful in Collier County, Florida. The findings indicated that several of the features of ICP, described in the previous section, enable teachers to develop the ownership of reform and make it part of their normal instructional practice (rather than implement it as something extra) so that it does not make additional demands on their time.

Professional Development Using STS and ICP: Efforts Around the World

Based upon its success with teachers and students in Iowa, and validation as an exemplary model of professional development from the U.S. Department of Education, the STS-based ICP model has been widely disseminated throughout the USA and in several other parts of the world. In some cases, such as Collier County, Florida, comprehensive programs have been developed emulating the ICP model while in other cases a Chautauqua-style series of workshops have been conducted.

Within the USA, almost 5,000 K-12 teachers have experienced professional development based on the STS-ICP model over the last 10 years, which in turn has impacted the science education of nearly 200,000 students. Some of the prominent programs that have used elements of the STS-ICP approach within the USA include the Vermont Chautauqua Program, South Dakota STS Project, Collier Chautauqua Program (Collier County, Florida), Tennessee Valley STS Project, North Carolina SCI-LINK/GlobeNet Project, and Oklahoma TEEMS Project. On the international landscape, the STS-ICP model has influenced professional development programs across several countries including Australia, China, Estonia, Germany, Indonesia, Israel, Japan, South Korea, Malaysia, Singapore, Spain, Taiwan, and Thailand. Internationally, nearly 500 teachers have been involved in these programs, impacting the science education of almost 15,000 students. It can demonstrably be argued that the STS-ICP model has been instrumental in helping realize the visions of contemporary science education reform worldwide by significantly improving professional development practices and programs for K-12 in-service science teachers.

Conclusion

On one hand, the notion of in-service education in the form of discrete workshops to “fix” teachers' inadequacies has been replaced by a notion of professional development for continuous enhancement and the ongoing learning of teachers. On the other hand, the notion of desirable education in the sciences has shifted from an emphasis on mastery of the so called “content” of science to an emphasis on the real-life relevance of science to students. The very nature of science has undergone drastic changes within the last 50 years and demands a new perspective on school science education. School education in the sciences must change to reflect this changing nature of science, as well as the changing notion of what is desirable science education. The two developments--the changing notion of in-service education and the changing notion of the desirable features of science education--have led to an urgent need for effective professional development programs that address both. However, such programs with proven track records are not easy to find.

The ICP model is based upon the idea that "in-service education is both a strategy for specific instructional change as well as a strategy for basic organizational change in the way teachers work and learn together" (Blunck, 1993, p. 132). This basis of the ICP model is congruent with the current notion of professional development for the continuous enhancement and ongoing learning of teachers. The STS approach, focusing on the teaching and learning of science in the context of human experience, is poised to provide real-life relevance to school science education. Thus, an engagement with the STS approach through the ICP model addresses both of the developments mentioned above. Further, the ICP model and the STS approach embedded within it have a track record (indicated by the studies described above) that demonstrates their effectiveness in bringing about the desired reform both in the general professional growth of teachers and in specific science instruction in their classes. The fact that this professional development package (i.e., STS plus ICP) model has been emulated successfully in several different settings worldwide attests to its adaptability to local educational realities and priorities. Thus, the STS approach presented through the ICP model of professional development offers undeniable promise in contributing to the educational reform much desired around the world as we progress through the 21st century.

Note

[1]The name *Chautauqua* in Iowa Chautauqua Program (ICP) reflects the ongoing, recurring nature of the professional development process, in contrast to professional development consisting of isolated, sporadic events that characterize the traditional notion of in-service education. The word Chautauqua is borrowed from the name of the recurring educational summer camp assemblies that began in 1874 on the shores of Chautauqua Lake, New York, and later spread to various locations across North America as recurring educational, cultural, and entertainment camps. Thus Chautauqua is meant to imply the recurring, ongoing, long-term characteristic of the ICP model of professional development.

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Appendix A: Elements of the Science-Technology-Society (STS) Pedagogy