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Application of the Guidelines for Effective Elementary Science Teacher Inservice Education

Beth Shiner Klein
State University of New York (SUNY) Cortland

Historically, elementary science teacher inservice has not been an effective means of improving science teaching for most elementary teachers. Guidelines for Effective Elementary Science Teacher Inservice Education *were developed by Klein (2001) to address this need. This paper illustrates, through a review of program evaluation documentation, how the guidelines were implemented in an elementary science teacher inservice education program.*

Introduction

There is agreement within the science education community that one way to improve elementary science teaching is to provide quality elementary science teacher inservice education (Crawley, 1987; Henry, 1947; National Research Council [NRC], 1996a; Prather, 1993; Weiss, 1978); however, teachers have not found many inservice programs sufficient to meet their needs (Bethel, 1989; Evans, 1986; Joyce & Showers, 1993; Luke, 1980; Yager, 1992). Haney and Lumpe (1995) and Evans (1986) offered suggestions for developing successful science teacher inservice programs. Klein (2001) presented 18 guidelines specifically developed for elementary science teacher inservice programs.

In this study, documentation from an elementary science teacher inservice program were examined to see if, and how, the inservice program utilized the *Guidelines for Effective Elementary Science Inservice Education* offered by Klein (2001). These guidelines, presented in Table 1, were developed through an extensive review of research on how to plan, implement, and evaluate effective science inservice programs.

Table 1. Summary of the Guidelines for Effective Elementary Science Teacher Inservice Education (Klein, 2001)

Guidelines for Inservice Planning

1. *Collaborative Effort:* Programs should involve a collaborative approach when planning, implementing, and evaluating a program.	6. *Incentives Provided:* Programs should provide teachers with benefits to encourage participation and follow-through.
2. *Well-Planned:* Programs have a thorough planning process.	7. *Principals Involved:* Programs should involve the principals to provide support for the teachers and to encourage school reform.
3. *Needs Assessment:* Programs should be based on teacher, school, and community needs.	8. *School-Based:* Programs should use the school site as the focus of activities.
4. *Clear Goals and Objectives:* Programs should have clear goals and objectives that address the identified needs.	9. *Complex and Ambitious:* Programs need to be challenging and complex to initiate teacher change.
5. *Ongoing and Developmental:* Programs should adapt to the changing needs of the teachers and provide continuous support.	10. *Comprehensive Evaluation:* Programs need to have well-executed, formative and summative evaluations.

Guidelines for Inservice Instruction

11. *Provide Variety of Instructional Strategies and Model Good Teaching Practices:* Programs should provide instruction that models good teaching practices and includes a variety of instructional strategies.
12. *Facilitate Skill Enhancement and Acquisition:* Programs should provide opportunities for teachers to practice these new skills in a supportive environment.
13. *Allow for Teacher Choices:* Programs should provide teachers with opportunities to decide what program activities/components would best meet their needs.
14. *Use Adult Learning Strategies:* When modeling best teaching practices, adult-learning strategies must be employed.

Guidelines for Inservice Follow-up

15. *Provide School-Based Support:* Programs should involve the school in providing financial, instructional, and moral support to the teachers involved in the program.	16. *Provide Continuous Support:* Programs should offer follow-up support for teachers as they continue their professional development.

Guidelines Related to Inservice Outcomes

17. *Change Teacher Behavior:* Programs should focus on changing teacher behavior.	18. *Build Teacher Self-Confidence:* Programs should improve teacher self-confidence, which is a factor in improving their teaching.

Methodology

The focus of this study was to see if and how the inservice program utilized the *Guidelines for Effective Elementary Science Inservice Education* (Klein, 2001). To begin the study, the researcher gave the project director and graduate research assistant a copy of the 18 guidelines (see Table 1). The researcher then interviewed the project director and graduate research assistant. The project director, a university faculty member, had co-authored the inservice program funding proposal and was a co-instructor in the program courses. The graduate research assistant was a former classroom teacher with over 20 years of experience and was initially a participant in the program, who then decided to pursue a doctoral program at the institution. She was also a co-instructor in the program and conducted participant interviews and collected documentation of the program. Their interviews revealed their perspectives about the relationship of the elementary science teacher inservice program to the 18 guidelines. Documentation of the program was reviewed and categorized according to the 18 guidelines. Then, a determination was made as to whether each guideline was reflected in the evidence. A ranking of "significant degree" was given if there was evidence in the project goals or project proposal and/or the project director and graduate research assistant indicated that it was a project goal. In addition, there had to be compelling evidence provided in the project outcome documentation that the guideline was realized in the project to receive the top ranking. A ranking of "some degree" was assigned if there was some evidence provided that the guideline was evident in the project. A ranking of "not evident" was assigned for any guideline that had little to no evidence present in the project outcome documentation.

Data

A variety of data were reviewed from the program documentation. This included program planning and development documents, participant interview transcripts, participant attitude and science content inventories, participant and school principal surveys, field supervisor reports, technical progress reports, and external evaluation reports.

Trustworthiness and Rigor

In order to ensure the study's credibility, a variety of data was reviewed and the utilization of triangulation strategies were employed. Dependability of the results was ascertained through use of a peer reviewer and an external auditor. A peer reviewer was designated for the study who possessed training in qualitative methodologies and familiarity with both the project and the data. The peer reviewer examined the raw data and interpretations as they were completed and made recommendations to the researcher during the data collection and analyses processes. Near the completion of the data collection and data analysis phase, an external auditor completed an inquiry audit. The external auditor had recently completed another qualitative study using similar methods to determine trustworthiness and was identified by other qualitative researchers as possessing competence in these methods. The auditor was provided with all pieces of the audit trail necessary in order to complete the audit. This included access to the results, interpretations, and raw data.

Description of the Elementary Science Teacher Inservice Program

The elementary science teacher inservice program involved teachers from Kindergarten through eighth grade. The School of Education and the College of Arts and Sciences at a major university in the southeastern United States, with the cooperation of two local public school systems and a community college, collaborated for the inservice program. During the second year of the program, it was expanded to include four additional public school systems in other nearby counties.

Over a three-year period, the inservice program prepared 59 elementary teachers for local, regional, and national leadership in the reform of elementary science education. The first cohort of teachers consisted of 29 participants, and the second cohort consisted of 30 participants. Their academic commitment included nine hours of graduate credit in physical science and science education. This began with a three-credit summer session course followed by a three-credit course during the fall semester, noncredit workshops during the spring semester, and a final three-credit course the following summer.

The intent of the inservice program was to increase the participating teachers' confidence and knowledge of physical science content and teaching skills and to promote their professional development through preparation for leadership in the improvement of elementary science teaching. As part of the program, participants were prepared and required to present elementary science workshops for their teaching colleagues, beginning in their own schools and then expanding as their skill and reputation as inservice educators increased. Program participants were also encouraged and financially supported in order to be able to present professional programs at local, state, and national conferences of elementary teachers. Many of the teachers made presentations at national and international conferences, including the National Science Teachers Association (NSTA) and the Association of Educators of Teachers in Science (AETS).

Academic Portion

The academic portion of the program presented integrated physical science—physics, chemistry, and earth and space science—concepts coupled with constructivist learning concepts and hands-on/minds-on science instructional strategies and activities. The instructors of the three graduate courses included both college-level science and science education faculty as well as exemplary elementary science teachers and science supervisors. During the project, the course instructors modeled instructional methods based on the constructivist learning theory.

Field Practica Portion

Following the initial year of coursework, the teachers in each cohort moved on to the field practica portion of the program. The participants had been recruited as three-member teams. One teacher represented the K-2 grade levels, another represented the 3-5 grade levels, and the third represented the 6-8 grade levels. This method of grouping provided each team with experience across different grade levels. Many teams also represented different schools within the same school system, which facilitated and enhanced cross-school cooperation.

As part of the field practica, each team was expected to plan and implement a school-based elementary science reform activity. For the initial step, each team conducted an assessment of the science education needs of their school. Each team was provided instruction and assistance in designing plans to meet the identified need(s) of each school. This support was designed to assist the teams in (1) planning for reform, (2) initiating and maintaining long-range programs for improvement of science teaching, and (3) establishing themselves as resources for inservice education and leadership by providing local and area elementary science teacher inservice education programs.

At the beginning of the program, an elementary teacher with a reputation for excellence in science teaching was employed on a full-time basis by the program to serve as the field supervisor. The field supervisor provided mentoring for the teams as they translated the concepts and instructional strategies they learned in the program coursework into professional practice in their classrooms and then as they designed and implemented their field activities.

Findings: Comparison of an Elementary Science Teacher Inservice Program with the Guidelines for Effective Elementary Science Teacher Inservice Education

Interviews with the project director and the graduate research assistant indicated that they both believed the program components and practices followed the guidelines. A subsequent review of the program documentation revealed that all 18 of the guidelines were evident, at least to some degree. A summary of the Guidelines for Effective Elementary Science Teacher Inservice Education were presented in Table 1.

Discussion of Components Related to Inservice Planning

As indicated in Table 2, each of the 18 guidelines was reflected, at least to some degree, in the project goals and was implemented during the inservice program.

Table 2. Comparison of Program Goals with the 18 Inservice Education Guidelines Identified in This Study

The 18 guidelines are listed in the left-hand column. The letters indicate the degree to which the guidelines were reflected in the program planning document and in the evidence contained within the program evaluation data.

Y: Yes, the guideline was reflected as a goal or implemented to a significant degree.
S: Yes, the guideline was reflected as a goal or implemented to some degree.
N: No, the guideline was not evident as a goal or implemented.

Guidelines	Indicated as a Program Goal	Implementation Observed in Program Evaluation Data
For Inservice Planning		
1. Collaborative effort	Y	Y
2. Well-planned	Y	Y
3. Assess needs	Y	Y
4. Clear goals and objectives	Y	Y
5. Ongoing and developmental	Y	Y
6. Provide incentives	Y	Y
7. Involve the principal	S	S
8. School-based	S	S
9. Complex and ambitious	Y	Y
10. Comprehensive evaluation plan	Y	Y
For Inservice Training		
11. Variety of instructional strategies and model good teaching practices	Y	Y
12. Skill enhancement and acquisition	Y	Y
13. Allow for teacher choices	S	S
14. Change teacher behavior	Y	Y
15. Adult learning strategies	S	S
16. Build teacher self-confidence	Y	Y
For Inservice Follow-Up		
17. Teacher support	Y	Y
18. Follow-up support	Y	Y

Guideline 1: Effective Inservice Programs Are a Collaborative Effort.

There was strong evidence in the program documentation that the inservice program was developed as a cooperative effort. The program development team included classroom teachers, science coordinators, principals, science teacher educators and scientists representing a major university, two public school systems, and a community college. The external project evaluators recognized this collaborative approach as a hallmark of the program throughout its conception, planning, implementation, and field support components.

Guideline 2: Effective Inservice Programs Are Well-Planned.

After determining the science content and science education needs of area elementary teachers through a needs assessment instrument (see Guideline 3), program developers determined that the program should emphasize (1) an activities-oriented science curriculum, (2) hands-on science teaching techniques, (3) the involvement of scientists and elementary school teachers in the instruction, and (4) leadership development in order to prepare teams of teachers for roles as volunteer leaders in local science education reform efforts. Also, the planning team determined that the integration of physical sciences, the development of conceptual and critical thinking skills, and an understanding of constructivist learning theory should be emphasized so as to maximize the potential benefits of instruction on hands-on science teaching and inquiry learning.

Guideline 3: Effective Inservice Programs Assess Teacher, School, and Community Needs.

The program development team determined needs for inservice education from three sources: (1) the results of national surveys of needs reported in the literature; (2) surveys of teachers in the program target area (n = 116); and (3) results of meetings with local school superintendents, principals, parents, students, and local business and community leaders interested in the improvement of science education. The survey of local teachers revealed that instruction in physical science and hands-on science teaching methods should be a top priority for inservice education. The meetings with local officials and community leaders revealed support for integrating the various science disciplines in order to encourage an interdisciplinary approach to classroom instruction. The program was purposely designed to meet those perceived teacher professional development needs.

Guideline 4: Effective Inservice Programs Contain Clear Goals and Objectives.

Following the needs assessment and the collaborative planning activities, program goals were developed and categorized into five key program areas: (1) Academic Preparation, (2) Leadership Preparation, (3) Professional Development, (4) Field Support, and (5) Program Assessment and Validation. Academic preparation included six semester hours of intense graduate study in science content and three semester hours of work in science teaching methods. Leadership preparation was provided throughout the academic portion and included instruction in adult education theory, inservice program planning, and grant and presentation proposal writing. The intent of these first two goals were to prepare the teachers to assume leadership roles in local, state, and national efforts for reform of elementary science teaching. Furthermore, professional development was also promoted by encouraging each teacher to join the National Science Teachers Association (NSTA), as well as the state affiliate, and to prepare programs for presentation at annual conferences. Field support was provided by the program staff to encourage and assist the teachers in implementing the new ideas they learned throughout the academic instruction and the planning of their field projects. This support was led by a full-time field supervisor. Formative program assessment and summative evaluation procedures were established in collaboration with a five-person external evaluation committee, who visited the program annually to evaluate the project and make recommendations.

Guideline 5: Effective Inservice Programs Are Ongoing and Developmental.

The program included one year of academic preparation for each team and one year of follow-up support for implementation of the field practica portion of the program. Instructional kits and other teaching aids purchased for the program were placed in a central clearinghouse located at a participating school. The equipment and other resources were maintained by establishing an agreement with the school system and were available for checkout by the participating teachers. Also, a regional science teachers' association was established during the first year of the program as a result of interest from the program participants. Four of the five founding officers of this organization were participants in this inservice program. One intent of this organization was to provide an ongoing forum for professional development and continued peer interaction among area science teachers.

Guideline 6: Effective Inservice Programs Provide Incentives. Participants in the Program Were Provided Monetary Incentives.

Tuition for the graduate credits was paid from grant funds, and each teacher also received a stipend for their participation in the program. Each participating school system provided membership in the NSTA and the state affiliate. Finally, each school also agreed to provide release time and support for travel for participating teachers in order to present professional papers and programs at state and national meetings.

Guideline 7: Effective Inservice Programs Involve the Principal.

The program involved the principals of participating schools in special work sessions conducted by the teacher teams in order to facilitate principal/teacher communication, cooperation, and collaboration. The field supervisor's reports and interpretive interviews with teacher-participants and their principals indicated that the majority of participants met regularly with their building principals for planning and received support for elementary science reform efforts for their schools. The meetings opened channels of communication, enabling the teachers to obtain administrative support in the form of funds for materials needed in classroom instruction, release time to conduct inservice programs for other teachers, and conference travel expenses.

Guideline 8: Effective Inservice Programs Are School-Based.

Each of the teacher teams' field projects was designed to meet the needs of their individual schools. The teacher-participants provided assistance to their respective schools through inservice programs, peer mentorships, obtaining and organizing hands-on science equipment, and team teaching efforts. In addition, program classes were held in many of the participants' classrooms in order to emphasize that the schools are the focus of the reforms promoted by the program. Other activities, such as an annual Science Circus and joint planning sessions with school principals, were also held at the participants' schools.

Guideline 9: Effective Inservice Programs Are Designed to Be Complex and Ambitious.

The program required a long-term pledge of commitment to professional development and reform of elementary science teaching by the teacher participants. The principals also agreed to encourage and support the reforms being developed in cooperation with the teacher-participants. The yearlong intensive program of academic coursework required more than 250 hours of in-class instruction, and each teacher was required to plan and offer 12 to 24 hours of local inservice programs for other teachers in their schools and in surrounding school systems. The yearlong program of field support was implemented to help the teachers maximize their potential for improvement, and the principals were required (as a condition of their teachers' participation in the program) to provide support in the form of release time and funding for teacher-participants to work toward reform goals and to attend science education conferences.

Guideline 10: Effective Inservice Programs Include a Comprehensive Evaluation Plan.

A comprehensive formative and summative evaluation plan was implemented for the program. The evaluation design included teacher and student performance evaluations. Teacher performance data included assessment of content and laboratory skill mastery collected by a performance-based science content assessment instrument, an attitude assessment from data collected with the Elementary Science Teacher Science Attitude Inventory, and data collected from interpretive interviews with teacher-participants. Data collected at the beginning of the program were used to determine teachers' initial understandings of basic physical science concepts and attitudes toward science and science teaching. In addition, this information, along with data collected during the program, was used for formative program adjustments. Data collected near the end of the project were used to determine the overall effect of the instruction on teachers' content mastery, attitudes, and teaching.

Student performance data included assessments of children in classes taught by teacher-participants, using alternative assessments designed by the teachers, the Draw-A-Scientist Test-Revised (DAST-R), and interpretive interviews with students. Pre- and post-instruction assessments were administered with both the DAST-R and the alternative assessment instruments.

The program staff developed checklists and observation procedures implemented by the field supervisor to document transference of the program course instruction into the classroom. The number of hours each teacher taught science, integrated science content, and used hands-on science teaching methods was documented; and progress in the implementation of the teams' field projects was reported.

Discussion of Components Related to Inservice Training

Whereas the previous guidelines for effective inservice education were devoted to the area of program planning, the following seven guidelines focus on inservice teacher enhancement. Features of the program are highlighted as they relate to these guidelines.

Guideline 11: Effective Inservice Programs Include and Model a Variety of Instructional Strategies and Good Teaching Practices.

According to teacher-participant interviews and course evaluations, most participants stated that the instruction conducted by those members of the program staff that they considered "classroom teachers" (i.e., the field supervisor, graduate research assistant, and visiting classroom teachers, all of whom were experienced elementary teachers) did model good teaching practices. One of the teacher-participants stated in an interview that other science courses that she had attended in undergraduate school had been either lecture or demonstration. Another participant commented that through this program, she acquired "more labs than she knew what to do with." Another teacher-participant said that it was important for her to experience the activities in order to "feel like one of them, not just a student, but a child playing and experimenting and trying out different things." The teacher-participants reported that the college science faculty, who were not initially very experienced in student-centered teaching methods and interdisciplinary instruction, improved in their attempts to model good teaching practices, but still needed to continue to improve in this area.

Instruction for the program courses was designed to promote the constructivist learning theory and to model a variety of teaching techniques and strategies. These included interdisciplinary teaching, hands-on teaching strategies, inquiry learning, uses of computers in science teaching, and the relation of instruction to current issues and events of interest to the teacher-participants. Science instruction involved the nature and history of science; science processes and experimental design; and the nature of the relationships among science, technology, and society. The project evaluation report indicated that hands-on science teaching was employed almost exclusively in the majority of the classes and that inquiry-based learning models were employed throughout all the courses; however, the report suggested that constructivist learning concepts were not emphasized as strongly during the first summer course as in later courses. This may be because participants did not recognize it, or it may indicate a lack of experience in this area by some of the course instructors.

Guideline 12: Effective Inservice Programs Provide for Skill Enhancement and Acquisition.

The program modeled a variety of teaching models, as described earlier, and the teacher-participants were required to prepare lesson activities and practice using the different approaches and methods as part of their preparation for peer teaching. The practice sessions involved feedback from other teacher-participants and program staff. This was in addition to feedback provided by the program field supervisor during observation visits to the teacher-participants' school classrooms. In addition, an annual Science Circus was conducted to give the teacher-participants experience in planning and presenting informal science education programs for diverse audiences. This program was provided in the evening at a local elementary school and was attended by teachers, students, and their parents.

Interviews with teacher-participants revealed that they believed their science teaching had improved. For example, one teacher-participant stated that the program had helped her in her "teaching of everything, not just science." Another teacher-participant stated that,

> *[I]t was hard to apply [constructivist-based methods] when you were stuck in the ways of the book. . . . [But now] they [the students] figured out [the concept of pitch] on their own. They figured out wavelength, frequency, and all of that—they understood it. Whereas last year's group [when I used the book] would regurgitate what the book said, [but] had no clue of what they were saying. If you asked them to apply it to what was in front of them, they could never do it.*

Guideline 13: Effective Inservice Programs Allow for Teacher Choices.

Prior to the beginning of instruction, the teacher-participants were surveyed to determine their perceived content needs; and the instruction was planned according to these self-reported needs. The teacher-participants were allowed to choose their own goals for the field practica and were given the freedom to design a program to accomplish their objectives, as long as it was developed in collaboration with their school principals and reflected an awareness of current research on effective methods for science teaching. They were also given limited choice in the selection of instructional activities associated with the courses.

Guideline 14: Effective Inservice Programs Change Teacher Behavior.

The program focused on providing teacher-participants with content knowledge in physical science and the teaching skills necessary to provide their students with increased student-centered learning opportunities.

One teacher-participant commented in her interview that,

> *[Before the program] I really could have given a flip about science. It was just not something that crossed my mind, and now, you know, here I am talking about a Master of Education in teaching science and that is something that would just never, in my wildest dreams, would have occurred to me.*

Another stated that the program had . . .

> *Changed my whole style of teaching; I no longer use a textbook. The text was out the window. It's only used for resource purposes, like if they have terms they have to look up. . . . [The program] just helped me so much to become a better teacher. Otherwise, I'd still be, "OK, here's the book; here's a worksheet. And I'd just do a couple of labs here and there. Now I'm more into labs than I've ever been.*

A third teacher-participant said in her interview that, since taking the program,

> *I keep buying books on labs. I don't care if they are high school labs. I'll break them down to fit the kids because I can do it now. Before, I would have looked at a high school lab, I would have said, " Now how in the heck am I going to teach this?" Next week, we are making aspirin and soap at [the students'] level. The lab will be taken from a high school book, but I can break it down to having questions at their level of thinking. Before I wouldn't have even known how to do that, but I now have the building blocks.*

Additional evidence was reported through the amount of hands-on instruction recorded by the teacher-participants and confirmed through the field supervisor's observations. The first cohort of teacher-participants reported that they were involved in an average of 3.8 hours of hands-on science instruction in self-contained classrooms and 7.3 hours of hands-on science instruction for departmentalized classrooms per week during the school year. The second cohort of teacher-participants reported presenting 3.1 hours of hands-on science instruction per week for self-contained classrooms and 15.7 hours of hands-on science per week for departmentalized classrooms. Interviews with teacher-participants in both cohorts indicated they perceived that there was a significant increase in time spent on hands-on instruction compared to prior to the inservice program. For the purposes of this program, hands-on science instruction was defined as occurring at those times in the school day when students were manipulating science materials for the purposes of reaching understandings about science concepts.

The program documentation indicated evidence that teacher behavior changed with regard to interaction with other teachers in other schools and school districts. Early in the program, several teachers realized the benefits of meeting periodically to exchange ideas about science teaching and to develop joint plans for inservice education programs. This human interaction seemed to be the primary factor in the founding of the regional elementary science teachers organization. Interviews with teacher-participants during the final stages of the project indicated that the increased involvement with peers was considered a major contributor to their increased sense of potential for improvement of their teaching. As one teacher-participant said, "I'm not the only one who feels like I need to improve, and that's a comforting thing to know—that we can work together to become better teachers."

Guideline 15: Effective Inservice Programs Implement Adult Learning Strategies.

Two basic instructional premises of the inservice program stated in the planning document were that teachers learn better when they are taught in the manner in which they are expected to teach (Judson & Sawada, 2001), and that teachers prefer to learn from other teachers. According to the project director, adult learning strategies were an integral part of the planning for the instruction on planning and conducting peer education programs; however, according to some of the teacher-participants interviewed over the course of the program, the instructors were not as successful in this endeavor as they would have liked. In some cases, when the instructors attempted to model adult learning strategies based on constructivist learning theory, it made some of the teacher-participants feel uncomfortable. This is consistent with work conducted by Tobin (1991), which discusses learner discomfort when first introduced to constructivist methodologies. In many cases, an initial experience with a constructivist approach represents a disorientation for adult learners because it may be rare to see this pedagogical practice in colleges and universities (NRC, 1996b, 1999; National Science Foundation [NSF], 1996).

Guideline 16: Effective Inservice Programs Build Teacher Self-Confidence.

Through interviews and surveys, the teacher-participants reported an increased self-confidence. As one teacher-participant explained, "I've learned a lot of the science background that I previously didn't feel confident teaching." Another teacher-participant shared in her interview that she had gained so much confidence in her science learning and teaching understanding that she had argued with the physics faculty member over the creation of a pulley device and had written a ten-page letter to her state's standards development committee offering suggestions to improve the science standards at her grade level. To better assess this dimension of their confidence, the second cohort of teacher-participants were surveyed at the beginning of their academic preparation (pre) and near the end of their last course (post) to assess their confidence level in teaching 24 specific physical science concepts. The results indicated that confidence improved in all areas among all teacher-participants.

A survey of teacher-participants and their principals indicated how they perceived the inservice program had benefited the teacher-participants and their schools. Table 3 indicates that both the principals and teacher-participants perceived an improvement in science teaching and teacher self-confidence in many of the schools.

Table 3. Program Teacher-Participants and Principal Survey Results on Improvement of Science Teaching and Level of Self-Confidence

Topic Area	Teacher-Participants (Self-Reporting) (n = 21)	Percentage of Teacher-Participants Self Reporting Improvement	Principals (n = 16)	Percentage of Principals Reporting Teacher-Participant Improvement
Improved science teaching	19	90%	14	88%
Improved teaching in general	13	62%	8	50%
Improved self-confidence	20	95%	10	63%
Developed constructivist approaches to teaching	16	76%	9	56%
Supported inservice to other teachers	No data	No data	11	69%
Encouraged interaction between teachers and administrators	No data	No data	7	44%

Discussion of Components Related to Inservice Follow-up

Two of the guidelines identified by Klein (2001) focus on providing follow-up for inservice education activities. As indicated below, there was evidence that there was an emphasis on these two guidelines in this program.

Guideline 17: Effective Inservice Programs Provide for Teacher Support.

With the assistance of external funds and support from the participating schools, the inservice program was able to provide classroom materials, financial support, and human resource assistance to support the teacher-participants in their science reform efforts. During the evaluation interviews, teacher-participants reported receiving valuable assistance from their administration, including funds for science equipment and travel, as well as release-time to attend conferences, present workshops, participate in peer teaching, and conduct mentoring programs. A total of 21 teacher-participants and 16 principals responded to a survey on the issues of support for teacher-participants (see Table 4).

Table 4. Results of Teacher-Participant and Principal Survey on Support Issues

Support Issue	Percent of Teacher-Participants Indicating They Received Support ($n = 21$)	Percent of Principals Indicating They Gave Support ($n = 16$)
Purchase of science materials	90%	94%
Release time for conferences	86%	94%
Support for teacher inservice presentations	86%	94%
Financial support for travel and other leadership expenses	52%	56%

Guideline 18: Effective Inservice Programs Provide for Follow-Up Support.

The program provided one year of field support following completion of the academic portion of the program. This follow-up included regularly scheduled classroom visits by the field supervisor, assistance of other program staff, and a series of noncredit workshops offered by program staff throughout the school year. The program staff also published a monthly newsletter and maintained frequent communication with the teacher-participants through e-mail. A teacher-participant noted in her interview that receiving the monthly information packet, which included the newsletter, copies of articles, newspaper clippings, and proposal forms for various conference opportunities, was . . .

> *incredibly beneficial to me, not just the newsletters, but the little clippings. . . . I pore over those like I do my* People *magazine. Every time I get a package . . . I'm just, "YEAH!" Not only because it's news about what is happening and everybody, but*

because I feel like there are so many things that I would not be able to pore through, and pull out things that are important to me, but I don't have time to do it.

As noted earlier, a regional science teachers support organization was formed during the program. Several of the organizing officers and board members were teacher-participants and instructors in the inservice program. A teacher-participant commented on the organization: "I think that it keeps it going, when people can get together and share ideas."

Summary

As described through the context of the *Guidelines for Effective Elementary Science Teacher Inservice Education*, this elementary science teacher inservice program included the provisions for collaborative planning, content, leadership preparation, professional development, field activities, follow-up, and program evaluation. A review of interview data collected from the teacher-participants provided evidence that indicated strong satisfaction with their experience during and after participation in the inservice program. The results of the review of all of the documentation indicated that the majority of the guidelines were strongly reflected in the inservice program, and the remaining guidelines were reflected in part. Evidence provided in the external evaluation of the inservice program indicated that this was a successful program, which had met its goals.

Information in this study provides evidence supporting the *Guidelines for Effective Elementary Science Teacher Inservice Education* and examples for how they were applied. This should provide assistance for those developing science teacher inservice education programs for elementary teachers.

Implications for Further Research

Additional elementary science teacher inservice programs should be examined to see how, and if, they implement the *Guidelines for Effective Elementary Science Teacher Inservice Education*. Program documentation should be examined to see if any additional guidelines might need to be suggested. Additional studies should be conducted to determine if some guidelines are more critical to the success of positive elementary science teacher change than others.

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Correspondence regarding this article should be directed to

Beth Shiner Klein
Childhood/Early Childhood Education Department
School of Education
SUNY Cortland
P.O. Box 2000
Cortland, NY 13045
(607) 753-5682
kleine@cortland.edu

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