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ABSTRACT

This paper introduces the Learning through Inquiry Science and Technology (LIST) program conceived in 1997 as a professional development program to familiarize science teachers with inquiry-based science instruction, instructional technology integration, and alternative assessment techniques in order to change their traditional teacher-centered instructional strategies to a more learner-centered approach. Key design elements of the LIST model include administrative endorsement, discipline-wide adoption, on-site delivery, participant input, clear expectations, quality instruction, collaborative climate, continued support, and incentives. Evaluation results indicate positive teacher and student outcomes and positive effects on partnerships for teachers and professional development partners. (KHR)

# EXCELLENCE IN RURAL SCIENCE TEACHING: EXAMINING ELEMENTS OF PROFESSIONAL DEVELOPMENT MODELS

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## Excellence in Rural Science Teaching:
## Examining Elements of Professional Development Models

### Introduction

Student learning is the focus of today's education paradigm (Lan, 2000). The most powerful influence on students' learning is the quality of teaching that students experience (Hawley & Valli, 2000). For teachers to establish new learning environments that support and sustain growth in student knowledge and skills, they must make changes in their practices and acquire new teaching strategies (NRC, 1996; ISTE, 2000). This precept and learner-centered principles for professional development (Loucks-Horsley, et al, 1998; Hawley & Valli, 2000) are the foundation of the current Learning through Inquiry Science and Technology (LIST) program.

Research has shown the benefits of educational technology use on student achievement, self-concept, and the quality of interactions between teachers and students (Silvin-Kachala & Bialo, 1994). Findings also show that teachers who have had graduate-level or in-service training in educational technology obtain significantly higher levels of student performance. In successful professional development activities, teachers expect a sense of ownership in their learning process (Dockstader, 1999) and explicit connections to their needs (Zhao, 1998). Eisenberg and Johnson (1996) support and expand upon these general expectations in their findings regarding teachers' effective integration of technology skills: "There are two requirements: 1) the skills must directly relate to the content area and to the classroom assignments, and 2) the skills themselves need to be tied together in a logical and systematic model of instruction." In the LIST program, needs assessments and an advisory planning panel that includes participants assist in satisfying general requirements. Specific requirements are met by linking the instructional technology to inquiry science teaching.

The foundation of inquiry pedagogy is a teaching procedure called the learning cycle, which is derived from the intelligence model of Jean Piaget (Lawson, 1995; Renner & Marek, 1990). Research indicates that sound understanding of the learning cycle teaching procedure and meaningful integration of technology into lessons only occurs through continued practice (Marek, Eubanks, & Gallagher, 1990). The results of past learning cycle institutes incorporating such practice have documented long term changes in the teacher participants. The most significant finding is that 93% of the participants continue to use this inquiry teaching procedure and/or curricula nearly a decade later (Marek, Haack, & McWhirter, 1994).

Teacher professional development is an ongoing pursuit that must be supported by committed partners if it is to be sustained. School systems and universities involved in long-term partnerships can benefit and learn from one another if the partnerships involve sharing of culture, power, trust, commitment, cooperation, respect, and flexibility (Kersh & Masztal, 1998; Swanson, 1995). Partnerships can model collaboration needed to improve teaching and learning in diverse contexts.

Rural settings include white and ethnically diverse populations characterized by challenging factors that impact learning, such as poverty, isolation, and limited access to resources, leading to low achievement levels and high drop-out rates (Lynch, 2000; Rosigno & Crowley, 2001; Veal and Elliott, 1996). Rural secondary science teahers in Missouri indicated that their use of inquiry teaching was low, their laboratory facilities were inadequate, and their actual teaching materials were outdated (Barrow and Burchett, 2000). The Appalachian Rural Systemic Initiative (ARSI) successfully addressed unique characteristics of "ruralness" by connecting trusted teacher partners and district liaisons with university and state resources in 66 Appalachian counties (Henderson and Royster, 2000; Smith, 1999-2000). To address the lack of laboratory equipment and computer resources in Appalachian high schools and to increase student interst and enrollment in science courses, Marshall University, with state of West Virginia funding, developed interactive science simulations, with accompanying teacher training and support materials. Developers are expanding the model used and the number of schools involved (Al-Haddad & Little, 2000).

Inquiry and socially relevant aspects of science teaching were emphasized with teams of elementary, middle, and high school teachers from rural Minnesota schools. The teachers participated in a six week summer program led by science educators, scientists, and other professionals, with weekend follow-up during the school year, resulting in positve impact on teacher classroom behavior (Hurst, 1999). Teams of elementary teachers from rural Texas districts improved their attitudes toward inquiry-based competencies and technology use in a four month project coordinated with a university and including inservice workshops, on-site visits, and instructional materials development; student cognitve gains were recorded (Ostlund, 1986). Models that use partnership approaches to infuse inquiry and technology into sound science teacher professional development experiences in diverse, rural settings need to be devised, studied over time, and shared.

## LIST Program

The Learning through Inquiry Science and Technology (LIST) model was conceived in 1997 as a professional development program to familiarize science teachers with inquiry-based science instruction, instructional technology integration, and alternative assessment techniques in order to change their traditional teacher-centered instructional strategies to a more learner-centered approach. Consistent with National Science Education Standards, LIST's ultimate purpose is to improve student learning in science.

The LIST Program model concentrates on teachers and students as learners. The program assists teacher learning by creating a non-threatening learning environment, by modeling technology integration and inquiry pedagogy, and by providing yearlong support as teachers try out and refine new instructional strategies. The program impacts student learning by helping teachers to establish a more learner-centered environment in their classrooms, to facilitate/promote learning in more relevant and motivating ways, and to use new methods for measuring and monitoring student performance. Teachers are supported through concerns identified with each of the three distinctive stages of change implementation: preparation, acceptance, and commitment (Rogers, 1995; Salisbury, 1996), allowing considerable change in teacher and student performance.

## Program Design and Procedures

Key design elements of the LIST model are: administrative endorsement, discipline-wide adoption, on-site delivery, participant input, clear expectations, quality instruction, collaborative climate, continued support, and incentives. Initial funding was secured from an Eisenhower in Higher Education grant and implementation began in 1998 with one rural South Georgia school system. Since then, LIST has successfully delivered the program in other South Georgia counties and expanded into North Florida, achieving positive teacher and student outcomes.

The LIST program in Georgia (GA-LIST) targets low performing schools in rural South Georgia systems. Discipline-wide adoption by a system's science teachers is sought and, when approval is gained, each project is based on the specific inquiry pedagogy and technology skills needs of those teachers. Spanning an entire year and beyond, LIST projects are led by master teachers and university faculty who model desired skills in on-site workshops and coaching sessions and who assist teacher participants in forming local communities of practice. This collaborative environment decreases fear of trying new methods, promotes the assimilation of new knowledge and skills, and influences change in practice and sustainability of the initiative. Though teacher participants receive stipends, instructional materials, and staff development units as incentives, they state their primary benefit is improved student performance.

Beginning in 2001, the LIST program was introduced in Florida (FLA-LIST) through funding from the Florida Department of Education. FLA-LIST is based on a train-the-trainer model in which GA-LIST staff demonstrates the program in one North Florida school system and then mentors the Florida staff (a postsecondary institution and master teachers) as they implement the process in another North Florida school system. The model assumes that Florida faculty and master teachers then will provide the program in additional Florida locations.

## Selected Program Findings

Quantitative and qualitative measures - pre/post test scores, graduation test scores, teacher and student surveys, teacher and student reflections, lesson plans and observations - were used to determine the success of LIST projects. Evaluation results indicate positive teacher and student outcomes.

Teachers who participate in the LIST Program have shown positive changes in teaching behaviors. Prior to the LIST workshop, 9.5% of participants were aware of the

National Science Education Standards (NSES), 52.7% of participants named lecture as their primary teaching strategy, and 57.1% of participants named multiple choice as their primary evaluation format. At least one year after participating in the LIST project, teachers considered NSES when writing lesson plans (sig.=.023), incorporated inquiry strategies from the workshop in their teaching (sig.=.026), and indicated changes in evaluation format - using alternative assessment strategies (sig.=.027). Teachers report that they have a renewed interest in science, greater self-efficacy and motivation, and increased classroom technology use. Students report that their science teachers incorporate more science laboratories and use more classroom technology.

Student behaviors have also shown improvement. In School System A where the project was implemented in Summer, 1998, scores on the science portion of Georgia's High School Graduation Test (GGHST) increased from 40% pass rate in 98-99 to 60% pass rate in 99-00; and percentile scores on the science portion of Iowa Test of Basic Skills for 8th grade increased from 39 in 98-99 to 44 in 99-00. In School System B where the project was implemented in Summer, 2001, scores on the science portion of GGHST increased from 63% pass rate in 00-01 to 70% pass rate in 01-02. Average scores on GGHST Physical Science, which was taught solely by learning cycle/inquiry methods in 01-02, increased from 508 to 530. Students reported that they had about the same interest in science, but achieved better grades in science class. Their science teachers concur that students perform better on tests; however, teachers report that students have demonstrated greater interest in science, decreased off-task behavior, and more positive interactions with science teachers.

## Learnings and Challenges

Project LIST is a testimony to the power of partnerships for teachers and professional development partners. LIST partners have learned that the following considerations are crucial to a partnership professional development initiative:

O joint planning and consensual agreements by all stakeholders
O inclusion of teacher leaders as team members and as role models
O nurturing of new teacher leaders at the school level
O growth of partners through planning, doing, and evaluating
O intensive, sustained inquiry focus with immersion activities
O emphasis on teacher inquiry and reflection focused on their own behaviors
O follow-up in teachers' settings
O relevant technology infusion
O availability of and access to resources by teachers

Challenges in the process need to be acknowledged. They include the politics of work in two states, along with shifting funding issues, often mirroring changing state and national priorities. In addition, funding agencies demand evidence of impact on student behavior and achievement, outcomes that require time and appropriate assessments. Teacher and student mobility in rural settings affect data collection over time. Clearly, studies of professional development in rural settings need to be well-designed, analyzed, and shared across multiple contexts.

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