

# Action Research Supported by Technology: A Professional Development Program in K-12 Science and Mathematics

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**Abstract:** Embracing science and mathematics instruction initiatives, the project described in this paper was developed around the needs of existing and aspiring teacher leaders. The project studied the sustained effects of a group of these teacher leaders in K-12 mathematics and science classrooms, specifically the impacts on student achievement and teacher collaboration of teacher participation in action research. Teachers used technology at each stage of their action research plan, and analyzed the data resulting from their cycles of action research. The products of the project were a real and virtual network of teacher leaders implementing action research and a dedicated website sharing the project and teacher action plans and experiences.

The state-funded research project, *Teacher Leaders Engaging in Mathematics and Science Action Research (TLEMSAR)*, studied the sustained effects of action research by a group of teacher leaders in K-12 mathematics and science classrooms, specifically the impacts on student achievement and teacher collaboration. Action research is a platform which is proving successful in helping teachers identify and solve problems they encounter, promoting improved teaching strategies, support, and retention, and positively affecting school accountability.

Research supports the idea that teaching practitioners who engage in their own collective, self-reflective inquiry are likely to improve and understand their practice far more than those who do not (Boles & Troen, 1997; Goodlad, 1994; Holmes Group, 1986; Kemmis & McTaggart, 1988; National Council of Teachers of Mathematics, 1989). Action research is a form of reflective inquiry conducted by teacher researchers to gather information about how they teach and how well their students learn. "This information is gathered with the goals of gaining insights, developing reflective practice, effecting positive changes in the school environment, and improving student outcomes and the lives of those involved" (Mills 2003).

The goal of the project was to study a model of in-service professional development experiences that supports action research by teacher leaders to improve mathematics and science teaching in grades K-12. Results of prior projects have suggested that teacher growth occurs through reflective practice around action research. The context for this project was a large urban school district where inquiry-oriented, standards-based mathematics and science learning was a critical portion of the district Framework for Implementation of Standards-Based Instruction. Higher education faculty and community partners have been collaborators in a number of initiatives supporting these district plans.

The research sample emanated from the population of teachers who participated in action research programs, who taught K-12 mathematics and/or science, and who agreed to participate in this study. The sample was 19 teachers teaching grades K-11 in schools with a range of socioeconomic levels. The teachers were aided by three mentors from the master teachers group in the district. One mentor teacher was also a doctoral student doing her dissertation study on professional development; another mentor teacher was a district resource teacher in science and mathematics. All three had extensive experience with action research in science.

The participating teachers met monthly for five months at a central location in the district. At each meeting the school district's mathematics and science curriculum coordinators were invited to attend and to speak with the teachers. In addition, the three mathematics and science master teachers attended the meetings as advisors and supporters. Each meeting was attended and facilitated by four or five of the university faculty members and two or three of the university graduate students involved in the project. Between meetings, the project faculty members and mentor teachers were available to assist the teachers in their projects.

Action research is conceptualized in four stages: Preparation, Planning, Action, and Results. The teachers in the TLEMSAR program used technology in each stage of their projects. Each technology resource was demonstrated or taught in a hands-on session at one of the program meetings. Between meetings, teachers were able to receive assistance through:

- Communicating with another participant
- Accessing the program website
- Contacting a program facilitator for help via phone or email
- Contacting the program technology specialist for help via phone, email, or a home/school visit

## Preparation Stage

As a guide to the action research process, a decision tree was prepared for the teachers using concept mapping software. The decision tree diagram is located at [http://www.nefstem.org/teacher\\_guide/materials/decision\\_tree.gif](http://www.nefstem.org/teacher_guide/materials/decision_tree.gif). Teachers were encouraged to develop graphical flowcharts for their own project plans, and were provided with 30-day demonstration copies of *Inspiration* software, as well as access to the online concept mapping tools *cMap*, located at <http://cmap.ihmc.us/download/>. During one of the program's monthly meetings, teachers used laptop computers to learn to use concept mapping software.

Each teacher was given online access to the university's full-text journal and electronic book databases to use in the background reading stage of the action research project. Teachers were also introduced to web sites including *Google Scholar* and *Google Print* in order to help them in broadening their search for background information. *RefWorks* was used as a bibliographic organizer. Teachers shared websites and other resources that they found useful, and links to those resources are collected at [http://www.nefstem.org/teacher\\_guide/resources/index.htm](http://www.nefstem.org/teacher_guide/resources/index.htm).

## Planning Stage

A website was set up for the project at <http://www.nefstem.org> which included blog space for each teacher to use to post project proposals, reports, and data. Other teachers, school district mathematics and science curriculum coordinators, and university project team read proposals and offered feedback. One of the project graduate assistants was a technology specialist who worked with teachers on an individual basis if a teacher requested assistance getting started with blogging. Complete project reports were also uploaded to the blogs at the end of the program.

Blogging came naturally to some of the teachers, and took more effort for others, however the teachers were uniformly pleased that they succeeded in using a technology that they had previously just heard about. One teacher commented that she had finally gained a technology skill before her tech-savvy colleagues, and she enjoyed being in the role of technology mentor for them. Once teachers passed the stage of learning the blogging process, the technology began to become transparent. At that point the teachers focused on the content of their work and on the interactions enabled by the technology.

Below are sample comments from the teachers about the changes they experienced as a result of increased communication networking:

- Other teachers want to know what I'm doing – more shared teaching.
- Trying to offer any knowledge that I have acquired.
- Much more collaboration thru various grade levels, different schools, resource people.
- Many colleagues give input, ideas, advice.

- Network with a wide variety of teachers in many areas and from three other schools on a weekly basis.
- Networking all over Jacksonville, still very involved with math/science cohort.
- Network with teachers at the middle school and high school.

As an alternative to blogging, learning management systems (LMS) such as *Blackboard* have been used successfully by the authors in another action research program for sharing materials and enabling feedback among participating teachers. Table 1 compares the features of blogging and learning managements systems for supporting action research programs from the authors' perspectives.

Factor	Blogging	Learning Management System
Public communication	Materials can be accessed by anyone, comments can be added.	Materials are only accessible to registered users and guests, limited commenting is supported.
Group communication	Group members must know the blog addresses of other members or use a directory created for the group, group email and discussion are limited.	All group materials are easily located within the space, group email and discussions are straightforward.
Personal communication	Individual email is possible	Individual email is included
Notification of changes in materials	RSS feeds can be used to receive notification of changes to any blogs.	Automated notification of changes is not supported.
Ease of use for participants	Participants must learn to administer their blog and to use the blog to view and comment on the work of others. Moderate technical skill is required.	Participants must learn to log in and navigate the system, and to use the communication tools. Little technical skill is required.
Transferability of skills	Successful users acquire the skills to independently create their own blogs	Successful users need additional skills to set up their own learning management space.
Ease of set up	Some knowledge of servers and html is needed to set up blogs.	Little knowledge is needed if an organization has an existing LMS. Setting up a new LMS requires knowledge of servers and html.
Licensing requirements	Fees and licensing varies. Some blog applications are free.	Fees and licensing varies. Some LMS applications are free.

**Table 1.** Comparison of blogging and learning management systems for supporting action research programs

Templates for Planning stage timelines are located at [http://www.nefstem.org/teacher\\_guide/plan/timeline.htm](http://www.nefstem.org/teacher_guide/plan/timeline.htm). The templates assist teachers in using *Excel*, *PowerPoint*, or *Word* for project planning.

## Action Stage

In Action stage, teachers collected preliminary data about the focus of their projects to use as a baseline for later comparison. In some cases, the baseline data was collected in the form of student surveys. A sample student survey form is located at [http://www.nefstem.org/teacher\\_guide/action/preassess.htm](http://www.nefstem.org/teacher_guide/action/preassess.htm). In other cases, the baseline data took the form of a student pretest of knowledge or skill. In keeping with the teacher-centered nature of action research, each teacher developed his or her own pre- and post-tests, with the guidance of school district staff and university faculty. The action research projects undertaken by the teachers were as unique as the teachers and their teaching contexts. Each teacher selected one or more methods of evaluation to use in judging the effectiveness of the teaching approach being studied

One of the action research projects focused on the effects of using classroom technology on student learning. In this project, the teacher compared the performance of students who used the technology with the performance of student who did not. The topic of project using classroom technology was “The Effect of Computer-based Mathematics on Problem Solving in Third Grade.”

## Results Stage

During the Results stage of action research, teachers analyze and interpret their data, plan changes to their teaching, and share their results with others. The TLEMSAR teachers learned to use the statistical tools in the *Excel* spreadsheet program to analyze data that was appropriate for statistical analysis. The program website provided a document summarizing the use of the statistical tools at [http://www.nefstem.org/teacher\\_guide/materials/using\\_excel\\_for\\_stats.pdf](http://www.nefstem.org/teacher_guide/materials/using_excel_for_stats.pdf). The teachers also used tables and charts in their word processing program and charts in their spreadsheet program to communicate their results. In addition to sharing their results in their blogs, teachers were encouraged to develop an article or conference presentation.

At two of the program's monthly meetings, a graduate student from a university multimedia course attended to videotape the teachers discussing their action research projects. The graduate student also visited teacher classrooms to record teachers in lessons related to their projects. The film and photographs were used to create a web-based guide to action research under the guidance of the course instructor. That website is located at [http://www.nefstem.org/teacher\\_guide/intro/index.htm](http://www.nefstem.org/teacher_guide/intro/index.htm).

## Program Findings and Recommendations

Several important outcomes have resulted from this project. Participating teachers have grown in their ability to collaborate as they used inquiry-oriented action research methodology to improve science and mathematics education in their classrooms and schools. Performance of K-12 students has improved in grades, classroom assessments, and other measures of success. An increased pool of highly qualified science and mathematics teacher leaders is now active in the schools.

In the teachers' words, the benefits they have received from the technology aspects of the action research program include:

- One thing I have learned a lot about is whether or not differences in data are statistically significant. Although I perceived patterns in my data by looking at my graphs, I soon discovered that many of the variance could be explained by chance.
- The results I have collected so far regarding computer-based math leads me to believe that computer-based remediation is a positive way to reteach students in areas they are weak. Students have benefited greatly from computer-based mathematics. Computer time has to be meaningful and focused and the computer curriculum should be aligned with the district's standards.
- Students that are working on technology projects seem to understand and grasp concept quicker than those who are reading and writing the information.
- I have learned how much clearer the picture becomes by displaying what I do day to day with my students using action research methods of analyzing data.
- I learned how to set up Excel sheets for data collection and how to set up charts in a word document.
- I enjoyed the benefit of the blog forum online. It was helpful to be able to review my colleagues' work at any time and get ideas for format and design
- I underutilized the electronic tools of the project because the idea of blogging out in public is very new to me.
- More time would have been desirable to learn how to better use and present information on the blog as well as gain more familiarity with Excel and how to present data in different ways.

Educator action research programs will higher levels of effectiveness if they reach larger numbers of teachers, provide stronger supports throughout the process, and understand the reasons that teachers have for participating in action research as professional development.

Specifically, we recommend that future action research programs seek ways to:

1. Provide participants with an introduction to quantitative and qualitative data collection and analysis methods early in their proposal development.

2. Provide participants with an introduction to examples of statistical software that can be used to help them obtain and support their conclusions.
3. Limit the size of the participant groups during meetings to at most three participants in each group in order to increase individual participation in the discussions, achieve effective and substantial contribution from the teachers, and to accelerate the development of their proposals.
4. Expand the target group of teacher leaders by including an action research workshop component.
5. Increase the facilitators' influence on the teacher leaders to help them address and select targeted and essential problems in their proposals.

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