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Abstract

The NSF funded Arkansas Statewide Systemic Initiative (1992), developed with the intent to restructure mathematics and science education in Arkansas, is a recent reform in the Arkansas educational system. The project aimed at changing Arkansas students' attitudes toward science and mathematics, improving student learning and performance, introducing appropriate technology into the classrooms, and allowing for a lasting community involvement in the Arkansas educational system. To implement change through Arkansas Science and Math Crusades, the project has provided large scale teacher training and professional development opportunities to Arkansas school teachers. This reform effort in education started in 1992.

A search of the ERIC Database back to 1992 produces no relevant records relating to Crusades in general nor the Science Crusade in particular. This article presents the results of a study of the effects of the Science Crusade as viewed by Arkansas River Valley science teachers who have participated in the Science Crusade training.

Introduction and Background

During the past few decades, to attract high-tech industries and investment capitol, the Arkansas economical and political leadership has come to the realization that the most crucial factor in such an effort is to prepare an educated and skilled workforce. Comparison of Arkansas public schools students' performance in standardized tests with those of other states had created an unkind national perception. To alter that perception, major improvements in the students' performance had to be made. To achieve better performance results, a fundamental reform in teaching methods and strategies had to be employed to maximize student learning. Major attempts in reforming the Arkansas educational system, particularly during the last fifteen years, have been made. President Clinton, former Governor of Arkansas, has been a leading figure in such reforms.

This article will address one component of the most recent reform in Arkansas education. The Arkansas Statewide Systemic Initiative (1992) made the implementation of the reform possible. Its components, Arkansas Mathematics and Science Crusades, sought improvements in Math and Science. In an effort to achieve the best results, the Crusades were formulated to utilize the most advanced teaching methodologies and the most efficient approaches to students' learning. The Science Crusade is the subject of this study, and the Revised Edition of the Arkansas Science Crusade Trainer's Manual (Arkansas Statewide Systemic Initiative Program, 1996) describes it as follows.

1. A series of modules designed around hands-on science experiences intended to encourage teachers to use hands-on, inquiry-based science; increase their range of assessment alternatives; broaden their teaching strategies; deepen their understanding of important scientific concepts and content; and assess in all informed manner the quality of their schools existing curriculum in the light of the National Science Education Standards and Arkansas Science Frameworks.

2. An opportunity to experience sample activities from existing instructional resources. The resources are intended to reflect a philosophy of teaching that incorporates higher order thinking skills and reflects the intent of the National Science Education Standards. Activities range from a very open-ended constructivist style to the more traditional guided format. The activities are designed to reinforce basic science concepts and skills; encourage the application of concepts in problem solving and decision-making; and stimulate class discussions on curriculum, reform and equity. Teachers are encouraged to compare the different resources with regard to effectiveness and student engagement.

3. A catalyst for reform in science education (curriculum, teaching strategies, etc.) and a motivation for further professional development.

4. An opportunity to investigate a broad range of assessment strategies (including but not limited to performance based assessment and portfolios) to better determine their students' progress and understanding.

5. An opportunity to look at strategies to engage all students (traditionally served and underserved) in a meaningful science curriculum.

6. An opportunity for teachers and administrators from the 5-12 science community (public and private) to net-

work/interact with each other as well as faculty members from our colleges and universities.

The reforms were initiated to address identified shortcomings and; therefore, were expected to achieve certain goals. This article intends to measure the degree of success of the Science Crusade as viewed by instructors who have been involved in the reform.

To fund the Arkansas Statewide Systemic Initiative of which the Science Crusade was a part, in October of 1992, the Arkansas Department of Higher Education submitted a grant proposal to the National Science Foundation for the amount of $10,000,000.00. The following is an excerpt from President Clinton's (former Governor of Arkansas) letter of support included in the proposal (Arkansas Department of Higher Education, 1992):

"Arkansas has a vision of economic growth and human progress which depends on the ability of every child to reach his or her full potential. Systemic change at every level of our education system is the means by which we intend to realize this vision. The proposed Arkansas Systemic Initiative Project makes substantial commitments of time, energy and resources from key state agencies and other important participants in this effort.

Systemic educational change in Arkansas has been under way for most of the past decade and will extend beyond the life of the NSF support we hope to receive. Our vision means that we fully expect to see the day when it is a routine outcome of the education system for all children to achieve at their full potential as human beings. I hope you will join us in this endeavor."

The proposal described the MISSION of the project as follows: "The mission of the Arkansas Science Crusade is to help teachers of science create successful learning environments for every student, and to promote professional growth for teachers involving science content, and instructional strategies, and to provide access to adequate instructional materials including science equipment and technology in all Arkansas science classrooms", and intended to create a vision of:

1. Science literacy for all in an evolving technological society
2. Science as an active, constructive, cooperative process
3. Science involving experimentation, investigation of scientific phenomena, analysis, inquiry and problem solving
4. A science curriculum that includes interdisciplinary content connections and real-world applications.

The goals of the Arkansas Science Crusade, reflecting it's mission and vision, are listed in the proposal (Arkansas Department of Higher Education, 1992).

Method of Study

During the summer of 1994, to be certified as trainers, the author and another faculty member from Arkansas Tech University took part in the initial training of the Science Crusade. The training included over 100 hours of science content, and methodology and lasted until the end of the fall 1994 semester. After receiving the required grant, funds to conduct Science Crusade classes, we were able to offer three Science Crusade classes during the following two years. The science teachers participating in the classes completed seventeen three-hour training sessions followed by three follow-up sessions. A total of 54 science teachers from grades 4 through 12 representing school districts in the Arkansas River Valley area participated in the three Science Crusade classes.

To meet the goals as specified in the introduction, the seventeen Science Crusade training modules followed procedures envisioned by the Arkansas Statewide Systemic Initiative leadership. Prior to conducting training sessions, services of many science faculty from around the State were utilized to prepare a Trainer's Manual. The manual included seventeen modules which covered most areas of the physical and life sciences. The module's material was prepared with an interdisciplinary approach, and the subject delivery was intended to utilize progressive national trends in teaching methodologies and the most up-to-date teaching technology tools available. In three years following the start of the Science Crusade, the training modules evolved substantially and the training sessions and the number of modules were cut to fifteen.

During the spring of 1997 in an attempt to measure the effects of the Science Crusade on participating science teachers' approach to teaching science, a survey was drafted. The survey included fifteen questions tailored to parallel the goals of the Science Crusade. The survey was mailed to fifty-four science teachers who had participated in the three Science Crusade classes offered through the University. The science teachers had three weeks to return the survey. By the deadline indicated in the attached letter, we received 30 of the fifty-four surveys that had been mailed to the science teachers. This represented a 56% survey response. The method of response and the fifteen survey questions are as follows.

Strongly Disagree				Strongly Agree
①	②	③	④	⑤

1. The Science Crusade has effected my approach to the teaching of science as inquiry.
2. The Science Crusade directly effected the frequency I employ experimentation in my classes.
3. The Science Crusade has effected the implementation of a more standards based curriculum in my classroom

/ science department, (National Science Education Science Literacy).

4. The Science Crusade has effected the implementation of an integrated curriculum in my classroom / science department.

5. The Science Crusade introduced me to new science content and/or effective teaching strategies.

6. The Science Crusade has enabled me to more effectively incorporate critical thinking activities into my daily routine.

7. The Science Crusade introduced me to new technologies, manipulative.

8. The Science Crusade introduced me to investigative and instructional materials such as FOSS, GEMS, etc.

9. My school districts participation in the Arkansas Math and Science Crusade School/College Collaboration (50/50) matching grant has enabled me to better equip my classroom with the appropriate equipment and manipulative needed to develop scientific literacy.

10. The Science Crusade has effected my teaching strategies in such a way that student interest in science has increased.

11. The Science Crusade has increased interest in students who in the past tried to avoid science, particularly females and minorities.

12. The Science Crusade experience has enabled me to employ strategies that engage traditionally under-represented groups (females and minorities).

13. The Science Crusade experience influenced my decision to continue my education toward a Master Degree or additional certification areas.

14. The Science Crusade increased the partnerships between our local school district and our local businesses.

15. I have experienced an increase in support from the administration since the Science Crusade, for example asked for supplies and equipment and received funding.

Table 1. Summary of the data analysis

Sample Size	Question Number	X (Mean Value)	σ (Standard Deviation)
30	1	3.83	0.64
30	2	3.67	1.06
30	3	3.10	0.96
30	4	3.43	0.86
30	5	4.03	0.93
30	6	3.66	0.71
30	7	4.37	0.81
30	8	3.50	1.04
29	10	4.00	0.60
29	11	3.34	1.04
28	12	2.82	0.98
28	13	2.61	1.34
28	14	2.53	1.23
28	15	3.21	1.17

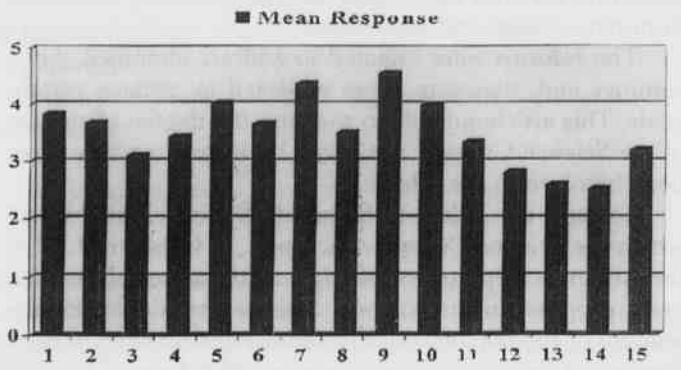

Fig. 1. Plot of the mean responses to the survey questions.

Table 2. Comparison of the means at $\alpha < 0.05$

AT $\alpha < 0.05$
$\bar{X}_1$ is greater than $\bar{X}_{12}$, $\bar{X}_{13}$, $\bar{X}_{14}$
$\bar{X}_2$ is lower than $\bar{X}_9$, and greater than $\bar{X}_{13}$ and $\bar{X}_{14}$
$\bar{X}_3$ is less than $\bar{X}_5$, $\bar{X}_7$, $\bar{X}_9$, and $\bar{X}_{10}$
$\bar{X}_4$ is less than $\bar{X}_7$, $\bar{X}_9$ and greater than $\bar{X}_{14}$
$\bar{X}_5$ is greater than $\bar{X}_3$, $\bar{X}_{12}$, $\bar{X}_{13}$, and $\bar{X}_{14}$
$\bar{X}_6$ is less than $\bar{X}_9$, and greater than $\bar{X}_{13}$ and $\bar{X}_{14}$
$\bar{X}_7$ is greater than $\bar{X}_3$, $\bar{X}_4$, $\bar{X}_8$, $\bar{X}_{11}$, $\bar{X}_{12}$, $\bar{X}_{13}$, $\bar{X}_{14}$, and $\bar{X}_{15}$
$\bar{X}_8$ is less than $\bar{X}_7$, $\bar{X}_9$ and greater than $\bar{X}_{13}$, and $\bar{X}_{14}$
$\bar{X}_9$ is greater than $\bar{X}_2$, $\bar{X}_3$, $\bar{X}_4$, $\bar{X}_6$, $\bar{X}_8$, $\bar{X}_{11}$, $\bar{X}_{12}$, $\bar{X}_{13}$, $\bar{X}_{14}$ and $\bar{X}_{15}$
$\bar{X}_{10}$ is greater than $\bar{X}_3$, $\bar{X}_{12}$, $\bar{X}_{13}$ and $\bar{X}_{14}$
$\bar{X}_{11}$ is less than $\bar{X}_7$, and $\bar{X}_9$
$\bar{X}_{12}$ is less than $\bar{X}_1$, $\bar{X}_5$, $\bar{X}_7$, $\bar{X}_9$, and $\bar{X}_{10}$
$\bar{X}_{13}$ is less than $\bar{X}_1$, $\bar{X}_2$, $\bar{X}_5$, $\bar{X}_6$, $\bar{X}_7$, $\bar{X}_8$, $\bar{X}_9$, and $\bar{X}_{10}$
$\bar{X}_{14}$ is less than $\bar{X}_1$, $\bar{X}_2$, $\bar{X}_4$, $\bar{X}_5$, $\bar{X}_6$, $\bar{X}_7$, $\bar{X}_8$, $\bar{X}_9$, and $\bar{X}_{10}$
$\bar{X}_{15}$ is less than $\bar{X}_7$, and $\bar{X}_9$

Data Analysis and Results

An IBM Model 9221 using SAS (1989) system was utilized for analysis of variance. Also, a Tukey multiple comparison was utilized to find differences among means ($\alpha \leq 0.05$). Table 1 represents the summary of the data analysis, Figure 1 is a plot of the mean responses to the survey questions, and Table 2 shows a comparison of the means at $\alpha <$

0.05.

A review of the Tables 1 and 2 indicates that five questions had five or more significant differences. Questions number seven (X = 4.37) and nine (X = 4.55) had high responses, indicating that the Science Crusade goals that science teachers become literate with the appropriate technology and their students have access to relevant science equipment have been met. The mean responses to question numbers 12, 13, and 14 indicate that the goals connected with science teachers use of strategies that engage traditionally under-represented groups; influence on science teachers' decision to continue their education toward a Master Degree or additional certification area; and increase the partnership between the science teachers' school district and their local businesses have not been achieved.

Conclusions

The analysis of survey responses indicates that, as viewed by the participants in the Science Crusade in the Arkansas River Valley area, a good number of the goals of the Science Crusade have been met. The Crusades have had precise planning and sought very progressive goals; therefore we believe that positive results indicate improvement in Arkansas science education.

In addition to the results of the collected data, there are other positive aspects of this reform. Some of the most energetic, optimistic, and reform minded science teachers and college science faculty from across Arkansas were recruited to implement the Crusade's vision. Those who were initially trained have been very active in training hundreds of Arkansas science teachers and numerous college faculty to implement this reform. The training processes and other organized activities after that training connected with the Arkansas Systemic Initiative Project have organized hundreds of concerned science teachers in professional meetings. These organizations have become the driving force which will sustain the continuation of reform and make it a lasting process.

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