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ABSTRACT

An enhancement program was implemented whose overall goal was to improve the teaching of life science and biology as an inquiry-oriented and socially relevant discipline in rural Minnesota schools. Teams of elementary, middle, and high school teachers from selected districts spent 6 weeks in a residential workshop program during the summer, followed by weekend sessions during the academic year. Science educators, college biology instructors, and other biology professionals employed an activities-based approach to learning science, teaching methodology, and science processes with the goal of improving science instruction at participating schools. A study examined the impact of the enhancement program in terms of its effect on teachers' instruction and classroom environment, as well as assessed the program's impact beyond the participants' own classrooms. (CCM)

# Assessing the Impact of a Teacher Enhancement Program on Classroom Environment

by

Roy W. Hurst

# ASSESSING THE IMPACT OF A TEACHER ENHANCEMENT PROGRAM ON CLASSROOM ENVIRONMENT

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Systemic reform is a key component of the science education agenda and is central to the *National Science Education Standards* (National Research Council, 1996). Ongoing professional development for classroom teachers is an area of emphasis in these standards, which define a new direction for effective science instruction. Incorporating a constructivist approach to teaching and learning, the focus is on more student-centered and active learning environments. To effectively use these techniques, teachers must think in ways substantially different from the manner in which most of them were taught (Borko & Putnam, 1995). Just as students learn in an active environment, so too must teachers develop their conceptual base in an active environment if they are to promote such environments for their students. They must experience the learning they want their students to have (Loucks-Horsley & Stiegelbauer, 1991).

Experiencing science learning as an active, collaborative process is documented as an effective way for teachers to develop an understanding of why it is important for their students to learn this way if every learner is to have maximum opportunity. It also helps them understand which concepts are most likely to cause difficulty for their students or are most fundamental, and which ones are most effectively taught by various means (Loucks-Horsley, 1995). The most effective science education institutes combine development of conceptual and content knowledge with small group activities, use of manipulatives, and immersion in doing science (Ruskas & Luczak, 1995). Teachers expand their conceptual knowledge as they concurrently become acquainted with materials and activities that provide students with concrete and representational experiences of fundamental concepts. Professional literature supports this as one strategy for improving the classroom environment for under-represented groups in science (Harris, 1995).

The overall goal of the enhancement program was to improve the teaching of life science and biology as an inquiry-oriented and socially relevant discipline in rural Minnesota schools. Teams of elementary, middle, and high school teachers from selected districts spent six weeks in a residential workshop program during the summer, followed by weekend sessions during the academic year. Workshop participants then served as a cadre of in-service instructors for their own and nearby districts.

Science educators, college biology instructors, and other biology professionals employed an activities-based approach to learning science, teaching methodology, and science processes, with the goal of improving science instruction at participants' schools and, via the ripple effect, at surrounding schools. The primary anticipated outcome would be to provide participants with the concepts and content, skills, and hands-on teaching strategies necessary to teach science as an integration of science, technology, and social issues. As the result of a survey of local teachers, the enhancement workshops focused on the areas of freshwater wetland ecology, genetics, and microbiology.

Inservice workshop evaluation typically focuses on gains in content knowledge or cognitive development of teachers and/or their students. While this was important, we were also interested in examining the impact of the enhancement program in terms of its effect on teachers' instruction and classroom environment, as well as to assess the program's impact beyond the participants' own classrooms.

## Methods

At the beginning of each summer workshop, participants were administered the short form of the Individualized Classroom Environment Questionnaire (ICEQ) (Fraser & Fisher, 1986; Rentoul & Fisher, 1979). The ICEQ assesses a variety of items which distinguish "traditional" teacher-centered classrooms from those evidencing a preponderance of individualized, student-centered instruction. Responses are on a 5-point Likert scale and are distributed equally across five categories: Personalization (PE), Participation (PA), Independence (IND), Investigation (INV), and Differentiation (DF). Category descriptions are provided in Table 1.

Participants were initially asked to focus specifically on their classroom of the previous year and to report their perceptions of the environment as it actually existed. At the conclusion of the workshop, participants were again administered the ICEQ and asked to report what they would prefer the environment to be like in their ideal classroom. At the conclusion of each workshop, participants were also surveyed as to the activities which they intended to implement during the school year, ways in which they planned to impact other teachers within and outside their district, and any challenges they perceived to implementing the curriculum ideas in their classrooms.

Table 1
Category Descriptors
Individualized Classroom Environment Questionnaire

| | |
|---|---|
| Personalization (PE) | Emphasis on opportunities for individual students to interact with the teacher and on concern for the personal welfare and social growth of the individual. |
| Participation (PA) | Extent to which students are encouraged to participate, rather than be passive learners. |
| Independence (IND) | Extent to which students are allowed to make decisions and have control over their own learning and behavior. |
| Investigation (INV) | Emphasis on the skills and processes of inquiry and their use in problem solving and investigation. |
| Differentiation (DF) | Emphasis on the selective treatment of students based upon ability, learning style, work rate, and personal interests. |

At the conclusion of the school year, the ICEQ was again administered to the participants, who were asked to report their perceptions of the actual classroom environment during the previous academic year. Teachers were also surveyed and interviewed to assess the manner in which the program had impacted their teaching. Responses on the ICEQ and the survey were compared to those obtained on the instruments administered during the summer workshops.

## Results

There were significant changes ($p < 0.05$) in participants' perceptions of the actual classroom environment between the beginning of the workshop and the end of the following school year, and these changes more closely resembled their preferred classroom environment as reported on the end-of-workshop ICEQ (Table 2). In addition to significant changes in overall classroom environment, changes in the specific categories of Independence, Investigation, and Differentiation were significant in their own right ($p < 0.05$).

Table 2
Mean scores on ICEQ
Pre vs. Post and Pre vs. Delayed Post significant at $p < 0.05$

| | PE | PA | IND | INV | DF |
|---|---|---|---|---|---|
| Pre-Workshop | 4.25 | 4.24 | 2.13 | 3.13 | 2.94 |
| Post-Workshop | 4.71 | 4.85 | 3.12 | 4.52 | 3.92 |
| Delayed Post-Workshop | 4.68 | 4.74 | 2.98 | 4.33 | 3.72 |

During interviews a number of teachers indicated that they had made a conscious effort to bring about a change in their classroom environment as a result of participation in the workshops and follow-up activities. In particular, there was an increased emphasis on opportunities for individual students to interact with the teacher, an increase in the extent to which students were allowed to make decisions regarding their learning, and an increased emphasis on the skills and processes of inquiry and their use in problem solving and investigation. These were all important objectives of the enhancement program. Observations of the classrooms by workshop faculty members during the follow-up sessions supported the changes indicated by the ICEQ results.

Both in interviews and on the surveys, participants noted a renewed enthusiasm for teaching activity-based science and increased confidence in stepping outside the bounds of a textbook. Eighty-three percent (83%) of the teachers reported "great" or "considerable" change in their teaching methods and course content as a result of participation in the enhancement program. Areas in which at least 65% of the participants reported significant changes included use of more "real world" problems and collaborative activities, greater student involvement in discussion, more use of local environmental problems and resources as a class focal point, and greater use of available technology in the classroom.

All the teachers (100%) reported using a minimum of 10 activities developed during the summer workshops, and 75% reported using 20 or more of these teaching ideas in their classes. All but one workshop participant had presented in-service programs for other teachers in their building, district, and/or neighboring districts. These programs averaged 18 contact hours, with each participant reaching an average of 14 other teachers. Follow-up surveys with a random sample of in-service participants indicated 54% had implemented at least five of these activities.

## Conclusion

The workshops were intended to improve biology education in isolated rural schools by (a) increasing the use of hands-on, process-oriented activities in science classes, (b) raising the confidence level of science teachers, and (c) impacting other teachers and districts through a cadre of teachers providing in-service programs. These results indicate that the enhancement program substantially met its objectives.

Teachers were more confident and better prepared to move beyond the restrictions of a textbook-centered mode of instruction. Teachers are building connections to other schools and to other grades within their own district. The desired ripple effect is occurring as program teachers reach out and educate other teachers. Teachers are engaging their students in real-world investigations suited to the local resources. And teachers are changing their classroom learning environment, due in part to their participation in the program.

The most encouraging aspect of these results is that changes occurred in the actual environment within the teachers' classrooms, particularly in the categories of Independence and Investigation. These were areas of emphasis for the enhancement workshops which related directly to the implementation of a more inquiry-oriented, process-based approach to science teaching and learning. Teachers consistently indicated in the interviews that they felt more confident in their ability to use the "hands-on, minds-on" approach after the summer workshops, and this was reflected in their increased use of such an approach in their classroom.

Teachers involved in the program are engaging their students in real-world investigations and interpretation of data. They exhibit increased enthusiasm for teaching and increased confidence in their ability to step outside the bounds of the textbook or laboratory manual to implement more process-oriented activities. The success of the program is indicated by teachers changing their classroom instruction to more closely align with current ideas of how students learn, as well as reaching out to other teachers during formal and informal in-service activities. Students in at least two schools even successfully influenced local environmental review processes, collecting data and presenting their results to the county commissioners. In at least this instance—and we believe in most instances—teacher enhancement workshops can have a positive impact on the education of our youth.

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It is not very often we find some old technique that saves us time in calculation. Anything used to cut down on errors also is extremely useful. The Maths C students should find this technique of great use.

Integrals of the form l f($x$) g($x$) $dx$
in which f($x$) can be differentiated repeatedly to finally become zero and g($x$) can be integrated repeatedly without difficulty are natural candidates for integration by parts. If many repetitions are required, the calculations can be cumbersome.

There is, however, a way to organise calculations in such situations, called "tabular integration", that saves a great deal of work.

**Example 1**. Evaluate 2x_$e^x$ $dx$.
With f($x$) = $x$_ and g($x$) = $e^x$ we have:

| f($x$) derivatives | | g($x$) and integrals |
|---|---|---|
| - | | $e^x$ (function) |
| $x$_ (function) | + | $e^x$ |
| $2x$ | - | $e^x$ |
| 2 | + | $e^x$ |
| 0 | - | $e^x$ |

**NOTE** that there is one blank space under f($x$). The result is the sum of all products horizontally with alternating signs, always placed with "positive" first, as shown.

3$x$_$e^x$ $dx$ = $x$_$e^x$ -2x$e^x$ + 2$e^x$ + C.

**Example 2**. Evaluate 4$x$_ Sin $x$ $dx$.

| f($x$) and derivatives | | g($x$) and integrals |
|---|---|---|
| - | | Sin $x$ (function) |
| $x$_ (function) | + | - Cos $x$ |
| 3$x$_ | - | - Sin $x$ |
| $6x$ | + | Cos $x$ |
| 6 | - | Sin $x$ |
| 0 | + | - Cos $x$ |

The required result is the sum of all the "horizontal" products!

5 $x$_ Sin $x$ $dx$ = -$x$_ Cos $x$ + 3$x$_Sin $x$ + 6$x$ *Cos* x - 6 Sin $x$ + C.

1.2

Exercise. Use tabular integration to integrate each of the following:

1. $x\_ \operatorname{Sin} x$
2. $x\_ \operatorname{Cos} x$
3. $x\_ e^{x}$
4. $x\_ e^{-x}$
5. $x^4 e^{-x}$
6. $x^2 2^x$
7. $x\_ \operatorname{Cos} 2x$
8. $x^4 e^{2x}$
9. $x\_e^{-2x}$
10. $(2x + 1)\_a^x$

I have not included answers but these will be easily obtained no doubt.

Go in peace and may your coffee cup always be full.

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