ED 429 828   SE 062 391

AUTHOR   Saurino, Dan R.; Bouma, Amy; Gunnoe, Brenda
TITLE   Science Classroom Management Techniques Using Graphing
                Calculator Technology: A Collaborative Team Action Research
                Approach.
PUB DATE   1999-03-00
NOTE   22p.; Paper presented at the Annual Meeting of the National
                Association of Research in Science Teaching (Boston, MA,
                March 28-31, 1999).
PUB TYPE   Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE   MF01/PC01 Plus Postage.
DESCRIPTORS   *Classroom Techniques; Computer Assisted Instruction;
                *Computer Interfaces; Computer Uses in Education; *Graphing
                Calculators; Laboratories; Middle Schools; *Science
                Education; Teacher Attitudes; Teaching Methods; *Technology

ABSTRACT
                This study evaluates the use of graphing calculators in the
science classroom within the context of a collaborative action research
approach. A class of diversified middle-class students (n=650) defined by
teachers and administrators as "above average" were studied. Initially,
information was gathered on current classroom management techniques as well
as feelings regarding graphing calculators and classroom management. The
equipment used included Texas Instruments TI-83 graphing calculators with
hand-held computer-based laboratory interfaces (CBL), a computer lab with 15
Macintosh Power PCs, and the teacher's own computer. Results indicate that
effective classroom management depends on early planning, revision, and final
implementation of the course for action with considerable thought given to
possible contingencies and their resolutions when using graphing calculators
and computer based-labs in the science classroom. Graphing calculators also
enabled students to complete higher level work with understanding, enjoy the
use of technology in the science classroom, and increased students'
independence and self-confidence in completing the lab. (Contains 15
references.) (CCM)

Science Classroom Management Techniques Using Graphing Calculator Technology:

A Collaborative Team Action Research Approach

Dan R. Saurino

Amy Bouma

Virginia Polytechnic Institute and State University

Brenda Gunnoe

Fairfax County Public Schools

Running Head: CLASSROOM MANAGEMENT TECHNIQUES

Classroom management has long been at the forefront of new teacher's thinking. One attempt to better understand and improve teacher thinking in recent years has been the use of collaboration and collaborative action research (Saurino, 1998; Pate, 1997; Elliott, 1990; Noffke & Zeichner, 1987; Carr & Kemmis, 1983), and we were interested in how its use by educational groups might help middle grades teachers answer questions related to their practice. It is important to note that when we refer to collaborative action research, we most often refer to a subset defined as collaborative team action research. In this study, we made use of collaborative team action research to answer our research question concerning classroom management techniques that utilize graphing calculators in the science classroom.

<u>Defining Collaborative Team Action Research</u>

The research process used in our study is described as cyclical, involving a recursive, nonlinear pattern of planning, acting, observing, and reflecting on changes in educational situations observed by the researchers. For the purposes of our study, we are using Lewin's (1947) definition of "action research" as the basis of our definition for collaborative team action research from his study of group dynamics. In Lewin's work, an attempt to solve a problem existing in the group was introduced by the group facilitator and the impact of the change was noted. Lewin's work began a trend influencing others over the next 50 years who emphasized issues of greater productivity and efficiency in many areas including education.

The addition of the word "collaborative" to action research implies that two or more researchers are working together, exchanging ideas and expertise, interacting as they conduct action research in an effort to be more productive than if they worked alone. The collaborators

met together regularly to plan, conduct, reflect, and write about the research they are

conducting. The collaborative team action research in our study involved a team of educators

and researchers conducting classroom-based inquiries to answer a question of interest to the

team.

The word "team" emphasizes an important area of development in middle schools.

"Interdisciplinary teaming" (Gallagher-Polite, 1997; McEwin, 1997; Wraga, 1997) combines

the concept of teaching in teams of content-area teachers with the concept of teaching an

integrated curriculum (Beane, 1993; Gatewood, 1998). The team concept has been one of

several attempts to meet the needs of students in transition between the self-contained

classroom atmosphere of the elementary grades and the departmentalized classroom structure

of high schools. In our study, we expanded the concept of teaming to include the benefits of

working in a group, especially the interactions of the group to brainstorm new ideas and reflect

on actions taken, to answer questions and solve problems.

Finally, the ultimate beneficiaries of the research process are the students, yet the

teachers and university researchers benefit from new knowledge gained through the

collaborative process. In addition, we see collaborative team action research as a

methodology, a process of conducting research using a particular sequence of research

strategies and theoretical perspectives (Saurino & Saurino, 1996). Collaborative action

research is a recursive sequence, each completed series of research steps often referred to as a

"cycle" of research. The term cycle is misleading, however, since the researcher never begins

again at the same starting point (Saurino, 1998).

Our Study

Our expansion of collaborative action research was to utilize a group, or teacher team setting, and to adapt the research process accordingly. The research question did not involve the topic of teams or teaming in the middle grades, yet the research was conducted with middle school team teachers, and was found to be an appropriate tool to help answer questions relative to middle grades teaching team school structures. An interesting byproduct of the study was to discover that the research process did have beneficial effects on the teaming process and the working relationships among the team teachers, and we recommend more research on the benefits of conducting collaborative research as a teaching team.

All the steps we took in the process can be considered the actions of collaborative team action research; they were the ongoing practice of the teachers, the actions we took to answer the research question, and include changes in practice, or new actions resulting from participation in the collaborative group. There has been very little research published about the use of collaborative action research in a middle grades (grades 6-8 in this case) setting, and even less about the process of conducting collaborative action research in a group or team of more than two researchers. With the increase in the use of teaching teams in middle schools, we were interested in how collaborative action research might be utilized with educational teams.

We believe the documentation of the process of adapting collaborative action research to teaching teams is an important first step in the use of the research process in other areas of education. The unique fit of collaborative team action research to the teaming process found in

many of today's middle schools could allow the process to become an important teaming tool,

allowing teachers to learn more about their practice and providing a forum in which to try new

strategies, receive feedback, and reflect on what is learned in the process. In addition, the

process allows university researchers to conduct meaningful research in the classroom

environment and learn more about what theoretical strategies have practical application in

practice.

Our Cycle of Collaborative Team Action Research

The research team in our study consisted of a science content area pre-service graduate

student teacher, two cooperating in-service science teachers, and a university researcher.

Meetings for the team were scheduled regularly throughout the study, and an informal

atmosphere was maintained. The team meetings were where plans could be made, questions

asked and answered, problems discussed, and reflections expressed. It was the opportunity for

discussion and flow of ideas between members of the team that proved most valuable in

moving the research forward. The group setting was conducive to the generation of new ideas,

strategies, and techniques used to initiate action, direct the research, solve problems, and

ultimately find answers to the research question. Through the process of self-conscious

scrutiny we could theorize our practices, revise our theories in light of reflective interaction,

and adjust our practice through reflectively informed changes in our behavior (Carr & Kemmis,

1983). An important goal of the reflection was to develop a rational understanding of our

practice of how it applied to the transfer of information to our students. This increase in

understanding was achieved through systematic reflection on both the unconscious and

deliberate acts which constituted the research process (Oberg, 1986). Another goal of the

process was for the participants to understand this form of team inquiry, that is, how the

reflective process increased awareness of our practice and eventually our capacity to direct it

more fruitfully.

For convenience in the discussion, we have divided the overall research process into four

chronological phases, based on the recursive collaborative team action research cycle in the

study, and a planning phase for future cycles:

1. August 1998   Planning phase of the project and Cycle 1

2. September 1998   Baseline data collection for Cycle 1

3. October - November 1998   Intervention strategies/ Modification of interventions

4. December 1998   Repeat baseline data / reflection for Cycle 1

5. January 1999   Return to Planning phase for future Cycles

Phases 1 through 4 comprise the first research sequence or "Cycle" and Phase 5 and any

following phases might repeat the cycle to gain more information. After the first cycle,

research questions could be modified or replaced, based on what was learned to date. A single

cycle consists of the steps in the phases outlined in Figure 1 below, as was conducted during

our study.

Planning

Phase 1 (Planning Phase in Figure 1) began in August of 1997 with an initial meeting of

the team members. The group volunteered to conduct the research after being contacted by the
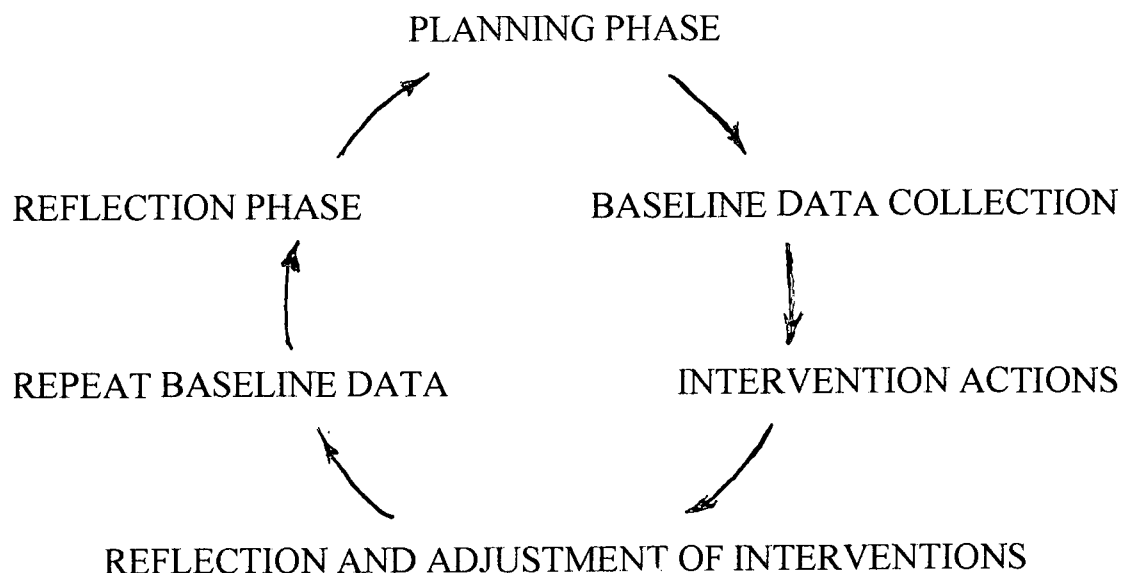
PLANNING PHASE

REFLECTION PHASE   BASELINE DATA COLLECTION

REPEAT BASELINE DATA   INTERVENTION ACTIONS

REFLECTION AND ADJUSTMENT OF INTERVENTIONS

Figure 1. Illustration of one recursive sequence of collaborative team action research, often

referred to as a "cycle."

university researcher, but did not know any particulars about the process of conducting the

research. The general plan of creating research questions, taking actions, collecting data, and

reflecting was discussed and a basic time-line for the cycle of research was established during

this meeting. The participants had a variety of questions and concerns that were expressed and

discussed, the most notably concern was about the amount of work required to complete the

project in regard to the process of data collection. We emphasized the flexibility of our

planning and of our time-line. During the project, we audio taped all meetings of the

participants, including individual and group meetings. In addition, we made field notes of

observations, kept personal journals from our individual points of view, and gathered data

concerning the research question from administrators and other teachers. These data were the

source for this report.

We met during pre-planning in August and finalized the research question for the cycle.

As a group, we decided to develop one group question, rather than individual research

questions. Decisions about research procedures concerning the group question were made by

the group. In fact, we decided that we all had to be in agreement in order for an idea to be

accepted. We were concerned initially whether unanimity might be a problem when trying to

move forward in the research process, but were pleasantly surprised that conflict and work

toward its resolution kept all members of the group involved, allowed opinions to be aired and

discussed, and generally united the group by insuring that everyone had input before a decision

was made. After discussion and reflection on our research interests, the group decided on the

following research question:

What classroom management techniques might utilize graphing calculator technology?

Baseline Data

Phase 2 (Baseline Data Collection in Figure 1) began with what we refer to as "baseline

data." Baseline data answers the question, "What is the current situation in regard to our

research question?" The middle school for our study was located in a semi-urban area just

west of a large mid-Atlantic metropolitan city. It consisted of about 650 diversified middle-

class students defined by teachers and administrators as "above-average." Initially we gathered

information on what was currently being utilized in classroom management plans, what plans

were already in place, as well as the feelings teachers had about graphing calculators and

classroom management. This information constituted our baseline data and would be used for

comparative reflection at the end of the cycle.

The middle school science department had class sets of Texas Instrument TI-83 graphing

calculators with hand-held computer based laboratories (CBL), a regular computer lab

containing fifteen Macintosh Power PCs, and each science teacher had his or her own

computer in the classroom. With a total of eight science teachers, four teaching life science to

seventh graders and four teaching physical science to eighth graders, the availability and the

functionality of the technology resources was often difficult to rely upon in the regular

computer lab room. Due to the initiation of SOL (Standards of Learning) testing, the county

where the study middle school was located developed a required POS (Program of Studies) for

science teachers at the eighth grade level. The created curriculum left little room for deviation

from its prescribed path, and included "teacher notes" of the expected topics to be covered as

well as the manner in which they were to be covered. The teacher notes also referenced

available resources dealing with each unit, lesson, and lab. The prescribed science curriculum

was a very "hands-on" experience for students including a lab manual containing the required

labs for each unit. For a person new to the teaching profession, it was extremely helpful, but

experienced teachers might resent having to conform to the county's packaged curriculum.

An informal interview process was used to collect baseline data from science teachers, math

teachers, and students, in addition to the science department head who had been instrumental

in the development of the eighth grade science curriculum.

The math teachers interviewed for the study also taught our science students and were engaged with attempts at integrating the math and science curriculum using the graphing calculators as a common instructional tool. Several challenges with integrating the math and science curriculum were being addressed during the time the study was conducted. First, since both the science and math departments were required to teach a prescribed curriculum it was difficult to coordinate the two curriculums. Second, the science students performed at very different math skill levels, as well as different levels of understanding in science. In addition, the science students from any one science class were not in the same math class so more than two classes (and often as many as four) had to be involved in any one integration project. One math teacher commented, "I used to start with graphing and line plots [so I could coordinate with science labs] at the beginning of the year, but with the SOLs and curriculum changes over the last few years, that has become unfeasible." Both the current math and science curriculums are relatively new to this middle school, and the process of coordinating ways to facilitate the integration of the science and math curriculums to allow for tandem use of the graphing calculator were still being developed.

As part of the baseline data collection phase, four purposely varied science students were interviewed regarding the use of graphing calculator technology. All four students were either currently enrolled in a math class that used the graphing calculator or had been enrolled in such a class the previous year. Two of the four students owned their own TI-83 calculators, whereas the other two students used the TI-83s provided by the middle school. It was interesting to note that not one of the four students had been exposed to the graphing calculator

in their science classes, yet all four students had used a graphing calculator in their math classrooms. Kim (all names except the authors have been changed) stated, "Last year we used graphing calculators in math. They were pretty neat...." Sara commented, "We are using the graphing calculators this year in math. They have a lot of buttons and a lot of functions. I am really excited about using them." The students enjoyed using the graphing calculators in their math classes, and had also loaded a number of games onto them. David said, "One of my teachers caught me playing a game [on my graphing calculator] in class, and I had to wait a whole day before it was returned. [My teacher] threatened to clear all my memory if I did it again. Needless to say, I was more careful about playing games in class." Except to do their math homework, the students did not see any real life applications for their graphing calculators. All four students understood how to link two calculators together, find and load programs onto their calculators, and in general use their graphing calculators for math and gaming purposes.

The four science students in the study were also asked about using the CBL (computer based lab). Kim responded, "What is a CBL?" Sara asked, "What does CBL stand for?" John said, "Guess not since I have never heard of it." The four students had never been exposed to or used a CBL in science or math classes.

Interventions and Adjustments

Phase 3 (Intervention Actions and Reflection And Adjustment Of Actions in Figure 1), included the interventive actions we took to answer our question, reflections about our actions, and adjustments of our interventions. It began in October (1998) as the student

teacher(Brenda) started her four-week period of full-time student teaching. The cooperating in-service teacher taught Brenda to use a scripted curriculum for science, with all teaching based on an extensive "hands on" lab experiences. These student-centered lab periods were when classroom management problems were arising with both our student teachers and some in-service teachers that were interviewed, especially those new to the profession. Our hope was that the graphing calculators could be used as a classroom management tool due to the discipline-preventive aspect of increased interest and motivation they might add to the labs, and perhaps as "real life" extensions of the mathematics curriculum through integration, also adding to interest and motivation. Each intervention was reflected upon and adjustments were made to try to improve the affect on classroom management. As this was our first series of interventions, we did not note significant differences in our adjustments of interventions. We expect that after completing a full cycle of research we would be better equipped to suggest other forms of intervention.

The first intervention was an experiment Brenda taught in her eighth grade physical science classroom which used a line plot based on the length of a student's foot. The students were required to trace their feet on construction paper, measure the length of the drawn foot in centimeters, and hang their feet on a clothes-line style string with centimeter increments attached. The lab required the students to manually create a line plot in centimeters from their data on a piece of paper. As an extension, the student teacher had the students enter the data into the graphing calculator to provide a means of comparison. For the calculator portion, the student teacher placed the students in small groups where the students who had experience

with the calculators helped and instructed students who did not have experience.

When asked about using the graphing calculator in science class, Kim stated, "I guess I kind of knew all along that the calculators had uses [other] than just helping me do my homework and class work in math and to provide an interesting game or two. This made it [the graphing calculator] seem more realistic to me." Sara expressed, "Since I am just learning to use my calculator, this gave me more practice in how to use it." John said, "I think it was kind of neat to see that there are places in real life that these calculators can be used and not just in made-up problems. I also think it was interesting looking at different types of graphs using the same data."

The students were asked whether the calculator experience was a worthwhile use of class time, or should the class have stopped once the line plot had been created on paper. Kim stated,

"I think it was worthwhile in that we could see the same data presented in three different ways." Sara said, "I think it was interesting to see how you could change the type of graph on the calculator." John expressed, "I think it made even more sense to me by seeing it on paper before using the calculator." David said, "I already knew what was going to happen. Why did I even have to put it down on paper before I used the calculator?"

As another intervention, the science students performed a lab experiment using the CBL and a temperature probe where the students plotted their data manually. For these labs, the student teacher paired students into groups of two. After completing the lab, the student teacher asked the students in her study sample about using the CBL with a temperature probe

versus using a standard thermometer. Kim stated, "It took a few minutes to get the hang of it."

Sara felt that the CBL was easier to read than a thermometer. John thought there might have

been something wrong with his CBL because he had a beaker in ice water, and the CBL

showed a -5°C reading. David stated, "I guess they are OK; not very exciting to just watch the

numbers go up or down for the change in temperature, but I guess they do their job." The

student teacher instructed that the increments on the CBL were correct, and had the students

work on calibration.

Another intervention involved connecting the CBL to the graphing calculator so the

students could view the resulting graphs. Students were placed in groups of three this time as

another variety of student-centered grouping. Each group performed an experiment to study

endothermic and exothermic chemical reactions. The middle school holds an annual parent

day where parents are encouraged to accompany their child to school. The endothermic-

exothermic chemical reaction lab occurred during parent day. Parents were interviewed and

seemed to enjoy a chance to participate and were impressed with the CBL and graphing

calculator combination. One parent remarked, "This is a lot better than when I took chemistry

in high school, and we had to record each of those temperatures [by hand]. I wish we had the

ability to link calculators and CBLs at that time. All we had were slide rules."

The students in the study sample were asked about their reactions to linking the CBL to

the graphing calculator, and were very receptive. Kim stated, "I could better understand the

decrease in temperature of an endothermic reaction by having [the CBL] linked to the

[graphing calculator] combination. I just wish I could have done both of the experiments

instead of having to share results." Sara said, "I thought it was fascinating watching the

calculator screen as each temperature was taken by the CBL, then seeing the full graph at the

end of the experiment." John stated, "The calculator screen is so small that it was a little

difficult seeing the highest and lowest temperatures from the experiment, but that was

definitely easier than taking all of those temperatures every five seconds." David responded,

"It was certainly easier to let the CBL collect the data, and the calculator record the data."

The students were also asked about the usefulness of linking the CBL to the graphing

calculator. Kim explained, "I thought it was quite useful to have the two linked. It provided

an immediate way of looking at the experiment." Sara said, "I sort of see how linking the two

could be useful to collect other data. I hope we will be using the linked setup in future

experiments. It is pretty awesome that I am using the calculators both in math and science."

John stated, "I appreciated not having to hunt for all of those little block coordinates on graph

paper." David responded, "I know that having the linked calculator and CBL did save me a lot

of time."

Repeating Baseline Data and Reflections

The first part of Phase 4 (Repeat Baseline Data in Figure 1) began in December of 1998

when Brenda had completed her full-time student teaching. We basically repeated the data

collection for the Baseline Data at the beginning of the study so that we could directly compare

the situation then with the situation at the end of the cycle. Because this was our first cycle of

research, the final baseline data paralleled the interventions initiated in the study. What was

different was the use of more interesting and motivating techniques used for student-centered

work, especially the use of graphing calculators, CBLs, probes, software, and integrating the

mathematics curriculum, as described above. In the next cycle of research, we might start at

this point and try more strategies and techniques to see if we could increase the level of interest

and motivation, and perhaps better define the effectiveness of each technique.

The other part of Phase 4 (Reflection Phase in Figure 1) began after all the data had been

collected. We examined the data and made direct comparisons between the initial and final

baseline data. Then we reflected on the other data collected, what we had learned as a result of

experiencing the process of conducting the research, and the research as ongoing cycles.

We reflected that we had highlighted a few effective techniques that might improve graphing

calculators as a teaching tool if implemented consistently over a long period of time. We also

believe that other techniques and strategies might be found to be effective if we continued the

research question through more cycles. We agreed that experiencing the research process

made us more aware of the needs of our students, and that by becoming proficient with the

research process itself, we could continue to grow professionally through other projects.

Conclusions

In summary, we believe that effective classroom management depends on the early

planning, revision, and final implementation of the course for action with considerable thought

given to possible contingencies and their resolution when dealing with TI 83's and CBLs in the

science classroom. By that we mean that when facilitating student performance on a higher

plane, the prior planning based upon the applicability of the tools to the task, and student

proficiency in the use of those tools is essential. Good planning and student proficiency with

the equipment help prevent loss of classroom control and student frustration. As the plan

emerges, revisions need to be developed based upon the availability of resources and of the

allotted classroom time factor. Student frustration if there is not enough time to complete the

activity, or student boredom if there is too much time given for an activity, both result in an

increase in classroom management problems. Prior to implementation, the teacher needs to

perform the activity and test the equipment for possible problems that can be handled before

students become involved. We routinely make sure that the units have charged batteries

installed, that the linking cables actually work at the proper junction, and that the program to

be used is correctly installed. The preliminary time spent on these basics pays off in the

classroom as middle school students enjoy the success of performing activities without

technical problems. The bottom line is that students who are actively and productively

engaged in a TI/CBL activity involved in learning and the classroom management takes care of

itself.

Specific ways in which the use of graphing calculators improved classroom management

include the following:

- Students were able to complete higher level work with understanding and without the

   frustration through the use of the linked TI 83/CBLs.

- Students enjoyed the use of technology in the science classroom, which made classroom

   management easier. At the end of her student teaching, Brenda had students fill out an

   evaluation which included references to the TI-83 and CBL. In answering the question,

   "Which labs did you find most valuable?" a majority of the students listed the labs

involving the CBLs and especially the lab which used both.

- Planning, trial and error, and using the TI-83 with a new regimented curriculum necessitated a plan for program implementation. Students really enjoyed using the calculators and CBL technology when explicit and detailed instructions were given to them through a set of guided instructions, verbally in a step by step approach, and kinesthetically with the process modeled by the teacher.

- The use of an overhead projector TI-83 view screen, which shows the screen of the connected calculator on the overhead projector, was very helpful and made instruction easier, but it is not absolutely essential. The view screen helped keep the class focused in the performance of the learning activity, again reducing the number of unacceptable behaviors in the classroom.

- The exposure of students to each component independently before linking the CBL to the calculator increased student self confidence. By becoming familiar with each component, students were able to achieve almost immediate success in the performance of the lab.

- The CBL and TI-83's smaller size, easier portability, and lower cost than comparable computer arrangements made the systems more accessible to students and teachers while providing the convenience of remaining in the regular classroom where students were accustomed to a certain standard of behavior.

Finally, we were satisfied with the positive effect our few techniques had on classroom management and think more research is needed along the lines of strategies to enable students

to take greater control over their learning through the use of technology like the TI-83s and

CBLs, so teachers can spend more time in the role of a facilitator than in the role of a

disciplinarian. And the real beneficiaries will be our students.

References

Beane, J. (1993). What is an integrated curriculum? Journal of the New England

League of Middle Schools, 6(3), 2-4.

Carr, W., & Kemmis, S. (1983). Becoming critical: Knowing through action research.

Geelong, Australia: Deakin University Press.

Dickinson, T. J., & Erb, T. O. (Eds.). (1997). Teaming in the middle schools.

Columbus, Ohio: National Middle School Association.

Elliott, J. (1990). Teachers as researchers: Implications for supervision and for teacher

education. Teaching & Teacher Education, 6(1), 1-26.

Gallagher-Polite, M. (1997). The art of creative composition: An administrative

perspective on interdisciplinary teams. In T. S. Dickinson, & T. O. Erb (Eds.), Teaming in

middle schools (pp. 229-270). Columbus, Ohio: National Middle School Association.

Gatewood, T. (1998). How valid is integrated curriculum in today's middle schools?

Middle School Journal, 29(4), 38-41.

Lewin, K. (1947). Frontiers in group dynamics. Human Relations, 1, 5-41; 143-153.

McEwin, C. K. (1997). Trends in the utilization of interdisciplinary team organization

in the middle schools. In T. S. Dickinson, & T. O. Erb (Eds.), Teaming in middle schools (pp.

313-324). Columbus, Ohio: National Middle School Association.

Noffke, S. E. (1995). Action research and democratic schooling: Problematics and potentials. In S. E. Noffke & R. B. Stevenson (Eds.), Educational action research: Becoming practically critical (pp. 1-10). New York: Teachers College Press.

Noffke, S. E., & Zeichner, K. W. (1987, April). Action research and teacher thinking. Paper presented at the annual meeting of the American Educational Research Association, Washington, DC.

Oberg, A. (1986). Using construct theory as a basis for research into professional development. Journal of Curriculum Studies, 19(1), 55-65.

Pate, P. E. (1997). Teaming and decision making. In T. S. Dickinson, & T. O. Erb (Eds.), Teaming in middle schools (pp. 425-442). Columbus, Ohio: National Middle School Association.

Saurino, D. R. (1998). A qualitative study of middle school collaborative team action research (Doctoral dissertation, University of Georgia, 1998). Dissertation Abstracts International, In press.

Saurino, D. R., & Saurino, P. L. (1996). Collaborative teacher research: An investigation of alternative assessment. Current Issues in Middle Level Education, 5(2), 50-72.

Wraga, W. G. (1997). Interdisciplinary team teaching: Sampling the literature. In T. S. Dickinson, & T. O. Erb (Eds.), Teaming in middle schools (pp. 325-344). Columbus, Ohio: National Middle School Association.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE
(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Science Classroom Management Techniques Using Graphing Calculator Technology: A Collaborative Team Action Research Approach

Author(s): Dan R. Saurino, Brenda Gunnoe, Amy Bouma

Corporate Source: Virginia Tech (Virginia Polytechnic Institute and State University)

Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE. AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY. HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1 ↑ [X]	Level 2A ↑ [ ]	Level 2B ↑ [ ]
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) and paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here,→ please

Signature: Dr. Dan R. Saurino

Printed Name/Position/Title: DR. DAN R. SAURINO, Asst. Professor

Organization/Address: Virginia Tech / Dept. of Teaching & Learning
7054 Haycock Road
Falls Church, VA 22043

Telephone: (703) 538-8479
FAX: (703) 538-8485
E-Mail Address: saurino@vt.edu
Date: 3/30/99

(over)

Share Your Ideas With Colleagues Around the World

Submit your conference papers or other documents to the world's largest education-related database, and let ERIC work for you.

The Educational Resources Information Center (ERIC) is an international resource funded by the U.S. Department of Education. The ERIC database contains over 850,000 records of conference papers, journal articles, books, reports, and non-print materials of interest to educators at all levels. Your manuscripts can be among those indexed and described in the database.

Why submit materials to ERIC?

- **Visibility.** Items included in the ERIC database are announced to educators around the world through over 2,000 organizations receiving the abstract journal, *Resources in Education* (*RIE*); through access to ERIC on CD-ROM at most academic libraries and many local libraries; and through online searches of the database via the Internet or through commercial vendors.

- **Dissemination.** If a reproduction release is provided to the ERIC system, documents included in the database are reproduced on microfiche and distributed to over 900 information centers worldwide. This allows users to preview materials on microfiche readers before purchasing paper copies or originals.

- **Retrievability.** This is probably the most important service ERIC can provide to authors in education. The bibliographic descriptions developed by the ERIC system are retrievable by electronic searching of the database. Thousands of users worldwide regularly search the ERIC database to find materials specifically suitable to a particular research agenda, topic, grade level, curriculum, or educational setting. Users who find materials by searching the ERIC database have particular needs and will likely consider obtaining and using items described in the output obtained from a structured search of the database.

- **Always "In Print."** ERIC maintains a master microfiche from which copies can be made on an "on-demand" basis. This means that documents archived by the ERIC system are constantly available and never go "out of print." Persons requesting material from the original source can always be referred to ERIC, relieving the original producer of an ongoing distribution burden when the stocks of printed copies are exhausted.

So, how do I submit materials?

- Complete and submit the *Reproduction Release* form printed on the reverse side of this page. You have two options when completing this form: If you wish to allow ERIC to make microfiche and paper copies of print materials, check the box on the left side of the page and provide the signature and contact information requested. If you want ERIC to provide only microfiche or digitized copies of print materials, check the box on the right side of the page and provide the requested signature and contact information. If you are submitting non-print items or wish ERIC to only describe and announce your materials, without providing reproductions of any type, please contact ERIC/CSMEE as indicated below and request the complete reproduction release form.

- Submit the completed release form along with two copies of the conference paper or other document being submitted. There must be a separate release form for each item submitted. Mail all materials to the attention of Niqui Beckrum at the address indicated.

For further information, contact...

Niqui Beckrum
Database Coordinator
ERIC/CSMEE
1929 Kenny Road
Columbus, OH 43210-1080

1-800-276-0462
(614) 292-6717
(614) 292-0263 (Fax)
ericse@osu.edu (e-mail)