

Changing the way teaching occurs in an American middle school



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(Received 29 July 2011; accepted 11 November 2011)

Abstract

IMPACT2 is a program at Marion Ohio's Grant Middle School, the sole middle school in the school district, that involves almost every science teacher. IMPACT stands for *Inquiry Model for Professional Action and Content-rich Teaching*. Some achievements of the three years of the grant-supported program will be given. In the third year of the grant, the program was spread to Harding High School. Some information on the changes middle school teachers have made will be discussed. Because of these changes, high school teachers became involved.

Keywords: Research in physics education, Inservice training, Philosophy of science.

Resumen

IMPACT2 es un programa en la Escuela Medio Grant en Marion, Ohio, la única escuela media en el distrito escolar, que involucra a casi todos los profesores de ciencias. IMPACT es sinónimo de modelo de la investigación profesional y la enseñanza ricos de contenidos. Algunos de los logros de los tres años del programa apoyo-otorgado se darán. En el tercer año de la subvención, el programa se extendió a Harding High School. Parte de la información sobre los cambios maestros de escuela intermedia serán discutidos. Debido a estos cambios, los maestros de la High School se involucraron.

Palabras clave: La investigación en enseñanza de la física, Capacitación en servicio, Filosofía de la ciencia.

PACS: 01.40.Fk; 01.40.jh; 01.70.+w

ISSN 1870-9095

I. INTRODUCTION

As part of the American rustbelt, Marion, Ohio, has many unskilled laborers, few jobs for unskilled labor, and a lack of skilled labor. Many residents are mired in poverty, and about three-quarters of pupils qualify for reduced-cost or free lunches. The proportion of minorities in the schools is relatively small (~5%). [1] Marion City Schools has multiple elementary schools, a single middle school, Grant Middle School, which enrolls all sixth, seventh, and eighth-graders, and a single high school, Harding High School, in the City Schools (Marion also has a Catholic elementary school with some enrollment from some local non-Catholics). The State of Ohio has achievement tests in reading, writing, science, mathematics, and social studies at the elementary and middle levels and a graduation test. Because of the powerful negative environmental factors mentioned above, scores on Ohio achievement and graduation tests (Ohio Achievement Test, OAT, and Ohio Graduation Test, OGT) are extremely low, and the Marion City Schools is under a form of state watch [1]. As a result of the poor economic climate, families are in disarray and it is no surprise that many students fare poorly in core courses and standardized high-stakes tests.

As a result of perceived positive outcomes from a state-funded program for Marion and Newark, Ohio, City Schools teachers, Project IMPACT (*IMPACT: Inquiry Model for Professional Action and Content-rich Teaching*) run by the Christopher Andersen, Gordon Aubrecht, and Bill Schmitt some years ago, administrators from the Marion City Schools approached us for help in improving the abysmal OAT science scores at the middle school. The Ohio State University at Marion collaborated through us with the entire Marion City Schools middle school science faculty to improve science teaching and learning systemically.

To meet the challenges of increasing teaching and learning in the schools, a joint Math-Science Partnership grant proposal to the Ohio Department of Education (ODE) was written with help from a small Department of Education proposal preparation grant that was given to fund one proposal from every regional educational district in the state. We and another Ohio State Physics Department proposal were the only two proposals chosen for funding. An attraction of the program in the ODE proposal was the commitment of nearly every science teacher in the middle school and of the local teacher union to the project.

While the usual funding support lasts for about two years, in this case the grant has been funded for three years with every indication of a fourth. During the third year of the project, it was extended to teachers from the high school. This was partly due to the success the project had in engaging middle school students—Why aren't the science classes at the high school as much fun as those the students had just had at the middle school?

II. FOSS KITS

In addition to enlisting us to help science teaching, the Marion City Schools independently decided in June, 2008 that the dire situation presented by the poor scores on the science achievement tests warranted buying kits for teachers to assist them in switching to inquiry. They decided to purchase the Full Option Science System (FOSS) [2]. FOSS kits are supposed to be inquiry-based, and there is indeed a good deal of inquiry in them (along with enough of a teacher-centric environment necessary to sell the idea to teachers used to being the “sage on the stage”).

There are many anecdotes about the great number of FOSS (or other school-district-purchased) kits that sit idle on the shelf because teachers have no idea of how or why to utilize them. Some teachers do use pieces of FOSS, but the point of FOSS is that it is a *system*. As a system, FOSS builds students' ideas to a view of the state of human understanding. FOSS accomplishes this by taking students through the intermediate steps often left out as teachers rocket through their “required” topics. A problem for FOSS is that different states have different requirements; while FOSS might meet them all, it must do more than each, setting up the unfortunate dynamic in which teachers jettison “irrelevant” parts, which undoes the systemic approach. So, a key to making FOSS modules a success is to use them as parts of a greater whole.

III. TEACHERS INTRODUCTION TO INQUIRY

We believe in guided inquiry and teach Physics by Inquiry classes to preservice teachers [3, 4]. The team decided that the FOSS curriculum could be made to work within the inquiry program we envisioned.

IMPACT 2 was funded by a grant through the Ohio Department of Education, originally to provide resources to teachers at Grant Middle School; as mentioned above, by the third year, we were working with high school teachers.

IMPACT 2 was conceived as a year-long professional development program that would provide over 150 hours of support to all science teachers, mostly during normal school days and hours. The organization and operation has been:

- (1) A two-week summer workshop prior to start of school to introduce teachers to inquiry and FOSS in summer 2008, with summer workshop experiences available (but not mandatory) to teachers subsequent years. For the high school teachers, we run a two-week program using

Materials World Modules from Northwestern University during summer 2010. They were eligible to participate in the 2011 summer workshop at Stone Laboratories on Lake Erie.

- (2) Twice per week grade level meetings and 3 day long meetings during the school year the first two years of the middle-school project; less often the third year. There was a joint day-long middle school-high school teacher meeting in 2011.
- (3) A focus on content and inquiry (*i.e.*, FOSS or Material World modules, as appropriate) through much of the year.
- (4) A gradual shift of emphasis to teacher reflection and interaction through the year; some of this was accomplished through discussion of district-mandated continuous formative assessments.
- (5) Coaching and professional bonding of the grade-level staff and the entire science faculty through posting on the Ed Gateway listserv throughout the first two years; and visits to classrooms by both Aubrecht and Schmitt.
- (6) A debriefing and planning for the future at the close of each school year.

There were two parts to project preparation. In the summer courses at Ohio State Marion, teachers participated in a different approach to learning—*i.e.*, that students can learn with “coaching” so that their ideas and thinking processes are valued in ways they cannot be when teachers force them to use one approach about what to learn and how to learn it. The instructional project team (Aubrecht and Schmitt; hereafter denoted AS) met before the grant was officially to begin with the City Schools math coaches, who helped develop the teachers' program. This is shown as the June session in Table I.

Another major focus of the summer part of the project was to help teachers at each grade level unpack and learn to use the FOSS modules in ways that reflect inquiry learning principles. The second summer part involved working with the math coaches and the science teachers at Grant Middle School. Some of this has been described elsewhere [5].

IV. TEACHER PARTICIPATION AND RESULTS

Middle school teachers did *experience inquiry* from the start of the summer workshop by doing investigations from *Physics by Inquiry* [4]. Some confided later that after the first day, they were nearly ready to drop out. However, the experience was essential for establishing a common understanding of inquiry. This helped them as they unpacked FOSS sections and taught them to each other at grade level and then taught some of the lessons to the other grade levels. The teachers acknowledged as much in later reflections.

High school teachers used the Materials World Modules. According to its developers [6]: “The Materials World Modules create an environment of scientific inquiry within a design context involving material objects; students ponder design problems that scientists and engineers

encounter every day in the workplace. Incorporating inquiry within a materials design context helps to provide purpose and structure in the learning of underlying scientific concepts". This fit in to our focus on inquiry instruction.

There was a great emphasis from the instructional staff on *questioning* as the basis of science and of education. Listening to students' questions and responding to them, waiting when asking questions of students, and not sequentially calling on students until the "right" answer was achieved. All these issues were discussed and modeled extensively in each of our interactions with teachers.

During the school years, AS continued to help teachers focus on these ideas through classroom visitation, in weekly meetings, and through list-serv discussions (these were replaced by email communications within FirstClass, which the Marion City Schools uses for intraschool communications). As teachers became involved in the implementation of this "new" curriculum the levels of excitement, frustration, apprehension, and hard work increased. Indeed this project required professional effort above and beyond the call of duty by the teachers and instructors alike. Some indication of the early middle school results were published in the FOSS Newsletter [7].

In addition, we funded substitute teachers for release days for professional development (mainly organized by the teachers themselves after the first year of funding. Here is what one eighth-grade teacher wrote about the group's trip to Hocking Hills, an area of gorges and erosion in southeast Ohio: "We filmed the area and aligned the scenes with our Earth History curriculum. ... showing erosion and other destructive processes occurring in Ohio brings the curriculum into the back yard of our students." A seventh-grade teacher wrote about a day the team spent working on STEM fair (an idea the group originated to replace science fair) and learning about a different way to do genetics: "They got so much more out of this years genetic unit, creating marshmallow men, than last when we created larkeys. If we didn't have the entire day to work on this and do it ourselves it would not have been nearly as successful." A different eighth-grade trip was to Caesar Creek State Park, where fossils can be found easily. One teacher who made the trip wrote: "The inquiry unit I did with my students was to use the fossil guide that we obtained from the park office and the fossils that we were able to harvest. Fossils were set up in stations around the room, students were asked to identify the fossil and jot down some notes about when and where the fossil lived. They then search the internet about where these fossil can be found. When they came up with Southern Ohio we were able to discuss what that meant about the area millions of years ago. We were able to look at the fossil record and they learned a great deal about Ohio and the many different 'stages' it has gone through". The teachers have expressed gratitude for the opportunity and generally (as indicated above) brought their experiences back to their classrooms.

These conclusions are supported by the grade-level interviews we did with one student from each classroom in February, 2009. We asked students to characterize a good

Changing the way teaching occurs in an American middle school science classroom for a fictional middle school principal, and the students from all grade levels essentially responded with the equivalent of "it should be like our science classroom". When asked what teachers in that school should not do, they responded with several suggestions. One of them was that teacher ask students questions but not provide answers to students so they could figure things out for themselves. We regard this as a measure of the extent of our teachers' success in their classrooms.

V. CONCLUSIONS

This project could not have evolved as it has without the extensive cooperation from most teachers, continuing guidance from the instructors, and the commitment we made with the blessing of ODE to do most of this project during school time. The literature on growth and change in education contains many reference to difficulties encountered in this type of effort. Many teachers would not have participated in a meaningful way without this commitment. As it was set up, most teachers actively participated. The use of tools appropriate for the task (in this case FOSS or Materials World Modules) were also essential components because in involved teachers in doing their own inquiry to learn the curriculum.

In addition, I had a brainstorm that was adopted during the first year to do a very long science project) one lasting the entire school year) with the middle school students, an idea embraced enthusiastically by most of the eighth-grade science teachers. It involved measuring the length and orientation of a gnomon's sun shadows on a wood platform in an open space surrounded by the school building. This was an interesting project, and did engage students in thinking for themselves. It is also more authentic science than is ordinarily done in a middle school classroom. The project has been described in detail elsewhere [8].

There needs to be a vehicle for teachers to implement the practices supported by the project. Major difficulties encountered included getting teachers to be reflective of the process, to see themselves as the professionals they are, and to see the importance of having a responsibility to each other. Also, because of an extensive workload, teachers often seemed to use project time during the school day as "planning time" rather than development time.

The time devoted to this project by teachers and instructional staff (AS) was very large, though for the teachers most of the time was during school hours (except for the summer meetings before and after the school year). Teachers had about 150 hours of direct instruction the first year of the middle-school program, with somewhat less time (~60 hours) subsequent years. The time commitment for the instructors the first year was around one thousand hours each; in the subsequent years, it has been around 400 hours each (a total of 3600 instructor hours so far). Should any other instructor attempt such a project, he or she should be aware of the extraordinary instructor time commitment we required for success.

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An important aspect of the project is that virtually ALL the science teachers implemented the curriculum and showed significant growth in being able to recognize improved opportunities for student learning. There was a significant change in their classrooms. To sustain this change, ongoing support has continued to be provided so that teachers can move from seeing how inquiry works to discovering why it works.

Evidence of student achievement as a result of IMPACT 2 involved reflections and discussions from teacher and staff classroom observations, from randomly selected student interviews, and discussions with administrators. Additionally, results of student performance on the Ohio Achievement Test in Science increased substantially over the preceding years, though the school still failed to attain an acceptable level. Because Grant Middle School is under state watch, the state-mandated Improvement Diagnostic Review of the school curriculum recognized excellence in science learning improvement, the only Grant curriculum to be so recognized.

ACKNOWLEDGEMENTS

This work was supported in part by grants from the Ohio Department of Education 60018325 (2008-2009), 60021887 (2009-2010), and 60028273 (2010-2011). Bill Schmitt from the Science Center of Inquiry was an essential

part of the instructional team and the success we have achieved.

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