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ABSTRACT

This Dwight D. Eisenhower Mathematics and Science Education in-service project in northwest Indiana, based on a contextual constructivist perspective, sought to enhance science learning by improving science teaching in grades K-8. Elementary and middle school teachers from urban, suburban, and rural public and parochial schools attended a summer workshop in which they engaged in activity-based science learning; participated in exercises in cooperative planning, science concept enrichment, process skills development, and relevant computer applications; and discussed options for interdisciplinary science learning. After school began, the teachers attended assessment training workshops during which they developed pre- and post-test instruments for evaluating student science learning. Lesson plans developed during the summer workshop were implemented during the school year, and assessment instruments were submitted, including journals, data record sheets, notebook entries, charting and graphing, laboratory techniques and reports, written tests and concept mapping, observations and oral exchange, and drawings and art projects. Nearly all teacher reported improved student attitudes and science learning among the 1,772 project students. Project results underscore the value of teacher-prepared multiple assessment measures for equitable and realistic evaluation of science learning. (NAV)

# Twin Tandem Science Initiative: A Celebration of Diversity

by

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# Twin Tandem Science Initiative: A Celebration of Diversity

Picture an elementary science class in northwest Indiana. How many students are there? What cultures and ethnicities do they represent? Who is the teacher? Does s/he live in the same neighborhood as the children? Are there other adults in the room who interact regularly with the children? What does the classroom look like? Are there windows, lab tables, sinks with running water? How much storage space is accessible to the students and their teacher? How many different classes use this room during a school day or week? How flexible are class schedules? How much money is budgeted for science supplies, for field trips?

Elementary science is taught in diverse settings to diverse student populations. Some students in northwest Indiana have ideal opportunities to build solid science concepts and to practice science process skills. Others are truly disadvantaged by lack of opportunity to learn. Teachers may conscientiously schedule the required number of class hours for reading science texts, but be reluctant to spend time and possibly their own money preparing discovery activities they don't really understand. Administrators who lack science background fail to prioritize science supply money in budget planning, and may not approve class time for science activities that require more than a single period.

Recognizing the need for educational reform, congress has made federal tax money available through the Dwight D. Eisenhower Mathematics and Science Education Act for upgrading science teaching. This is the story of one Eisenhower project funded in northwest Indiana in 1993.

Our project was grounded in a contextual constructivist perspective (Cobern, 1993, von Glasersfeld. 1993). We assumed that students construct their own understanding of science, bringing prior knowledge and theories about the natural world to the elementary classroom. Their unschooled theories are informed by social interactions with members of their families, with their peers, and by media messages from the wider society ( Gilbert & Watts, 1983).

Expert scientific knowledge is also a social construct, informed not only by the experiences of present-day scientists, but also by historically significant theories that still make sense among researchers (American Association for the Advancement of Science, 1990). Equitable assessment of science learning must be sensitive to diverse modes of learner expression, and to diverse opportunities for learning, but it must also be in accord with well-established and contemporary understandings of science and technology (Hein, 1990, Kulm & Malcom, 1991, Freedman, 1994, National Research Council, 1996).

The "Twin Tandem Science Initiative: A Celebration of Diversity" was a Dwight D. Eisenhower Mathematics and Science Education Act in-service project funded by the Indiana Commission for Higher Education. Our goal was to enhance science learning among area students by improving science teaching, K-8. This collaborative program brought together elementary and middle school teachers from urban, suburban, rural, public, and parochial schools for a summer workshop hosted by Saint Joseph's College. The teachers experienced activity-based science learning and engaged in cooperative planning, science concept enrichment, process skills development and computer applications. They also discussed options for interdisciplinary science learning.

We will now relate how some of our project teachers dealt with the assessment challenge, and how we, as a project staff, sought meaningful coordination of their diverse reports.

At our summer workshop, teachers developed hands-on classroom lesson plans, noting there would be embedded assessment. Lessons were implemented by summer program participants during the following school year. After school began, we offered assessment training workshops, during which teachers developed specific pre-and post-test instruments for evaluating student science learning They decided on multiple assesment measures, including journals, data record sheets, notebook entries, charting, graphing, laboratory techniques and reports, written tests, concept mapping, teacher observations, oral exchange, drawings, and art projects.

Current research findings ( National Research Council, 1996) show hands-on, collaborative teaching/learning methods are an effective means for teaching science to children, especially those from underrepresented populations. Twin Tandem project results are in agreement with this research data.

All teachers who submitted assessment documentation stated their own impressions/convictions regarding student science learning. Nearly all teachers reported improved attitudes toward learning science, for example,

> "...The major benefit of this lesson was the awakening of students' enthusiasm for science." (4th grade teacher, School City of East Chicago)

Some participants used conversational pre-assessment for monitoring class baseline knowledge, and translated their students' orally expressed ideas into assessment documentation. Here is what two teachers reported,

> "...I really thought this was going to be over their heads, but they absorbed everything." (Kindergarten teacher, Lafayette Diocese)

> "...I'm not sure it is necessary for children at this age, eight and nine years old, to record observations. The experiment, followed by general discussion, is sufficient." (3rd grade teacher, Lafayette Diocese)

Expert teachers went further, perceptively noting specific cases of improved learning, and their own ideas on how to improve their teaching of the lesson, next time. Here is what one such teacher wrote,

> "...While they responded to the hands-on process with great enthusiasm and excellent questions, the students were very limited in their ability to communicate their observations. They gave opinions rather than descriptive. If I were to do it over, I would have a "bank of adjectives" or "descriptive words" from which students could draw." (5th grade teacher, Lafayette Diocese)

Most of the 1,772 project students were from underserved or underrepresented populations. Significant gains in their science learning were reported. Of 78 project lessons evaluated, teachers noted they would teach 41 (53%) again. 75 teachers indicated that both they and their students benefitted from project activities.

One strength of our project was that teachers assessed science learning in varying and creative ways to meet the needs of diverse student populations, often using performance assessment. Students expressed their understanding of basic science concepts and mastery of process skills in a variety of ways attuned to individual learning styles and diverse cultural tendencies. Each teacher thoughtfully interpreted proficiency guidelines and focussed on one or more appropriate measures for assessing the science learning which occurred during a project lesson in her/his classroom.

Formative science learning assessment by the teachers was directed towards answering the question. "What scientific concepts/skills from the Indiana Proficiency Guide were learned by the children through this activity (or activities.) and what evidence do I have that this learning occurred?" Teachers used their assessment data to evaluate the activity and their own science teaching technique, then turned in a brief essay on their experiences, together with samples of student work. Site visits were made by project staff to encourage project teachers and to observe their science teaching.

Time was an enemy for many project teachers. They planned lessons to fit their own curricular schedules, but assessment documentation had to be submitted during the project year. This meant that a teacher needed to prepare, implement, and assess a new science lesson, all on one trial. Even experienced teachers felt pressured by this challenge. They weren't used to thinking about assessment on a lesson-by-lesson basis. They reported that they assessed students semester-by-semester, or yearly. This doesn't mean they only gave one test a semester, but rather that grading tests and turning them back seemed a different thing than collecting data about whether their work as teachers had impact on student science learning.

Because each teacher was free to draw up her/his own lesson plan using a life science, earth science, physical science, computer, or math theme, all sorts of assessment documentation were submitted by teachers. There were quantitative pre-and post-tests with fill-in-the-blanks or short essay questions. There were were standard black line master test sheets. There were portfolios of experimental data, charts, graphs, and lab journals, drawn with crayon on construction paper, or lab notebooks made by stapling recycled office paper together. On the other hand, one seventh grade class submitted their data as elegant computer print-outs. Much art work came in from teachers of primary grades, but ornate metal sculpture insects were also put together by students in one fifth grade class. Their new knowledge of arthropod anatomy was expressed in imaginative forms fashioned from recycled aluminum pop cans. Photos were taken of students engaged in science activities. As stated,an evaluative essay was submitted by each teacher describing the impact of her/his project lesson on student science learning.

How were we able to draw such diverse assessment documentation together into meaningful data? Our project focus remained, from start to finish, student science learning. Everything we did with the teachers was to enhance student learning. Because the children were diverse, their science learning experiences were diverse. But although the teachers chose what lessons to teach, and how to place them in the curriculum, exerting local control of specific science topics, teaching/learning activities, and assessment measures, they needed to justify their choice of lesson and assessment plans according to the Indiana State Science Proficiency Guidelines, and code their students' work according to the Indiana State Science Proficiency Matrix. These state guidelines are in accord with national goals and priorities for K-8 science teaching. Thus, the relevance and significance of student science learning was established within the broader social and cultural context in which taxes are paid and new citizens must be educated. A measure of the usefulness of the project itself was to be found in the high number of project lessons that teachers stated they would use again, and in many teacher requests for further project inservice.

Further evidence that our project was on the right track with teacher practitioners came when some of us spoke about using diverse assessment measures at the Hoosier Science Teachers' Annual Convention in Indianapolis. (Jones, Dalhoumi & Stankovich, 1994). We asked members of the audience to join with us, presenting their favorite tried-and-true assessment measures for science learning. From the group of nearly 20 experienced upper elementary and middle school science teachers came these suggestions, many of which were methods of assessment used by our project teachers: multiple-choice test (teacher-made and publisher-made), fill-in-the-blank test, problem solving, Ames productions/predictions, Foss-Gems: Scientific Method, graphing data & drawing conclusions, hands-on performance tests (using learning center stations, ) required science projects, Science Olympiad, student demonstrations, poster/art displays, essays, peer monitoring/cooperative groupings, formal laboratory reports, learning logs or journals, concept maps, oral/videotaped presentations, rubrics, process skills checklist.

The "Twin Tandem Science Initiative: A Celebration of Diversity" Eisenhower inservice project resulted in improved science teaching and learning among students and teachers, K-8, in northwest Indiana. Multiple assessment documentation provided evidence that such learning did, indeed, occur, throughout the project outreach area. Our project illustrates the importance of committment to serving diverse student populations.

Such service demands good will and effective cooperation between collegiate and K-12 instructors and administrators, with support and guidance from state and national governmental agencies. While on the one hand, we recognize the great need for improvements in science teaching and learning, K-8, we emphasize and endorse the value of teacher-prepared multiple assessment measures, as the most effective route to equitable and realistic evaluation of science learning.

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