Web-based Curricular Innovations with Diverse Learners: Stories from a University/School Partnership

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As professional educators continue to work to improve student learning, partnerships within the school and the larger community are becoming a means to facilitate reformed-based changes in science education. In this article, we describe a partnership between a local university and a suburban school district that worked to implement technology-integrated classroom practices to promote learning within a diverse student environment. In this collaboration, two university faculty members, a science educator/researcher and a special education educator/researcher, partnered with a classroom biology teacher and a special education teacher who co-instructed in an inclusive ninth grade biology classroom. This collaborative endeavor followed a modified-partnership model presented in the Center for Education of the National Research Council report, *Educating Teachers of Science, Mathematics, and Technolog*y (2001). In this partnership model (see Figure 1), science and special education educator/researchers and classroom teachers work as essential partners to enhance inclusive science teacher education and to promote effective learning strategies. The partnership activities were informed by (1) educational research, (2) recommendations from national organizations involved with enhancing teaching and learning, and (3) data gathered from curricular implementations by the partnership itself.

Need for the Partnership

The classroom instructional partners co-teach a mix of lower-level learners and students identified with learning disabilities in an inclusive biology classroom setting. Prior to the partnership, computer use by the biology teacher was limited and mainly consisted of information-seeking activities on the Internet by students. The special education teacher had used interactive educational software with her students and had prior experiences using Power Point presentations that contained links to available Web resources.

Both teachers were aware that the World Wide Web provides various instructional resource types to enhance student science learning. These resources include: scientific visualizations, simulations, animations, video clips, and still images. The teachers believed that incorporating such instructional resources combined with effective instruction would assist student learning. However, the school team was frustrated in their attempts to incorporate technology within their instruction. Locating suitable instructional materials was a time consuming endeavor. In addition, they often experienced technical problems with their computers and network connections in the school computer lab.

Despite this frustration, or because of it, the biology teacher accepted an invitation to participate in a National Science Foundation sponsored evaluation workshop of a new Web-integrated biology curriculum at a local university. This new curriculum was designed to promote biology literacy, consistent with the *National Science Education Standards (National Research Council*, 1996*)*, using a learning cycle (*engage, explore, explain, evaluate*). The curricular materials consisted of a short concepts-oriented textbook, an extensive Website, and inquiry-based laboratory activities and experiments.

The classroom teachers were interested in using the curricular materials with a goal to improve the integration of instructional technology within their instruction. The university educators/researchers interests included learning about contextual factors pertaining to the successful implementation of these materials in inclusive classroom settings. In addition, the educators/researchers were updating their knowledge in this area to better prepare the preservice science and special education teachers in their university methods courses. Therefore, a partnership was established to benefit the goals of both groups of educators.

Partnership Implementation

During a period of six weeks, the university educator/researchers observed two inclusion biology classes as participant observers. During class and lab activities, the educator/researchers would question students individually and in small groups to determine how they were learning with the classroom activities. After class, the educator/researchers would recommend pedagogical changes that could be implemented in future lessons and activities.

Many of the conversations among the partners included how to restructure the physical learning environment and how to customize the curricular materials to better accommodate the learning needs of their students. Additional guided prelab questions and activities were developed to provide learners with additional supports to help guide their thinking about the processes that would be occurring in the laboratory. Partnership discussions resulted in new sequencing of instruction and implementing new instructional practices that enhanced existing inclusive science classroom practices.

Assessing Inquiry Skills

Prior to the partnership, the teachers did not use inquiry-based laboratories with their inclusive classroom students. Often the laboratories that were used with these students were highly structured, material-centered verification type activities. During the partnership, students participated in a guided research laboratory. The inquiry-based activity was a weeklong laboratory, much longer than the usual laboratory implemented for the level of these students. This investigation was a two-part laboratory in which learners are provided with two questions to investigate: *How fast does photosynthesis occur? How can an organism's photosynthesis be measured?* In the first part of the investigation, students were provided with a detailed laboratory protocol and procedures for data collection and analysis. The "Conclusions" section of the laboratory prompted learners to formulate their own questions to be investigated in the second part of the laboratory. Learners then designed and implemented a new experiment based on the protocol of the initial laboratory. The results were presented in a laboratory report that was assessed through use of a rubric (see Figure 2).

Web-based animations in the online prelab materials illustrated how to utilize the tools for the laboratory. The integration of these visualizations in the prelab procedures provided students with additional confidence as they followed the written directions. Through a repetitive process of reviewing an experimental protocol, seeing the use of equipment in a Web-based visualization, and developing experimental protocols for their own investigations, the students became more confident in their use of laboratory equipment and investigative processes.

Student assessment of inquiry processes included the use of the laboratory report rubric by the classroom teachers and informal student interviews conducted by the educator/researchers. The analysis of the laboratory report rubrics and interview data indicated that most of the students understood the investigative processes and the fundamentals of the content. In addition, the inclusion students were able to successfully complete an inquiry-based investigation.

Technology Implementation

The university educator/researchers provided specific technology implementation suggestions to the classroom teachers. They provided the teachers with vocabulary necessary to communicate properly with the school's technology office. One of the most important recommendations was to use an LCD projector in the teachers' classroom instead of having students use computers individually in a computer lab setting. The science teacher, who had limited experience with computers as a tool in the classroom, was encouraged by the educator/researchers to use an LCD projector in a one-computer classroom setting to deliver direct instruction. Upon implementation of this recommendation student attention and participation increased during the class. The educator/researchers noted an increase in the students' time on-task from 42% when working on individual computers in a computer lab to 88% when the teacher used the LCD projector in her own classroom. With the more frequent use of the one-computer setting, the teacher's confidence increased; thus, obtaining one of the goals of the partnership.

During the partnership implementation, student content knowledge increased significantly on biology content assessments. This improvement in test scores provided credible evidence for the classroom instructional team to petition their school district administration to purchase an LCD projector and interactive whiteboard for classroom use in the forthcoming school year. This research-supported evidence was a key factor to assist administrators in making technology-purchasing decisions.

Inclusive Science Practice

The educator/researchers provided validation for many of the techniques the teachers had developed during their careers. They noted the importance of assessing student background knowledge and prerequisite skills. Students in the inclusive biology classroom struggled with content and activities when they did not have sufficient background knowledge to complete a particular task (Kame'enui & Simmons, 1990, 1998). For example, students inaccurately calculated results for their chromatography lab because they did not have proficiency with prerequisite measurement skills.

The classroom teachers used explicit instruction to facilitate inquiry learning. Teachers directly modeled and demonstrated how to think about biology content and how to think through steps in laboratory experiments. Students were consistently involved in a variety of academic tasks: students took notes, completed guided-note sheets, engaged in conversations about biology content during small group activities with peers, used Web-based activities, and participated in laboratory experiments. The students demonstrated increased understanding of the content and became progressively more independent with inquiry-based applications as learning shifted from teacher-directed to student-directed.

Advantages of the Partnership

From the classroom teachers' perspective, having additional sets of eyes during the learning activities provided an increased comfort level for the classroom teacher. An inclusion biology classroom consists of diverse learners both motivated and unmotivated. In addition, ninth graders, as a group, have difficulty adjusting to the curricular content that is demanded of high school age learners. The university educator/researchers, both clinical supervisors of instruction, focused their observations on the learners' engagement. The feedback that was provided assisted the classroom teachers with thinking about applying new pedagogical practices and implementing additional curricular customizations.

From the perspective of the university educator/researchers, new insights were gained to help train preservice science educators and special education teachers for future work in inclusive science classroom settings. These insights included: provisions for collaborative planning between special education teachers and science teachers; the importance of curricular customizations to existing materials; additional supports to access content for science instruction; use of inquiry supports to assist student learning; and diverse instructional delivery systems to meet the needs of inclusive science classroom learners.

New Pedagogy-Roadblocks

Successful experienced, classroom teachers frequently do not have the time nor inclination to explore new tested pedagogical techniques. Three major factors contribute to this lack of interest in learning new pedagogical approaches: time, energy, and risk. Time is needed to find, explore, learn and practice new techniques. When attempting to incorporate new techniques into an existing teaching style, teachers use more energy compared to using the style with which they are comfortable. The extra attention needed when using a new methodology is added to the usual teacher concerns about student involvement and content delivery during the class. Another factor is the risk to a teacher's professional reputation. To successful teachers, the risk of failing in an attempt at new pedagogy can be a threat to their self-confidence.

New Pedagogy-Reducing the Roadblocks

Becoming part of a partnership reduces some of the anxieties caused by the factors listed above. Our partnership presented the opportunity to implement well-designed Web-based instructional materials without requiring the classroom teacher to expend time to locate science visualizations and interactive resources. Some time was needed to customize the existing materials to accommodate the needs of an inclusive classroom. However, the educator/researchers offered suggestions that directed successful customizations. The energy needed to incorporate the curricular materials into the classroom was reduced since the educator/researchers shared their knowledge of pedagogical approaches. The fear of failure was buffered by the educator/researchers' support of the good pedagogical practices already a part of the teachers' classroom strategies. This encouragement provided positive feedback to assist teachers in overcoming difficulties they experienced. Finally, the school administration was supportive of the partnership. They knew the teachers were exploring new curricular materials and practices to benefit their students.

Conclusion

Partnerships, as described in this article, can provide a way for classroom teachers to participate in ongoing informal professional development as they explore new pedagogical approaches in a supportive climate. Classroom teachers experience enhanced professionalism as new content, new pedagogies, and new resources are shared in a collaborative endeavor. The real benefit accrues to the students. The classroom students in this partnership were provided with the opportunity to participate in an inquiry-based scientific investigation and improved their content knowledge. In addition, they had the opportunity to use Web-based materials that helped motivate them to learn.

The National Research Council and National Institute for Science Education are encouraging partnerships as the most effective way to bring about improvement in science education in K-12 institutions. With opportunities for partnerships available, the most important recommendation to a science teacher is get involved in a partnership as soon as possible.

Notes

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Figure 1. Partnership model.

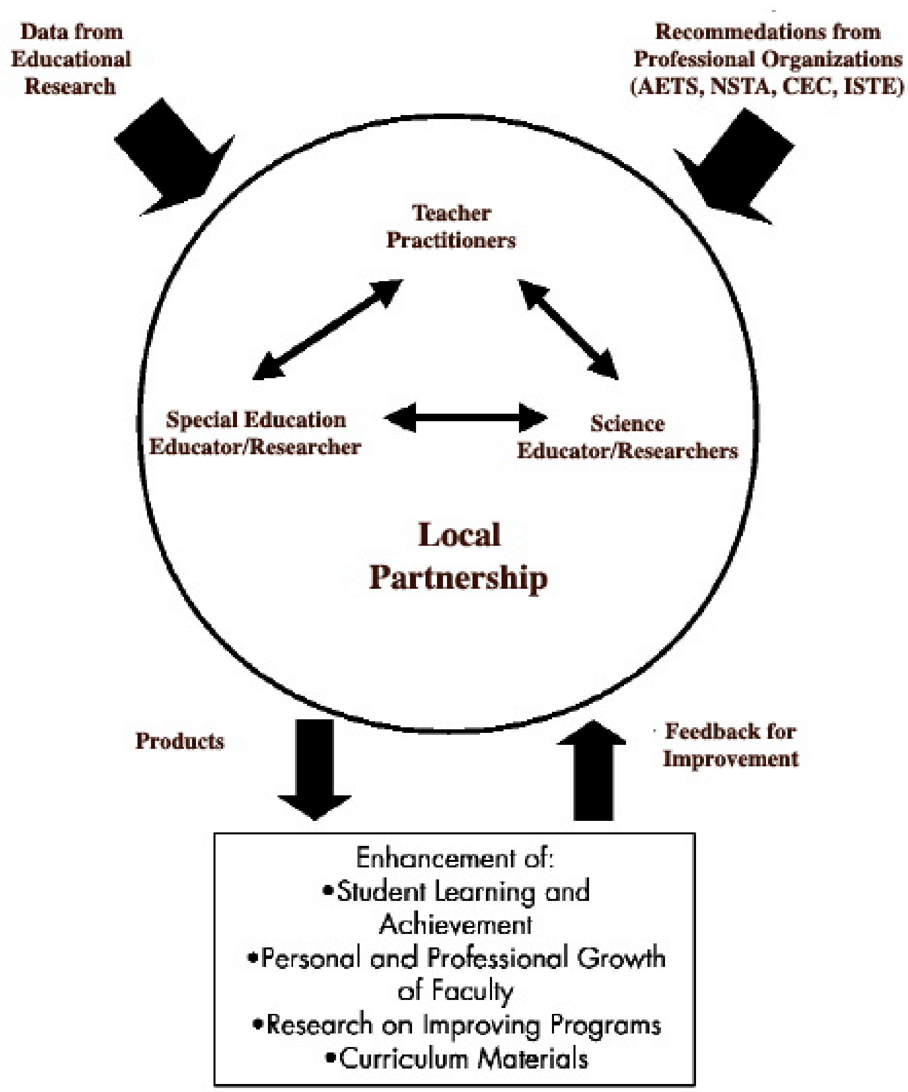

Figure 2. Laboratory Rubric

(modified from a rubric used by the Olathe East High School Science Department, Olathe, KS)

Standards: The levels at which students are expected to perform the task

Score		Advanced (5)	Proficient (3)	Needs Improvement (1)
______	***Question***	• Question is narrowly focused and suggests how an answer might be investigated. It is answerable.	• Question is answerable but not narrowly focused.	• Question is too broad and not practically investigated.
______	***Identification of Variables***	• Correctly identifies specific, measurable independent and dependent variables.	• Identifies variable being tested & variable being measured.	• Variables and constants significantly incomplete &/or inaccurate.
______	***Hypothesis***	• Hypothesis is testable and clearly stated in “If… then…” format. Specifically predicts relationship between dependent and independent variables.	• Hypothesis is clearly stated. It predicts the influence of one variable on another.	• Hypothesis is poorly stated and doesn’t directly mention the variables.
______	***Materials***	• Complete, detailed list of materials (size, conc., quantity) presented in vertical list format.	• Most materials are listed and appropriate.	• Materials quite incomplete or inappropriate for experiment.
______	***Procedure***	• Accurately tests the hypothesis	• Attempts to test hypothesis	• Does not address hypothesis.
______		• Conducts or analyzes at least 3 trials.	• Multiple trials attempted or need is recognized.	• Single trial, poor understanding of use of multiple trials.
______		• Procedure is in vertical list format, accurate, complete, easy-to-follow, and reproducible by another person. Includes diagrams to clarify procedures.	• Step-by-step procedure, generally complete. Minor errors/ omissions make it difficult to follow or not always repeatable.	• Procedure difficult to follow. Major omissions or errors.
______		• Includes all appropriate safety concerns.	• Includes critical safety concerns.	• Safety concerns trivial or inadequately addressed.
______	***Data Collection & Presentation***	• Data table contains accurate, precise raw data & summary data reported in correct SI units with descriptive title.	• Data table with accurate data, most units labeled or implied. Minor errors. Title absent or trivial.	• Data table inaccurate, confusing, and/or incomplete. Missing units.
______		• Data summarized in well-organized, easy-to-read graph &/or figures. Descriptive title, appropriate labeling, keys, etc.	• Data displayed in well organized easy to read graph &/or figures. Descriptive title, minor errors in use of units and labeling.	• Graph/figures presented in a confusing and/or sloppy fashion.
______		• Data summarized in a clear, concise, logical manner. Patterns identified & described, but no conclusions drawn.	• Reasonable, but somewhat unclear summary of data. Patterns in data not clearly identified.	• Summary is unclear and illogical. Patterns in data not identified.
______	***Conclusion***	• Scientifically valid, logical conclusion, well supported by the data collected. Clearly addresses problem and stated hypothesis.	• Scientifically valid, logical conclusion, supported by data collected. Attempts to address problem and stated hypothesis.	• Conclusion is incomplete or illogical. Does not address the problem and hypothesis.
______		• Sources of error identified and explained. Appropriate recommendations made to eliminate errors.	• Sources of error identified.	• Weak/trivial attempt to identify sources of error.
______		• Student generates specific questions for future study.	• Student makes attempt to generate questions for future study.	• Student makes incomplete or inappropriate attempt to extend or apply knowledge.