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ABSTRACT

This digest, part of the Spotlight on Student Success series, outlines the implications of new national science standards for the preparation of science teachers. This Spotlight on Student Success describes changes in teacher education students' conceptions of science, teaching, and learning as they participate in a K-8 science methods course at an eastern urban university that utilizes principles derived from national reform initiatives. The course, conducted in 1996 during the spring semester with 35 teacher education students, focused on the role of teachers as decision makers in promoting scientific literacy for all students. The overall goal of the course was to familiarize teacher education students with reform initiatives in science education and their role as change agents in the reform. During the course, students learned to apply the principles of national reform initiatives in designing, implementing, and evaluating curriculum, instruction, and assessment. The course had four phases that addressed the following topics: (1) confronting and challenging teacher candidates' conceptions of science and science teaching; (2) applying the principles reflected in the national reform initiatives in developing science lessons; (3) evaluating science resources and instructional programs; and (4) sharing with teachers the process of reform. Among the outcomes of the program were: although the teacher education students had varying conceptions of science, the majority revealed that their conception of science is directly influenced by their conception of effective science instruction; students articulated an intellectual understanding of the process of constructing knowledge, but expressed a difference in how to facilitate knowledge construction; and the principles reflected in the national reform initiatives were viewed by teacher candidates as being beneficial but very time consuming. (MM)

What the Science Standards Say: Implications for Teacher Education. Spotlight on Student Success.

Penny L. Hammrich

LSS Spotlight on Student Success

A digest of research from the Laboratory for Student Success No. 208

What the Science Standards Say:
Implications for Teacher Education

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THE SCIENCE STANDARDS MOVEMENT

Teacher educators are constantly searching for the best models of instruction to help teacher education students become effective teachers. While there is little disagreement among teacher educators about the need for reform, the same cannot be said about the specific modes suggested to achieve this reform. One commonly agreed upon theme for reform in science education is the active involvement of learners in the teaching and learning process.

Because of the importance of promoting systemic reform, many professional science associations have recently developed national science standards for grades K-12: the National Science Education Standards ([1]National Research Council, 1996) and Project 2061: Benchmarks for Science Literacy ([2]American Association for the Advancement of Science, 1993). Although developed by two separate groups, both share the same goal—the development of a nation of scientifically literate citizens.

The national movement has trickled down to state and local boards of education with the development of state and local science curriculum standards. Schools, colleges, and departments of education across the country are incorporating the curriculum standards into their science methods courses.

The standards movement has specific implications for the preparation of science teachers. It provides a map for teacher development of curricula with improved content, teaching methods, and assessment, as well as a guide for institutions of higher education to refine programs for learning science through inquiry. The national reform initiatives also provide a framework to support the goal of lifelong learning by addressing teachers' conceptions about science, teaching, and learning. By successfully incorporating science standards into science methods courses, teacher educators help teacher education students to better understand science and the teaching of science.

This *Spotlight on Student Success* describes changes in teacher education students' conceptions of science, teaching, and learning as they participate in a K-8 science methods course at an Eastern urban university that utilizes principles derived from national reform initiatives. The course, conducted in 1996 during the spring semester with 35 teacher education students, focused on the role of teachers as decision makers in promoting scientific literacy for all students. The overall goal of the course was to familiarize teacher education students with reform initiatives in science education and their role as change agents in the reform.

During the course, students learned to apply the principles of national reform initiatives in designing, implementing, and evaluating curriculum, instruction, and assessment. The course had four phases that addressed the following topics: (a) confronting and challenging teacher candidates' conceptions of science and science teaching; (b) applying the principles reflected in the national reform initiatives in developing science lessons; (c) evaluating science resources and instructional programs; and (d) sharing with teachers the process of reform. These four phases are briefly described below.

PHASE ONE: CONFRONT AND CHALLENGE

The purpose of the first phase of the course was to enhance teacher education students' knowledge and understanding of national reform initiatives in science education and to challenge their conceptions of science and science teaching. Students engaged in a series of activities designed to confront and challenge their conceptions of the nature of science; explore their world views and how they impact the understanding of science; expose them to the notion of conceptual change; and familiarize them with the content and pedagogy implicit in the science reform initiatives.

PHASE TWO: APPLICATION

In the second phase of the course, the students applied the principles of the national reform initiatives by designing curriculum, instruction, and assessment. They analyzed model lessons that showed how effective science instruction establishes connections across grade levels and subject areas. The students made curriculum and assessment decisions by drawing on knowledge and experiences from the earlier phase. The application phase enabled the students to experience and share in shaping their conceptions of science, teaching, and learning.

PHASE THREE: EVALUATION

In phase three of the course, students applied the principles of the national reform initiatives to evaluate instructional resources and programs. They analyzed and reviewed curriculum packages and materials, assessing the match between the content and pedagogy of the materials with those of the benchmarks.

PHASE FOUR: SHARING

In phase four, students taught lessons they designed utilizing the recommended principles reflected in the national reform initiatives. They spent four weeks, one class period a week, teaching lessons to fourth-grade students in two elementary schools. The teacher education students met with the classroom teachers before they presented their lessons and discussed with the teachers which content and process benchmarks they identified for the lesson.

OUTCOMES

Fifteen of the 35 students participating in the course were interviewed to determine their conceptions of science, knowledge construction, and the principles implied in the national reform initiatives. The interviews were designed to elucidate students' beliefs concerning science and how science should be taught. The following are key outcomes.

- Although the teacher education students had varying conceptions of science, the majority revealed that their conception of science is directly influenced by their conception of effective science instruction. They were accepting of examining and even embracing new conceptions of science, but they clung to their prior conception of science when pressed with uncertainty in a teaching situation.

- Students articulated an intellectual understanding of the process of constructing knowledge, but expressed a difference in how to facilitate knowledge construction. Some said that individuals construct their own understanding while others stated that teachers are responsible for an individual's construction of knowledge.

- The principles reflected in the national reform initiatives are viewed by teacher candidates as being beneficial but very time consuming. Students indicated that while they recognize the necessity of aligning curriculum to match the content and pedagogy implied by the national reform initiatives, they feel that the time needed to conduct such a process may outweigh the benefits.

CONCLUSIONS

The call for systemic reform presents a great challenge to teacher educators in facilitating teacher education students' conceptions of science and what it means to teach science effectively. Students' conceptions of teaching science are guided by their conceptions of science. In order for teacher candidates to model practices of teaching and learning as outlined by the national reform initiatives, they need to participate in activities that cause reflection and apply the standards to lessons that they can or will use. First, students need to confront their conceptions of science and scientific thinking. Second, they must be familiar with the pedagogical philosophy addressed in the standards that reflects current research in science education. Third, they must be familiar with the content of the standards. Finally, students need the opportunity to work with the standards either through analysis of existing curricula or development of their own lessons and curriculum. Only in doing so will students gain a new and better understanding of science and effective science instruction.

As teacher educators strive to embed the recommendations of the science reform initiatives into their methods courses, they must actively involve teacher education students in the process of reform. The implementation of science reform initiatives must have a reciprocal relationship with teacher education students' conceptions and actions because the students will be the future agents of reform in the classrooms of tomorrow. How reform should be implemented into a methods course must be informed by teacher candidates' conceptions of science and science teaching. Likewise, students need to be informed by the reform recommendations.

Reforming science teaching at the school level requires reforming teacher education first. Unless prospective teachers experience reformed science teaching, it is unrealistic to expect change. Simply telling teachers what pedagogical changes are desired is unlikely to have any effect. If students are to be taught in a way that helps them construct their own knowledge, then teachers need to learn science in the same manner. Teacher educators cannot continue to

teach undergraduate science by providing brief, unrelated exposure to pedagogy in a methods course and expect prospective teachers to teach differently. Science courses for prospective teachers need reforming before effective, long-term changes in classroom teaching are systemic. Using the framework of the national reform initiatives is both necessary and essential in demonstrating the importance of promoting scientific literacy for both our students and teachers.

REFERENCES

[2]American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy*. New York: Oxford University Press.

[1]National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Spotlight on Student Success is an occasional series of articles highlighting findings from the Laboratory for Student Success (LSS) that have significant implications for improving the academic success of students in the mid-Atlantic region. For more information on LSS and other LSS publications, contact the Laboratory for Student Success, 9th Floor, Ritter Annex, 13th Street and Cecil B. Moore Avenue, Philadelphia, PA, 19122; telephone: (800) 892-5550; E-mail: <LSS@vm.temple.edu>.

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