

A Community of Practice among educators, researchers and scientists for improving science teaching in Southern Mexico

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Abstract

This paper presents findings of a project aimed to improve the quality of science education in Southeast Mexico by the creation of a community of practice among scientists, researchers and teachers, involved in the design, implementation and evaluation of a professional development program for mathematics, chemistry, biology and physics secondary school teachers. Based on the results from an assessment of teacher competencies, a professional development program was designed and implemented for improving the preparation of science educators from public secondary schools. The program involved a collaborative effort from chemists and physicists from the Center for Advanced Research of the Politécnico Nacional, biologists, mathematicians and educational researchers from a public university, and personnel from the State Department of Education.

Antecedents

One of the main indicators of the capacity of a nation for competing in the global market is the performance of its students in mathematics and sciences. The growing interdependence of the markets are demanding a labor force with solid preparation in mathematics, language and communications, as well as more creative and flexible students, capable to work with others (Castro, Carnoy & Wolf, 2000).

In the case of Mexico, the interest for improving the quality of science teaching was a consequence of the needs detected in the Third International Mathematics and Science Study (Peack, 1996; Peacock, 2000, Wang, 2003) conducted by the International Association for Student Assessment in 1993. In that study, Mexican students of elementary and secondary schools obtained lower achievement scores in mathematics and sciences when compared with their peers of 40 other countries. In average, Mexican students were 100 points below the world mean. Among all, secondary students were the ones that obtained the lowest scores (Peack, 1996).

Given this situation, Mexico began to make stronger efforts for improving the quality of science education and for reducing student dropout in this area. The National Program of Education (2001-2006), states policies aimed to improve student achievement in science such as, the review of curriculum contents, articulation between levels of education, the use of teaching strategies that favor the application of knowledge and problem solving. In addition, the government through a new National Institute for Assessment in Education began to evaluate school performance and conduct a follow-up of their advance, create accountability policies, and provide support for teacher professional development (National Program of Education, 2001-2006).

However, there is limited research about the benefits of government policies, particularly in the context of schools in which the reform has been implemented. Among the few preliminary studies in this area, there is the study of Cisneros-Cohernour, López, Canto y Alonzo (2005). This study examined the conditions for

science education in secondary schools, the challenges faced by different stakeholders, and the possible alternatives for improving the quality of teaching in the Southeast of Mexico. According to the results, secondary schools faced problems in four main areas:

- (a) Curriculum content and design. (Problems of curriculum coverage, sequence and design, limited resources for supporting the curriculum, lack of appropriate transition between educational levels)
- (b) Assessment of student learning (Assessment procedures do not match the constructivist approach promoted by the educational reform of 1993, problems with the new grading scale)
- (c) Student and family related factors (Increased divorce rates of parents related to problems in student behavior and discipline, drug addictions, teen-age pregnancy, alcoholism. In addition, lack of student prerequisite knowledge, critical thinking skills, and need for a better relationship between home-school).
- (d) Teacher professional development (Most science teachers are hired on an hourly-basis and had limited opportunities of professional development. The best professional development activities were not available for these teachers, who lacked knowledge of the course content, teaching abilities, and skills for teaching teenagers.) Findings of the study also indicated the need for teachers to be involved in the design, implementation and assessment of professional development activities.

Professional development was selected by the researchers as the focus of this study because of its impact on student learning as well as the interest of the State Department of Education in this area.

Objectives or purposes

This paper presents the findings of a project aimed to improve the quality of science education in Southeast Mexico by the creation of a community of practice among scientists, researchers and educators, involved in the design, implementation and evaluation of a professional development program for secondary school teachers of mathematics, chemistry, biology and physics in Yucatan.

Perspective(s) or theoretical framework

This project uses the framework of Communities of Practice developed by Lave & Wenger (1991). This framework is being used in the development, implementation and evaluation of a professional development program for promoting innovation and improvement on science teaching among public secondary school science teachers in southern Mexico. Communities of practice are groups of people who share goals and common interests. They work with the same tools and express a common language. Through their common activities they share beliefs and values systems (Hammon-Kaarreemaa, 2002). This theoretical framework was selected because it promotes a constructivist approach for learning among community members and favors participation and active learning among teachers.

In virtue that the results of prior studies conducted in the Southeast of Mexico indicate that science teachers work less than four hours daily in each school and have to work in three or four schools to support themselves, it is essential to develop a model that is sensitive to the characteristics of these teachers and their working conditions, in order to involve them in professional development activities. The framework of communities of

practice is consistent with the needs of the instructors and has demonstrated to be effective in the creation and development of communities among health professionals (Lathlean & Le May, 2000), administrators (Plaskoff, Lilly y otros, 2003) and among researchers (Somekh & Pearson, 2002). During the creation of the community of practice teachers, researchers and scientists have been involved in (a) determining common aims and needs of professional development; (b) identifying human capital for accomplishing the goals, (c) determining the nature and importance of the relationships among the teachers in the community and with the authorities of the Department of Education, parents, and other stakeholders in the teaching and learning process; (d) determining the relationships between the work of the community and the value of its activities.

Methods, techniques, or modes of inquiry

The project involves five stages. In the first stage an assessment was conducted to determine the characteristics of teacher population and interest for participating in a community of practice. The second stage involved the assessment of teacher needs and interests for professional development. This assessment involved both secondary schools teachers and students of a sample of 37 schools in Yucatan. The findings of the needs assessment were to be used in the design, implementation and evaluation of professional development program aimed to promote teacher innovation, improve teacher's knowledge content as well as teaching skills. The third stage involved the design of the professional development program according to perceived needs and expectations of the community of teachers, scientists and researchers. The fourth stage involved the implementation of the program, followed by the fifth stage that included program evaluation and dissemination of evaluation results.

Data collection included multiple methods of inquiry, such as observations, surveys, document analysis, open ended interviews and focus groups. The use of multiple methods of data collection is one of the strengths of the study because it contributes to a deeper understanding of the issues and provides an opportunity for triangulation.

Results and/or conclusions/point of view

First, researcher involved main stakeholders to assess the possibility of building the community of practice. After involving main stakeholders, the researchers conducted an assessment of teacher competencies about knowledge content and teaching skills. Findings of this assessment indicate that:

- There is a gender balance among instructors, 50% are women and 50% are males
- Most teachers have more than 20 years of teaching experience. Only 5.3% has between 36 and 45 years of teaching experience.
- 83 % of the instructors have a bachelor degree, only 17% have a master degree.
- 74.5% of the instructors work in more than one school. The majority of these instructors work as teachers in their second job (91.4%), although some are administrators (8.5%).
- According to the findings teachers indicated to need more preparation on innovative teaching strategies for teaching science (74.5%); development of teaching materials (67%), and learning how to work with other instructors in the design of strategies for improving their teaching (45.7%).
- Instructors indicated less interest in receiving preparation on research competencies (27.7%), and being involved in the design of strategies for continuing education and reflective practice (22.3%).

- In addition, the assessment found that all teachers need to be prepared in all content areas included in the school curriculum for mathematics, physics, chemistry and biology. The topics in which most teachers indicated they need preparation and information are the following:

Physics	Chemistry
<ul style="list-style-type: none"> • Knowledge about the structure of the matter (75%) • Electricity and magnetism (66 %) • Measurement and experimentation (66.7%) • Systematic observation (66.7%) • Newton Laws (76-8%) • Energy (76-9%) • Force, area and pressure of fluids (84.5%) • Electric interaction (76.7%) • Electromagnetic radiation (76.9%) 	<ul style="list-style-type: none"> • Atoms and molecules (68.8%) • Reactions and decomposition (62.5%) • Atomic weight (62.5%) • Synthesis reactions (62.5%) • Acidity (88.9%) • Products from Petroleum (88.9%)
Biology	Mathematics
<ul style="list-style-type: none"> • Nucleus and cell division (53.8%) • Heritage Laws (75%) • Growth, puberty, conception (53.8%) • Sexually transmitted diseases (53.8%) • Chromosomes and genes (54%) • Human genetics (55%) 	<ul style="list-style-type: none"> • Construction of models (72.7%) • Negative and positive numbers (63.6%) • Operations and use of parenthesis in arithmetic (63.6%) • Probability (55%) • Tree diagrams (63.7%) • Functions (78%) • Simulations and schema of Bernulli (78%)

As the former study conducted by Cisneros et al (2005), shows that teachers needed preparation in content knowledge, teaching skills and how to educate adolescents. It was also found that the professional development program was a perceived need for all teachers who wanted to be involved in its planning, development and evaluation.

In addition, a survey to 5000 secondary school students at the participant schools indicated that students perceive science courses as complex and difficult (30%). They also feel science instructors do not know how to teach science (50%), they are not patient and understanding of student needs (14%). In addition, students indicated that one of the factors that affect science teaching is other students who do not pay attention during classes and distract others from learning (30%). Moreover, schools lack science materials and laboratories (12%)

Based on the findings, researchers worked in the design of a professional development program taking into consideration teacher needs and interests. The development of the program involved scientists from the Center for Advanced Studies of the Politécnico Nacional, and another university research center, authorities from the State Department of Education, researchers of the college of Education from the main public university in the Southeast of Mexico, and secondary school teachers. The

professional development program used inquiry based teaching and resulted in all participants modifying their classroom planning and materials for teaching science. At this stage, the program has been completed and it is in the process of being evaluated. In addition, the researchers are preparing a conference for teaching innovation in science in which the instructors will share with other instructors their learning experiences and newly acquired skills.

Educational or scientific importance of the study.

The study is providing needed professional development to secondary school science educators in the southeast of Mexico. As a result of the project, instructors will improve their knowledge and skills, the sharing of experience with other teachers and with exemplary teachers of science, as well as the creation of a community of science educators. The study also contributes to teacher development by implementing an innovative program designed to address teacher needs as identified in the need assessment process. By involving instructors in the design, implementation and evaluation of the program, there is a higher possibility that they will use in their practice their new designed materials and acquired skills.

By using the framework of communities of Practice (Wenger, 1998), a framework from Organizational Learning in the development of the professional development program and its evaluation, the study constitutes an innovation since the limited use of this framework in educational settings, particularly in Latin America.

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