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CHAPTER 3

THE EVOLUTION OF AN INTERDISCIPLINARY COLLABORATIVE FOR PRE-SERVICE TEACHER REFORM

Research Informs Practice

Abstract. The Arizona Collaborative for Excellence in Preparation of Teachers is a large National Science Foundation funded project aimed at revising science and mathematics pre-service courses at a large public university in the South-western United States. This chapter describes the collaborations of a community of university faculty in reforming a block of five pre-service mathematics and mathematics education courses. Through a series of workshops and ongoing dialogue, both the instructional delivery and curriculum for these pre-service courses has shifted to student-centred classrooms with inquiry, concept development and problem solving as central themes. The chapter provides information about the process and products of these reforms, with a major focus on providing specific insights into the role of research in guiding the curricular and instructional philosophies and decisions.

INTRODUCTION

The 1996 TIMSS results revealed major deficiencies in US students in the area of mathematics. In a 1996 National Research Centre report, it was stated that US teachers' instructional practices are as splintered and fragmented as the curricula that shape them. Calls have been made to rethink the experiences of pre-service teachers (Ball, 1991), and investigate the complex interaction between teachers' knowledge of the content, their beliefs and their actions in the classroom (Cooney and Wilson, 1993). The Shaping the Future Document (1996) of the National Science Foundation calls for a re-evaluation of the pre-service experience for teachers. As a result of these calls, this collaborative has undertaken a multi-year effort to improve the pre-service mathematics curriculum and instructional methods for a block of five pre-service courses, two for pre-service elementary and three for pre-service secondary. A thematic emphasis on developing classrooms that promote students' analytical abilities, content knowledge and problem solving processes was established as early goals for the curricular changes, with past research and ongoing evaluations shaping the products of the reforms.

The Arizona Collaborative for the Preparation of Teachers (ACEPT) has affected more than 20 university level courses for pre-service mathematics and science teachers. The focus of this chapter, however, is on the mathematics and science

collaborations and their influence on the revision of the five pre-service mathematics courses taught in the Department of Mathematics.

The reform of each course was initiated by a two-month summer workshop involving approximately 20 faculty working collaboratively to develop new curricular materials for a particular course. During the workshop faculty were initially involved in reading and discussing the research literature and working collectively to understand and define the process of acquiring an understanding of major conceptual strands of K-12 mathematics. This was followed by faculty working in teams to develop curricular modules aimed at developing pre-service teachers' mathematical understandings and problem solving effectiveness. Faculty leaders supported less experienced teaching faculty in making pedagogical shifts from a strict lecture format to student-centred courses integrating technology, group projects and co-operative learning.

The patterns of collaboration have been similar for each course. Small communities of (3-5) faculty were involved in the process of: learning, defining, creating, evaluating and refining. Initial workshops were designed by faculty leaders with primary goals to improve the teaching faculty's knowledge of students' concept development and to prepare them to develop curricular activities for their students. This was achieved by collectively reading relevant research literature and consulting with local and national experts with experience teaching and developing curriculum for the course. Intense negotiations among faculty preceded the definition of the content focus and instructional approach for each course. After identifying the course's central ideas, the research literature was again reviewed to gain information about the complexities involved in acquiring these concepts. Curricular modules were created and evaluation instruments were developed, with their development involving pairs of faculty working collaboratively over a period of five weeks.

Pre- and post-test evaluations of students' mathematical behaviours, beliefs and conceptual understandings were also developed, with the results used to revise curricula and instructional approaches. This process of development, re-evaluation and revision was repeated for the collection of courses in this collaborative. The work of this collaborative has evolved over a period of nearly five years with core individuals remaining fairly stable over this time period.

Early co-operation among the project's approximately 25 mathematics and science faculty included the identification of common interdisciplinary content strands and processes. Workshops involving select mathematics and science faculty moved beyond a focus on goal setting, to more intense and extended collaborations aimed at creating integrated interdisciplinary curricular activities. The process of creating this curriculum resulted in the emergence of a common awareness of the major concepts of mathematics that could be further developed in the context of scientific exploration, and a broader base of relevant science applications for motivating important mathematical concepts. These collaborative activities were relatively brief, as they took place only during the initial two-weeks of the workshop. Once the workshop concluded, further discussions between mathematics and science faculty reverted to one of co-operation, with periodic meetings held to exchange relevant information to benefit individual efforts (Hord, 1986).

EVOLUTION OF A PRE-SERVICE COLLABORATIVE

This chapter details the early collaborations between mathematics and science faculty. The workshop format and activities that facilitated the curricular reforms for the pre-service elementary mathematics content course are described. This is followed by a description of the planning and workshops that produced conceptually based modules for the pre-service secondary methods courses. A description of the pre-service geometry course, and its related teaching experiment are detailed. An overview of various aspects of the evaluation team's efforts is followed by a detailed description of the process of orienting one faculty member to the philosophies, curricula and methodologies of this collaborative.

SCIENCE AND MATHEMATICS FACULTY COOPERATE IN CURRICULUM DEVELOPMENT

One of the major goals of the ACEPT collaborative was to promote interdisciplinary collaborations, with summer workshops used as the initial vehicle for achieving this goal. The first workshop involved the science and mathematics faculty in joint explorations of the processes of scientific investigations and major concepts and methods of mathematics. Invited presenters and local experts led discussions and activities that required the faculty participants to confront their views about issues such as content focus and technology use. These introductory sessions were followed by science and mathematics faculty working together to develop interdisciplinary projects. The daunting task of negotiating every design decision created numerous tensions and revelations, with early discussions revealing the barriers presented by our different uses of language and notation. However, our commitment to gain a better understanding of each other's content focus and methods motivated our continued efforts to better understand the obstacles that divided us. With this increased understanding, questions emerged regarding how our students were managing their concurrent enrolment in a sequence of mathematics and science courses that frequently made use of, and reference to, the same ideas (e.g., functions) in very different ways. The tension was expressed by one mathematics faculty revealing, "I don't understand how the scientists can spend so much time building a model to predict some future event, but fail to use the mathematics to explore some of the interesting behaviours of the model. Why aren't the scientists interested in probing their students about the subtle behaviours that are conveyed by the concavity and inflection points? Do scientists only use models to predict future behaviour?" As well, scientists frequently expressed questions regarding why mathematics faculty chose to engage students in solving problems with no apparent connections to the real world (e.g. understanding why the Pythagorean theorem is true). Other issues with notation and convention disparity were more easily sorted out, with the negotiations causing each faculty to emerge with a new appreciation of the complexities encountered by students as they concurrently enrol in science and mathematics.

Following the two-week workshop, the participants worked in small groups, meeting regularly for about a month, to develop a science and mathematics integrated project. This project involved selecting and preparing tasks ranging from

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Examples from the Context of Mathematics Education

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