THE IMPACT ON TEACHER SELF-EFFICACY OF A MISCONCEPTIONS-BASED APPROACH TO TEACHING SCIENCE METHODS

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Introduction

Current reform in both teacher education and science education has focused on the need for improvement of preservice teacher training (APA, 1993; Blosser, 1989; Silversten, 1993). In particular, the improvement of preservice elementary teachers has been shown to be the cornerstone on which the sustained reform of classroom instruction becomes a reality (Raizen, 1994). Unfortunately, preservice elementary teachers often pose a significant challenge when addressing the issue of science teaching. It is particularly apparent that this group of teachers generally has a high level of discomfort toward the content of science and very little confidence (self-efficacy) toward the teaching of science.

Considerable research has shown the apparent linkages between teacher self-efficacy, teacher performance and student achievement (Ashton, 1984; Gabel, 1977). The most important of these linkages are in the findings that the higher the level of teacher self-efficacy the greater the accomplishments of students in these teachers classrooms (Bandura, 1982; Ashton, 1984). The challenge is to determine how we can build on this research base to begin to develop the self-efficacy of preservice elementary teachers in science.

Self-efficacy theory provides us with perhaps the strongest indicators of subsequent classroom behaviors. This linkage is critical in the reform process in which theory is bridged to practice leading to increased student performance. Previous research has consistently shown that the cognitive mechanism of perceived self-efficacy has influenced the teachers' judgment as to their ability in performing the task at hand. Moreover, these studies have shown an indication that self-efficacy can be enhanced in the individual (Ashton, 1983; Evans & Tribble, 1986). If this is the case, enhanced self-efficacy should be manifest in the preservice teachers behaviors, attitudes and abilities toward the teaching of science.

The impact on methodology courses on preservice teacher self-efficacy has been examined previously and notes a correlation between the type of methodology advocated for in the course and teacher self-efficacy (Gorrell & Capron, 1990). However, this impact was studied under the experimental conditions of "learning to teach". The impact of an increase in teacher self-efficacy in the classroom setting should be based on the preservice teacher's choice of activities to be included as well their understanding of the role of these activities in student learning.

Method of Study

Perhaps the most significant role that research in science education can play in the improvement of instruction is to focus greater attention on student understanding of the topic being presented. By focusing on the student, successful teaching may likely depend as much on how the material is taught as on what is taught. The teachers' confidence in teaching can then

be developed by attempting to insure that the curriculum that they develop is matched to the needs of the students and couched in research on the learning and teaching of the topic presented. Meaningful learning, which connotes the ability to interpret and use knowledge in situations different from those in which it was initially acquired, requires that students be intellectually active.

Development of a functional understanding cannot take place unless students themselves go through the reasoning involved in the development and application of concepts. Moreover, to be able to transfer reasoning skills learned in one context to another, students need multiple opportunities to use that same skill in different contexts. The entire process requires time. Inevitably, this constraint places a limit on both the breadth of material that can be covered and the pace at which instruction can progress. However, unless we design instruction to meet the needs and abilities of students, our efforts will produce little of either intellectual or motivational value.

The SUNY Fredonia teacher education program is organized around two central features, the process of responsive instruction and the Four Pillars of Understanding. Responsive Instruction implies that four key stages take place during instruction: Planning; Instructing; Reflecting; and Responding. These stages, taken together, represent a recursive process that all effective professionals engage in when providing best teaching practice. When this process is informed and shaped by ongoing measures of learner performance, it provides the basis for the validation and self-correction of one's teaching practice. Such adaptation requires teacher candidates to adopt an improvement-oriented approach to inquiry in which they use information on student progress as the basis for professional reflection, adaptation, and self-correction in their own teaching.

To attempt to accomplish this the preservice teachers in this study were trained in the context of a misconceptions-based approach to the teaching of elementary science. The focus of this methodology course was the intersection between the science content being presented and the research-based understanding of children's understanding of the topic. This focus was carried throughout each of sessions leading the preservice teachers to the application of this process in their student teaching experience. The capstone experience for this course was the Teaching Participation project. During this experience, the preservice teachers were able to develop a working knowledge of the application of this approach in the classroom setting.

The Teaching Participation project began with the preservice teachers investigating children's understanding of a particular science idea or an aspect of scientific inquiry in the classroom they would be student teaching in. The preservice teachers then identified the ideas the children had and investigated the development and evolution of these ideas. Sources of data for this portion of the project included the student's written work, comments made by the student during class discussions or in small group activities, and the student's comments, behaviors, or diagrams constructed during interviews that the preservice teacher had designed.

Based on their findings, the preservice teacher then constructed a plan of written and/or interview questions that helped them assess the children's developing understanding of the concept they were teaching. The results of these questions were then used to develop a mini-unit addressing the misconceptions revealed through the questions. This mini-unit consisted of 3 to 4 lessons directly focused on challenges the students' misconceptions. At the completion of the mini-unit the methods students administered a posttest evaluation they have constructed to measure the change in the occurrence of the misconceptions identified on the part of students.

At the completion of the Teaching Participation project, the preservice teachers were asked to reflect on their experiences in developing their unit of instruction. This reflection paper focused on:

- A brief summarizing description of the experience from their personal point of view
- An analysis of the students' responses to the posttest question(s)
- An evaluation of their curriculum, including suggestions for curriculum revisions based on the post-test results and their experiences working with the students
- Their thoughts regarding pedagogical issues that may have emerged as a result of the experience

Design of Evaluation of Self-Efficacy

In order to measure the effectiveness of the misconceptions-based approach to teaching science, data on preservice teachers' self-efficacy toward teaching science was collected through the use of The Science Teacher Efficacy Belief Inventory (STEBI) Form B (Enochs & Riggs, 1990). This instrument identifies two separate constructs as defined by Bandura's theory of self-efficacy. A science teaching outcome scale (STOS) and a personal science teaching efficacy scale (PSTE). Respondents were asked to indicate their level of agreement with each of 23 Likert scale survey items. The level of validity of this instrument was established by the authors and reaffirmed by subsequent researchers. Finally, the reflective responses of the preservice teachers' at the completion of the Teaching Participation project were used to cross-reference the results of the STEBI-B.

Subjects

The study included a section of undergraduate elementary preservice teachers (n=24) in the Professional Year Program at the State University of New York at Fredonia. The 24 paired pretests and posttests of the STEBI- Form B were analyzed for significance in mean score gains using a pared t-test. The treatment consisted of an eight-week, two day per week, two and one half hour per session program in which the teachers undertook a misconceptions-based approach to teaching elementary science. The end of the course culminated in the Teaching Participation project. The responses based on the preservice teachers' reflection on the methods course were analyzed using comparative analysis techniques.

Results/Conclusions

Results of the paired t tests yielded a t value of 10.78 which is significant at p>.001. The mean gain score between the pretest and posttest score was +12.33. Furthermore, analysis along the two subcategories of self-efficacy also yielded statistically significant results at the p>.001 level. The results for self-efficacy along the three comparisons (Total STEBI score, PSTE and STOE) are shown in Table 1.

Table 1

		pretest			posttest				
Measure	n	Mean		SD	mean		SD	t	p
PSTE	24	39.62		3.98	46.92		3.27	7.41	<.001
STOS	24	34.29		3.69	39.33		2.81	5.77	<.001
TOTAL	24	73.92		4.91	86.25		3.72	10.78	<.001

Results indicate that the use of the misconceptions-based approach to teaching elementary science had a significant impact on the preservice teachers self-efficacy. The study shows that the science teaching self-efficacy was positively impacted by taking a student centered focus and by allowing the preservice teachers to apply their learning in a classroom context. Preservice teachers were afforded the opportunity to first explore their own learning in the context of the methods classroom; investigate the thought processes of students in the context of the elementary science classroom; and finally, integrate these two experiences to inform their curricular design decisions.

Implications

The implication for teacher educators is that the specific affective dimension of self-efficacy can be enhanced by use of this reflective practice. The use of the misconceptions-based model can provide the factors identified by Bandura as sources of information regarding self-efficacy. By allowing the preservice teacher to develop their own understanding of science through the "lens" of misconceptions, the preservice teacher is able to set aside some of the apprehension they have felt toward the teaching of science. The majority of these preservice teachers entered the methods class viewing the teaching of science as negative, but they left the course viewing their future as science teachers in a very positive light. Many of these preservice teachers reflected on the Teaching Participation Project as an indication that they would in fact be successful in the teaching of science because they were allowed to view science through the eyes of those who "saw it differently".

To insure the validity of the claims made in this paper, this study needs to be expanded to encompass a larger population. If when expanded, these results hold true, the technique of focusing on a student centered, misconceptions-based approach to teaching science may impact on the future professional development of preservice and inservice teachers alike.

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