DOCUMENT RESUME

ED 418 871 SE 061 350

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TITLE	The Nature and Assessment of Teaching Competency in Apprentice Science Teachers.
PUB DATE	1998-04-19
NOTE	22p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (71st, San Diego, CA, April 19-22, 1998).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Beginning Teachers; Constructivism (Learning); Elementary Secondary Education; Evaluation Methods; Foreign Countries; Higher Education; Knowledge Base for Teaching; *Preservice Teacher Education; Science Instruction; *Science Teachers; *Teacher Certification; *Teacher Evaluation
IDENTIFIERS	Taiwan

ABSTRACT

In an effort to develop a contextually-based evaluation of teacher competence, a three-year study was undertaken that focused on the classroom practices of beginning science teachers and beginning science teachers' perceptions and reflections of the teacher competence evaluation. Data related to instructional skills and changes in the growth of instructional skills was analyzed and suggests that beginning teachers transmit content knowledge to students. Only in a few cases were the teachers observed using the most appropriate instructional practices. Results of the study suggest that assessments of teacher competence from beginning teachers should be systematically collected and used for establishing the validity of any teacher evaluation instrument. (Contains 29 references.) (Author/DDR)

The Nature and Assessment of Teaching Competency in Apprentice Science Teachers

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Paper Presented at the Annual Meeting of the National Association for Research in Science Teaching

San Diego,CA

April, 1998

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In an effort to develop a contextually-based evaluation of teacher competence within a three year study, the purpose of first year focused on the: (1) classroom practices of beginning science teachers, and (2) beginning science teachers' perceptions and reflections of the teacher competence evaluation instrument. One apprentice teacher, who graduated from the department of physics at a university located in the central part of Taiwan in 1995, was invited to participate in this study. Data related to instructional skills and changes/ growth of instructional skills were collected and subsequently analyzed. Two additional beginning science teachers were selected to allow comparisons and to develop a thorough understanding of what beginning teachers actually do and think in different contexts and classroom cultures. The progress of learning to teach during the first year can be interpreted as constructivist growth. Beginning teachers tended to transmit content knowledge to students. Only in a very few cases were the beginning teachers observed using the most appropriate instructional practices. Assessments of teacher competence from beginning teachers should be systematically collected and used for establishing the validity of any teacher evaluation instrument. In addition, more practice in the preparation and organization of instructional activities are needed in preservice teacher education programs.

Keywords: Certification, Apprentice teachers, Science Instruction, Teacher education

The Nature and Assessment of Teaching Competency in Apprentice Science Teachers

Introduction

The education system of Taiwan has changed drastically during the past 10 years. One of the biggest changes was the popularity of teacher education programs within universities throughout Taiwan. The bureaucracy of teacher education has been in disarray since 1994. Prior to 1994 only graduates of normal universities/colleges could become teachers. Currently, any university/ college can have its own teacher education program, if it is accredited. Therefore, it is critical that evaluation approaches be developed for teacher candidates who have completed a minimum of 26 credits hours in education, science education, and practicum experiences. In accordance with the new laws governing teacher certification, the Division of Science Education, National Science Council of Taiwan has funded eight integrated research projects (37 sub-projects) focused on the study of teacher preparation programs and teacher evaluation across both science and mathematics. The study described in this paper is one of the 37 sub-projects.

The influence of constructivism (Tobin, 1993) and pedagogical content knowledge (Cochran, deRuiter, & King, 1993; Shulman, 1986, 1987) have been clearly noticeable in science teacher education programs and practice during the past decade. On reflection, however, the teacher education programs in Taiwan have primarily used didactic/lecture (Stofflet, 1994) methods to enhance or improve preservice teachers' instructional skills and knowledge. The preservice teachers do not have much opportunity to learn or even observe alternative instructional approaches besides the lecturing used by professors in the classroom. In this case, the practice of instructional skills or reconstruction of

knowledge are often delayed until the preservice teacher enters his/her first year of teaching. Learning about teaching and experiences based in the context of teaching, for preservice teachers, are often out of phase. On the other hand, most preservice teachers may have prepared the "front stage behaviors" of teaching, but not backstage behaviors of teaching (Rust, 1994).

The professional development of beginning science teachers has regained attention in the past years. Standards for professional development for science teachers were reported recently by the National Research Council (1996). Further, many research studies have been conducted which emphasize the professional growth of beginning teachers, such as Appleton and Asoko (1996), Gunstone, Slattery, Baird, and Northfield (1993), Lederman, Gess-Newsome, and Latz (1993), Loughran (1992), Schmidt and Knowles (1995). The knowledge, nature, and progress of beginning teachers were systematically investigated and discussed by these studies. The results and discussions could be used as a referent for the reform of teacher education systems in another society. Geddis (1993) concluded that the task of learning to teach becomes an inquiry into subject matter content and its teachability. In fact, in order to help students understand science, beginning science teachers should reconceptualize what they have learned from university science courses. Clermont, Borko, and Krajcik (1994) have examined the pedagogical content knowledge of experienced and novice chemical demonstrators. They suggested that the experienced chemical demonstrators possess a greater representational and adaptation repertoire for teaching fundamental concepts in chemistry than novices.

In order to assess beginning science teachers with both formative and summative techniques, a teacher competence evaluation instrument was used in this study. Sixty items were grouped into seven categories: (1) planning for instruction, (2) establishing classroom climate conducive to learning, (3)

implementing instructional plans, (4) instructional skills, (5) knowledge of subject matter, (6) evaluating pupil achievement, (7) interpersonal relationships and professional conduct. These categories were derived from the teacher education portfolios of Oregon State University. Fewer categories, however, are currently included in the Oregon State University assessment program (Lederman, 1997 May). In addition, teacher evaluations should be valid, reliable and sensitive to particular teaching contexts (McKenna, Nevo, Stuffbeam & Thomas, 1994). The characteristics of CASE (Certification and Accreditation in Science Education) standards described by Gilbert(1997, May) are also concerned with the development of a teacher competence evaluation system. Therefore, beginning science teachers' perceptions and reflections upon the teacher competence system should be systematically analyzed and interpreted for the revision and development of teacher competency evaluation.

New reforms for the education and certification of science teachers in Taiwan may help to alleviate many of the well-documented problems of classroom practice and teacher education. All beginning teachers will be required to complete a one-year apprenticeship program (under the guidance of an expert teacher/mentor) before they become formally certified as a science teacher. It is during this apprenticeship that beginning teachers will be expected to apply and improve upon the knowledge that they have gained during their teacher preparation programs. Upon completion of this apprenticeship, beginning teachers will be required to document, in three ways (cooperative teacher and school, university supervisor, and performance of participating intern workshops), successful performance of those skills necessary to become a fully certified science teacher. Although a paper-and-pencil test is not included in the certification and assessment system at this stage, it remains important to develop a systematic teacher competency evaluation instrument to assess

beginning science teachers' performance and facilitate their professional growth. Given the large variation in beginning teachers' ability to demonstrate instructional skills in the current Taiwanese system, it is believed that this requirement will considerably elevate the motivation of preservice and apprentice science teachers to develop those instructional skills necessary to promote student learning.

The purpose of this 3-year study was to establish a model that could be used to facilitate the professional growth of beginning science teachers and to develop an instrument to assess beginning science teachers' instructional competencies. However, the major focus of the first year of this study was on the following two areas of interest: (1)classroom practices of beginning science teachers, and (2) beginning science teachers' perceptions and reflections of the teacher competence system. The result of this study will provide contextual data of beginning teachers thoughts and actions.

Method

One apprentice teacher, who graduated from the department of physics at National Changhua University of Education in 1995, was invited to participate in this study. This apprentice teacher was expected to plan and present an instructional activity during the study. The instructional activity was observed (and videotaped) by the researcher/research assistant and oral feedback was often provided after the class. Data related to instructional skills and any changes/growth of instructional skills for the apprentice teacher were subsequently analyzed. Further, two additional science teachers were selected to participate in the investigation to allow the researcher to make comparisons and to develop a thorough understanding of what beginning teachers actually do

and think in different contexts and classroom cultures. The method of peripheral sampling was recommended by Miles and Huberman (1994).

An interpretative research method was used to collect and analyze data in this study. Triangulation was used to validate the data which were gathered from multiple sources. Classroom observations, interviews, and questionnaires were major sources of data. Further, a systematic assessment of the apprentice teachers' science competence was performed during and upon completion of the full year apprenticeship. Upon completion of student teaching, the apprentice teachers were interviewed by the researcher using an instrument consisting of seven categories with 60 items. This procedure allowed three participating teachers to perform self-evaluations and reflect on their teaching context. The result of this procedure was used to validate the teacher competence instrument.

Results and Discussion

The results of this study indicated that the beginning teachers tended to learn how to teach in actual classroom settings, in the same manner that McNiff (1995) posited teaching as learning. The progress of learning to teach for the apprentice teachers during the first year can be interpreted as constructivist growth (Geddis, 1993; Keiny, 1994). For the initial implementation of teaching plans, the teachers may not understand, in depth, the underlying theory, however, they proceeded on what they thought and planned about teaching. Then, they reflected on what they actually did in the classroom and adjusted according to students' responses and their personal perceptions about the classes. The development of instructional skills was commonly observed. Consequently, understanding of the nature of teaching and

learning was enriched through practical experiences. During one interview with the researcher, the participant teacher stated the following:

> For the first semester, I spent most of time lecturing. I added lots of ideas, problem sets to the textbook. However, students didn't feel interested in learning science. Therefore, I started thinking about using an alternative teaching strategy, i.e. cooperative learning. I found that students' engagement significantly improved.

Mr. Lin taught in a rural school. Most of his students (approximately 75%) had already lost interest in school. Therefore, he needed to think how to successfully complete his first year of teaching. Therefore, he kept reflecting on his teaching and tried to revise instruction to students' needs. His growth in teaching could be described as a developmental, constructivist (Keiny, 1994) learner. On the other hand, he was just beginning to practice constructivist teaching. A beginning teacher once arranged to teach a science lesson in front of his colleagues. The unit he taught was force and motion. After a brief introduction of force, he asked:

> When you put clothing on a hanger and hang it on a coat rack, what is the direction of the force that is exerted by the coat rack on the hanger? Is it upward or downward? Why ?

Immediately one student raised his hand and answered: "Downward". Mr. Lin then said :

You will earn two points for your answer.

I couldn't agree with what Mr. Lin did because the student's answer was incorrect. I discussed this with him after class. He explained that he awarded the student credit for expressing his idea in the classroom. It is good to encourage students to actively contribute to classroom discussion, but it would perhaps be better to clarify the student's reasoning first and then decide how much extra credit could be given.

Insert Figure 1 about here

Wildy and Wallace (1995) have pointed out that a teacher may not fit the mold of a constructivist teacher, but he/she may still be meeting the needs of students in his/her class. A belief in constructivism, however, is influential to the development of the beginning science teacher. With respect to learning about students, classroom atmosphere, school context, reflection on classroom events, and how a teacher should be evaluated, constructivist views (Guba & Lincoln, 1994)are quite appropriate.

Beginning teachers tended to transmit content knowledge to students. Only in a very few cases were the beginning teachers observed providing junior high students with appropriate examples and activities. It was observed once in the classroom that Mr. Lin addressed the question of why a ship could float in the ocean while a cube of steel would sink. It was anticipated that most students wouldn't know the answer. Mr. Lin tried to help the students

understand why the cube of steel would sink in water, but after his explanation, it was still unclear to the students. However, Mr. Lin was able to convince students that if the ship was crushed it would sink, since it became more dense.

Another day Mr. Lin asked two students to stand in front of the class to demonstrate an action-reaction force pair. One student represented a rocket and the other represented the exhaust gas. The two students were told to stand face to face and stretch their arms out horizontally. Then, by using their palms to quickly push off each other, it was found that, as a result of the push, both of them went backward a little in opposite directions. The classroom was instantly filled with expression of surprise. It could be concluded that for most students, it is more effective to help them to visualize phenomena than to make them memorize theory.

Insert Figure 2 about here

In addition, Mr. Lin was assigned to teach a low achievement class. Most students in this class were afraid of abstract thinking. They also hated to listen to lectures, especially when memorizing formulas and calculations were strategies to motivate students' learning. Mr. Lin did find out it was effective to allow students to learn science in a laboratory activity environment. He discovered that arranging students in cooperative learning groups during laboratory work was beneficial to students' engagement and would lessen classroom management problems. Further, he found that students' ability was much better than what he often perceived by interacting with students in

laboratory situations. Mr. Lin shared his experiences with the researcher as follows:

> During laboratory sessions students often asked if they could try something in a different way. After asking them to think about why they wanted to try it that way, he often responded by allowing them to do it the way they wished . Consequently, students were encouraged to inquire and to learn very interesting things. For example, one student put a magnet under a sheet of paper to make a pattern of iron filings around the magnetic field lines. This is different from the traditional way of making the pattern of a magnetic field. Usually, a magnet is held over the paper to produce a magnetic field.

He further stated that several students could think about and solve problems in different ways. Other students were busy in manipulating materials. In a word, the implementation of laboratory activities allowed the teacher to discover students' interests, potentiality and broaden his perspectives of teaching.

On the other hand, owing to lack of experiences of representing science knowledge in an appropriate way, apprentice teachers tended to spend a lot of time thinking how to start a new lesson. They thought it was very important to motivate students' interest in learning science. However, it was difficult to collect and organize many efficient activities to attract students' attention and learning for each lesson.

Three beginning teachers often discussed among themselves or with their supervisor ways to start new lessons in a motivating way. In fact, the integration of subject matter knowledge and pedagogical knowledge was thought

to be difficult for the beginning teachers (Clermont et al., 1994; Geddis, 1993). In addition, it may be a good idea to organize an induction team consisting of cooperating teacher, colleagues, and beginning teachers who teach at the same school. The scheduled meetings will allow teachers to learn from each other. Then, beginning teachers can more effectively learn how to prepare lessons, implement materials, and other instruction methods/strategies. In order to enhance beginning science teachers' ability to represent science subject matter, more practice in the preparation and organization of instructional activities are needed in preservice teacher education programs.

Further, time use and concern for classroom management were also a continuing burden for apprentice teachers. Inappropriate behavior has become an educational, even social, and political problem in Taiwan. Since a strictly competitive examination for entering senior high school still exists, the state wide textbook is used around the island. Unfortunately, students' variations in ability and interests are not considered. Therefore, there is a high percentage of students who have lost their interest in learning and school. Then, they became low academic achievers. Finally, these students can cause a serious management problems.

For the apprentice teachers' self-evaluation using the teacher competence evaluation instrument, it was found that beginning science teachers could describe their teaching with contextual understanding and interpretation. In other words, even though each item of the evaluation instrument seems to have a broadly descriptive statement, the apprentice teachers responded with concrete, specific, personal perceptions of their teaching. Further, for the implementation of inquiry teaching, these apprentice teachers admitted that they rarely teach in that way. There were two major reasons hindering beginning teachers from using inquiry approaches. They said:

> There should have been some basic skills and knowledge for junior high students to learn science in a inquiry-based environment. But, to my understanding very few students have these experiences in their previous years of schooling. Further, the noisy level, and safety concerns should be taken into account before making decision to conduct inquiry oriented teaching. Above all, the principal doesn't want to see a classroom in apparent disorder.

This situation confirmed Costenson and Lawson's views (1986). In addition, the teachers' understanding of the nature of inquiry were weak. It is important to provide preservice teachers an opportunity to do scientific investigations. However, relating their experiences in scientific investigations a discussion of the nature of scientific knowledge and development of science knowledge development is of critical importance (Abrams &Wandersee, 1995; Bleicher, 1996; Lederman, 1996 April). In order to provide students with the opportunity to understand the nature of scientific inquiry and inquiry experiences, all preservice teachers at National Changhua University of Education need to take six credits of independent study that emphasizes science research project.

Three beginning teachers also noted it was a good idea to use alternative or authentic assessments to evaluate students' achievement. However, three beginning teachers commented on one item categorized in the evaluation pupil achievement: "Selects and uses tests, observation, pupil interviews, and other formal and informal assessment procedures to determine the extent to which each pupil has achieved the objectives of the lesson and/or unit of lesson." They thought:

> It may take a long time to deal with more than 40 students in one classroom by using performance-based assessments or oral examinations. Further, it is very difficult to determine each student's achievement level by using alternative assessment. But, paper-and-pencil tests can provide you with exact scores. Then, you don't need to feel uncomfortable about the calculation of students grades.

The major reason why beginning teachers chose paper-and-pencil tests was convenience, concreteness, and easiness in grading. Especially, after having had lots of experience in taking examinations, quizzes, and tests, to give students paper-and-pencil tests is much easier than alternative approaches. Since a strictly competitive entrance examination for senior high school still exists, teachers tend to use almost all class time teaching students how to answer the questions or familiarize them with question types which might appear on the entrance examination. It is obvious that the traditional method and types of assessment (Doran, Lawrenz, & Helgeson, 1994) were used most of time to assess students' performance. Even beginning teachers thought this is inhumane for most students, they still believe that in order to allow more students to pass entrance examinations, more practice in calculations and solving pseudo real-world problems is indispensable.

The comments and experiences of the three beginning teachers for the items of category "in implementing instructional plans" were as follows: The three teachers didn't use different instructional techniques to achieve planned objectives. They didn't even use overhead projectors during the year because of the inadequacy or inconvenience. However, they used video film pictures to show students about scientists or some other interesting pictures which were thought to be helpful for students' learning. But, it was uncommon to allow students to have discussions after viewing vedios. Therefore, the value of

relating the videos to subject-matter was decreased. On the other hand, the three teachers agreed that promoting students' critical thinking and problem solving ability were very important. However, they didn't know how to promote these outcomes. These teachers may know which way is most appropriate for students' learning, but they didn't address these issues instructionally because of their feelings of unfamiliarity with new techniques, and their perceptions of the school culture. So, it is very common that there exists a conflict between knowing and the practice of science teaching for apprentice teachers. Overall, the result of interviews provides contextual understanding of each item in the evaluation instrument. The interview approach was quite helpful in the validation of the teacher competence evaluation instrument. The integration between what experts think beginning teachers should know and be able to do and beginning teachers really could know and be able to do are necessary to construct a teacher evaluation instrument.

The Implication of Teacher Education

As previously mentioned, teacher has changed significantly in Taiwan during the past two years. Therefore, the findings and conclusions related to beginning teachers' development and assessment of competencies have similarities with what has been found throughout other countries. However, this researcher has been attempting to explore the unique aspects of Taiwanese teacher education. It is believed that those findings related to beginning teachers' perceptions of classroom management and the focus of science teaching will be similar to elsewhere, while views of teaching, roles, responsibilities, social tradition, and the methods of teaching will exhibit distinct differences. It was found that apprentice teachers act as active learners under the guidance of

university supervisors or cooperative teachers. It has been found that a beginning teacher tends to use same way of teaching that his junior high teacher used. However, for an inquiry-based use of a new instructional strategy, a beginning teacher should start learning because (s)he should explore the way to succeed. This process will allow him (her) to prepare, act and reflect on his teaching. Finally, (s)he put (her)-himself in a learning environment. Therefore, there it is critically important to ask beginning teachers to try methods different than what they have experienced traditionally. A similar situation may have occurred to the ancient Chinese. Those Chinese may not speak English well when they first moved to America, but they should learn how to speak English if they expect to survive.

On the other hand, it is commonly believed that most undergraduate science majors in Taiwan can teach physical science well. It means that these preservice teachers learned science content well enough to be a junior high teacher. But, these undergraduates rarely have an inquiry-based learning experience. Consequently, they were easily taught science algorithmically at the moment of becoming beginning teachers.

Unfortunately, for the novice teachers, they were often assigned to teach in low ability classes. These students didn't have any interest in learning science. But, beginning teachers didn't know how to adjust and use alternative methods to motivate students. Therefore, teaching and learning were compromised.

Further, a systematic observation and systematic evaluation of apprentice teachers' growth should provide an empirical base to establish a teacher competence evaluation instrument. On the other hand, for the evaluation of the currently proposed apprenticeship program to be valid, it is recommended that the assessment instruments be consistent with the goals

and components of the teacher preparation program. Of particular interest, in this study, was that the assessment instrument for teaching competence was consistent with the empirical literature and the various aspects of the teacher preparation program related to science instruction. Furthermore, it was of critical importance that the new teacher preparation program carefully considered the roles and responsibilities of administrators, university supervisors, and prospective teachers in the continued professional development of the apprentice teacher.

Maskill and Selles (1995) concluded that the mentors' role as evaluators often interfered with their support role. Consequently, it was often noted that beginning teachers did not reveal, to the university supervisors, all that occurred in the classroom. Further, they did not discuss difficult problems until they were asked or something happened out of their control. Therefore, it is important that university supervisors should show support and appreciation to beginning teachers while they describe their classroom practice.

In order to promote the effectiveness of the preservice teacher education program, a conceptual reconstruction of the preservice teacher education program is also needed. Adams and Krockover (1997) pointed out that the affects of preservice teacher education programs on beginning teachers should be further investigated.

In order to fit to different purposes and uses of assessing beginning teachers' competence in different contexts, the items/categories of teacher competence evaluation instruments should also be different. For example, the summative evaluation instrument should be different from a formative one. If the assessment of specific instructional strategies such as inquiry is taken, the evaluation items should focus on this instructional approach. Naturally, these items should be different from assessing a class lecture.

It should be remembered that the major tasks of the second year of this research study were to validate the teacher competence evaluation instrument by collecting the comments of science researchers/educators around Taiwan. Further, both quantitative and qualitative data should be gathered from more beginning teachers to understand how these teachers recognize, interpret and reflect on the instrument categories and items. These procedures are critically important to the development of the teacher competence instrument.

Acknowledgments

This study was sponsored by a grant from the National Science Council, R.O.C. (NSC 84-2511-S-018-029). In addition, I'm truly grateful to Professor Norman Lederman for his editing and comments.

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