

# CAN BE THE PRESERVICE SCIENCE TEACHER A RESEARCHER?

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## Abstract

*In this theoretical research an impersonal style should be used the status of teacher research in science education, examine the advantages of science teacher research, and consider possibilities for the role of science teacher research. In literature teacher research or teacher action research was mentioned only briefly as a part of qualitative research or science teacher education. This lack of attention to science teacher research might reflect the relatively late entry of science teachers into the teacher research movement. Teacher research is an effective model for teacher learning and development. Teacher researchers can make valuable contributions to the knowledge base for science teaching. Teacher researchers step outside their own assumptions and preconceptions and maintain a healthy skepticism about their observations of themselves and their students. One semester action research project was implemented in observing teaching practice course at the preservice science teachers training at Faculty of Science Palacky University in Olomouc. Students during this semester observed science lessons in upper secondary schools. They analyzed pedagogical events that happened in the class. They also developed a research-base rational paper describing how they will teach science. During this semester students examined one aspect of this rationale in an action research project carried out in collaboration with the host teacher. Science teacher research can contribute to the development of prospective science teachers and the development of a knowledge base for science teaching and learning. This is a particularly interesting moment in time to examine the contributions and potentials of science teacher research.*

**Key words:** science education, preservice science teacher training, science teacher research, development of preservice science teachers, action research, preservice science teacher as a research.

## Introduction

There continues to be a gap between research knowledge and science teaching practice. Preservice science teachers and science teachers might help close this gap. Advocates of action research claim that action research can lead to practice and that through action research the theory-practice gap can be bridged (Carr, Kemmis, 1986). For example, although the traditional university-based research community has built a large body of knowledge about students' ways of thinking about specific science topics and phenomena, there is still much to be learned about how to best utilize that knowledge in teaching. This is one example of a type of research that teachers are uniquely situated to explore.

In order to understand what is possible in terms of student learning, the science education community can benefit from teachers' investigations into their attempts to give students' ideas a prominent role in teaching about specific content ideas and phenomena. In this way, preservice science teachers research can play an important role in contributing to the knowledge base in science education and in making links between the worlds of practice and research.

Recently we can find the growing interest in teacher research although there are not so many studies about this research (Fraser, Tobin, 1998). This lack of attention to science teacher research might reflect the relatively late entry of science teachers into the teacher research

movement. Teacher research, which dates back to the late nineteenth and early twentieth centuries, initially investigated teaching and schooling in ways that cut across disciplinary boundaries, rather than with specific subject matter lenses. The re-mergence of the teacher research movement in 1980s, however was spearheaded by teacher inquiry groups focused on the literacy curriculum, especially in the area of writing (Atwel, 1987; Bissex, Bullock 1987;

Myers 1985; Wells, 1994). More recently the teacher research movement has gained momentum in other subject matter areas, including science.

### Definition of Teacher Research

Teacher research, in its many forms, shares with other forms of research a goal of understanding educational practice. However, teacher research is distinct from other forms of educational research in its emphasis on “changing practice as a result of study and changing practice to better understand it” (Zeichner, Noffke, 2001, p. 306). This emphasis on change and improvement of practice plays out in different ways in different forms of teacher research, with teacher entering into teacher research for a variety of purposes – to know more about how students learn, to understand a particular aspect of one’s teaching practice, to improve a particular aspect of one’s teaching, to try out a new teaching approach, to become a more reflective practitioner, to document successful teaching approaches, and so forth (Fischer, 1996, Zeichner, 1993).

Teacher research is defined using the definition provided by Cochran-Smith and Lytle (1993, 1999). They defined teacher research in the broadest possible sense to encompass all forms of practitioner inquiry that involve “systematic, intentional inquiry by teachers about their own school and classroom work” (Cochran-Smith and Lytle 1993, pp. 23-24). Included in this definition are inquiries that are referred to as action research, practitioner inquiry, teacher inquiry, first person research, and so forth. This is consistent with Stenhouse’s (1975) definition of research as systematic critical inquiry made public. Teacher research comes in many forms, but all forms focus on issues of teaching practice. Teacher research is distinguished from other forms of research in the deliberate fusing of the work of teaching and the work of inquiry (Ball, 2000): “What most clearly distinguishes first-person inquiry from other approaches to the study of teaching and learning is that deliberately uses the position of teacher to ground questions, structure analysis, and represent interpretation” (Ball 2000, p. 365). Reflective practice is most closely tied to the ongoing work of teaching and does not require any special plan or design. The goal is to heighten awareness and deliberation about teaching (Abel, Bryan, 1997; Erickson, Mac Kinnon, 1991; Grimmett, Erickson, 1988; Schon, 1983, 1988). To be considered as teacher research by Cochran-Smith and Lytle (1993) definition, reflective practice must have some intentional element. Teacher narratives written after a process of reflection on teaching represent teacher research where the intentional element arose after the teaching act.

Action research is more planned and, as its name suggests, has traditionally had a goal of improving practice (Carr, Kemmis 1986; Loucks-Horsley et al, 2003; Reason, 2001). Prospective teachers identify a problem of practice that they want to understand and address, develop a method to study the problem, collect data to inform the problem, and analyze the data to generate ideas for improving practice. The learning from the research is documented and shared. In some settings, action research is seen as a cycle, with results informing changes in practice and the generation of new questions to investigate. However, in practice, action research studies are often carried out as stand-alone studies, using a more linear set of steps from questions to results (Zeichner, Noffke, 2001). Most proponents of action research encourage a collaborative process in order to help individual practitioners develop inquiry and reflection skills (Miller, 1990; Reason, Bradbury, 2002).

Teacher research emerged as distinct from action research in the 1980, and, according to

Zeichner and Noffke (2001), teacher research differs from action research in at least four ways. First, teacher research does not have the action emphasis of action research; understanding practice and documenting knowledge held by expert teachers are valid goals of teacher research that do not necessitate change in practice. Second, teacher research incorporates more qualitative methods that was typical of action research prior to the 1980s. Thus, teacher research includes case studies and conceptual research, such as teacher essays (Cochran-Smith and Lytle, 1993; Gallas, 1995, 1997). Third, and reflective of the qualitative research methodology, a teacher researcher's questions, change and evolve during the inquiry process. Thus, the path from questions to data interpretations is not as linear and prescribed as in traditional action research projects. And, finally, the teacher research movement included a new focus on the value of teacher-generated knowledge as having unique contributions to make to the field of educational research because of its insider status (Cochran-Smith and Lytle, 1993). Thus, teacher research is as much about empowering teachers and making teacher voices a part of knowledge generation efforts as it is about teacher professional development and improving the practice of individual teacher researchers.

Teacher research takes place in the university setting as well as in schools. Two variants of teacher research carried out by university faculty have had a significant impact on the way educational research is defined in academia. The first is what Ball (2000) names "research teacher". In this form of teacher research, university-based academics trained in research conduct research on their own teaching in school settings. University professors also engage in research on their university-level teaching. Such self-study research has been growing in acceptance as a valid form of scholarship, especially among teacher educators, at colleges and universities.

### **Preservice Programs and Science Teacher Learning**

In 1996, Pekarek et al. stated that the idea of teachers as researchers "ought to be incorporated in science teacher preparation" (p. 112). Others agree that teacher research can play an important role in enhancing science teacher learning, and a variety of rationales are used to support this view. Research on teacher reflection, for example, makes a strong case that reflection is a central and critical part of a professional educator's responsibility, requiring the teacher's consideration of many factors in deciding how to act in a particular situation (Abel, Bryan, 1997; Grimmer, Erickson, 1988; Schon, 1983). The importance of the role of the reflection in teaching is underscored by the growing body of research knowledge about how difficult and complex it is to teach science so that all students develop meaningful understandings of central concepts and scientific ways of knowing (Anderson, Roth, 1989; Mintzes et al., 1998). There is a wide agreement in the science education community that science teaching cannot be reduced to a set of techniques and knowledge that can be quickly given to teachers.

Thus the complexity of the teaching environment in the twenty-first century suggests that learning to teach science is a lifelong undertaking and that teachers need to learn how to learn from experience. Teaching should be viewed as a form of inquiry, experimentation, or research.

There are other arguments supporting the case for teacher research as a way to improve science teacher learning. Mc Goey and Ross (1999) argued that, just as science in the construction of new knowledge representations and new understandings, so science teaching should involve construction of new knowledge about teaching science. "In order for science teachers to demonstrate authentic inquiry, we must be engaged in authentic research ourselves. Researching our practice is a natural fit" (Mc Goey and Ross 1999, p.118).

Both teachers and teacher educators suggest that preservice teacher education programs should include teacher research experiences. Mc Goey and Ross (1999) argued that "the way

to deal with the research practice gap is to engage new teachers in action research from the very beginning of their own practice” (p. 118). Teacher educators Abell and Bryan (1997) concurred, challenging teacher educators to “coach prospective teachers to purposefully and systematically inquire into their own practice, encouraging them to make such inquiry a habit that will become increasingly valuable throughout their careers” (p. 136). Loughran (2002) noted that the possibilities for preservice teacher learning could be enhanced through effective reflective practice. Kyle, Linn, Bitner, Mitchner, and Perry (1991) went so far as to claim that “the process of recognizing the role of teachers-as-researchers should permeate every teacher education course” (p. 416).

These studies provide evidence that teacher research conducted during a student teaching experience is possible and that preservice teachers can find it valuable. Many preservice teachers and teacher educators wonder whether a novice teacher can simultaneously learn how to teach and learn how to conduct research on teaching: it is not trivial matter to be able to act in the classroom and to step outside of that action to observe and analyze.

The studies also showed some impact on preservice teachers’ awareness, beliefs and knowledge. Most commonly, preservice teachers became much more aware and oriented to students’ ideas and ways of thinking. They became aware of conflicts between their beliefs and visions and their teaching practice. Some preservice teachers reported changes in their teaching as a result of the action research (Featherstone, Munby, Russel, 1997), there is a little evidence that the teacher research components of these programs had much impact on the teaching practices of the preservice teachers. This is not surprising, given the short time frame of the programs and the many demands placed on the preservice teachers, especially during their teaching experience, which typically lasted 6-12 weeks. It is not realistic to expect that preservice teachers’ conceptions of science teaching will undergo significant change in such a short period. To better understand the role of teacher research in the teacher learning process, studies that trace unfolding impact of these activities on preservice teachers’ thinking and actions are needed.

### **Benefits of Science Teacher Research: One Example Based on the University Experience**

Teacher research is an effective model for teacher learning and development. Teacher research can make valuable contributions to the knowledge base for science teaching. Teacher researchers step outside their own assumptions and preconceptions and maintain a healthy skepticism about their observations of themselves and their students (Ball, 2000). There is the danger that the research will become too personal, resulting in products that are useless and sometimes even embarrassing (Behar, 1996). The teacher researcher is uniquely positioned to examine efforts to implement a new science teaching strategy. The teacher has unique access to knowledge about the full scope of the thinking and planning that took place before, during and after teaching and about how teaching with the new strategy was more or less difficult than strategies used in the past.

In addition, the teacher has a special vantage point for understanding the variety of influences that contributed to her experience using the new teaching strategy. Those involved in teacher research commonly emphasize the importance and value of collaboration among teachers researchers, which challenges the prevailing norm of teaching as an isolated activity. The opportunity to work with other teachers researchers plays a central role in helping teachers make sense of the particulars of their own classroom, it provides insights into other teachers’ practices, and it can support teachers in learning to be more analytical about teaching by challenging their assumptions and preconceptions.

One of the major goals of teacher research is to stimulate and deepen teacher learning

and to promote changes in teaching practice. There is also danger that teacher research can be used to justify the status quo (Ball 2000). Teacher researchers must be wary about their claims; the fact that something is stated from a first-person perspective and experience does not necessarily make it true (Ball, 2000).

One semester research project was implemented in observing teaching practice course at the preservice science teachers training at Faculty of Science Palacky University in Olomouc. Students during this semester observe science lessons in upper secondary schools. They analyze pedagogical events that happened in the class. They also can develop a research-base rational paper describing how they will teach science. During this semester students examined one aspect of this rationale in a research project carried out in collaboration with the host teacher.

One way of describing the knowledge produced by these studies is to examine the issues addressed in the student-teacher inquires. Issues addressed in the student-teacher research studies are shown in the following table (Table 1):

**Table 1. Issues addressed in the student-teacher research studies.**

| Issues addressed                           | Percentage of studies |
|--|-----------------------|
| Use of traditional teaching methods        | 8                     |
| Use of active learning methods             | 8                     |
| Use of constructivism                      | 5                     |
| Climate of the science classroom           | 15                    |
| Assessment strategies                      | 10                    |
| Group work, cooperative learning           | 8                     |
| Using different teaching materials and ICT | 24                    |
| Individual conception of teaching          | 6                     |
| Other                                      | 16                    |

As shown in Table 1, 8 percent of the studies focused primary on the use of traditional teaching methods (exploration, demonstrations, tasks solving), 8 percent on the use of the methods of active learning (inquiry based learning, problem solving, discussion, simulation, role play, didactic games). There is an equity between traditional methods and active learning methods, what is positive because active learning methods are used more an more recently. Preservice science student-teachers also focused (15 percent) on the climate in the classroom during science lessons (relations teacher-students, students-students, communication). 8 percent of students focused attention on group work and cooperative learning and 24 percent of students on use of ICT (computers, data projectors, electronic tables) in science classes. Only 6 percent of preservice student-teachers reviewed their individual conception of teaching (their ideas how to teach science). Sixteen percent of studies were classified as “other”.

Effectiveness of the student-teacher research might have been due to:

- Students were required to revisit their research-based rationales;
- Studying teaching rationales in the context of teaching gave credibility to research credibility to the research review process;
- Research collaboration with the host teacher allowed research results to discuss with experienced science teachers and teacher educators in the course.

The study and rationale were presented in a final portfolio. This approach was applied for five years and our experience is very positive.



## Concluding Remarks

Science teacher research holds much promise for enhancing science teacher learning within preservice teacher education programs and teacher researchers inquiry groups. These programs has been used as a strategy for developing reflective, inquiring science teachers. There is evidence that science teacher research contributes to teachers' professional dispositions, learning, and growth. There is less evidence that it affects science teacher practice in ways that result in improved student learning. Further research is needed to examine the impact of teacher research on science teachers' practice.

A common feature of the studies was at least some attention to student learning, thinking, and actions. Most of the studies presented examples of students' work to support evidence of student learning, but these examples were used in different ways, and some provided more insights into student learning and thinking than others. In many cases, the examples of preservice science students work were presented as exemplars, showing what is possible without addressing how other students or groups of students performed the same tasks. Other student-teacher researchers attempted to show a range of student work. This was sometimes accomplished by describing a particular assessment tasks and then reporting students' scores on the tasks, usually reported as a percentage of correct answers rather than standings. Rarely did the studies present a sequence of student work to illustrate changes in student thinking over time.

That might help bridge the gap between traditional academic research and science teaching practice. But science teacher research is in its infancy as a movement within science education community. There is a possibility to look forward to a day when collaboration between the academy and the classroom teacher is a commonplace of science teaching.

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