Resistance-Engagement Continuum in Inquiry-Based Elementary Science Methods Courses

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Abstract

The purpose of this paper is to illustrate the continuum of resistance-engagement found in an elementary science methods class. An inquiry-based course was taught at a four-year institution. Data was collected using various sources including critical analysis cards, lottery project reflections, teaching-experience designs and observations, conversations, inquiry-based project reports and field study analyses. Data were coded for emerging themes. Some themes include student natural inquiry, classroom community, self-reflection, lack of preparation in pre-service teacher program, student motivation, student frustrations, change, process of problem solving, reflection/self-assessment, nature of science, connections to daily phenomena and cooperation. Through emphasis with inquiry, pre-service teachers can be prepared to contribute to the public good as informed consumers and model citizens for their students.

Objectives/Purposes

The purpose of this paper is to illustrate the resistance-engagement continuum found in an elementary science methods class taught with an inquiry-based format. The current national and state emphasis in teaching science in elementary school involves teaching science through inquiry. In order to address this emphasis, this course focused on engaging in inquiry processes and examining how these processes can be facilitated with children. To tie in with the American Educational Research Association's annual meeting theme of education research in the public interest, the authors propose how attitudes of pre-service teachers can affect the views of their own teaching. The implication is that these students then become the teachers of future generations. With inquiry-based learning, students gain the critical thinking skills that allow them to contribute to the public good by being informed citizens. Illustrative examples of collected data are reported. These examples support students' place on the continuum of resistance-engagement.

Perspectives

The theme of pre-services teachers' resistance to inquiry in elementary science methods courses is explored. Many undergraduate students arrive coming from a common U.S. educational model: teachers lecture about a topic and the students' repeat the information. Their concern is what the teacher wants, not about what can be learned. Resistance emerges when students are challenged to think critically about science and how it can be learned, as this defies their existing paradigm. It is this interface when students are encouraged to try a new way of learning, where resistance and engagement form.

Methods/Techniques/Modes of Inquiry

An elementary science methods course at a four-year institution was the subject for the research. Approximately 50 undergraduate students participated in the semester-long course. This course was a requirement in a pre-service teacher education program as part of a bachelor of arts awarded within an education college. Students signed a waiver to give permission to use their verbal and written comments in a publication. The course had two, two and a half hour sections; one that convened three times per week and one that convened once per week. It presented specific methods of exploring science through inquiry. For the ease of reading this paper, the term 'students' can also mean pre-service teachers; those students enrolled in a teacher education program as well as students within a practicum setting. It was stressed to the pre-service teachers their responsibility to help their students acquire the set of skills with which they can develop their own explanations and make their own discoveries about science and the natural world. Students were encouraged to engage themselves and others through inquiry.

Some modes of inquiry that the students pondered throughout the course include:

(a) how children think and learn in science;
(b) how to facilitate and manage children's discourse;
(c) how to create a classroom community of young inquirers;
(d) how to assess children's engagement in inquiry, learning, and discourse;
(e) how to plan for the uncertainty of teaching through inquiry (i.e., how to plan so that the interests and questions of children can be followed);
(f) how the nature of science can impact on how we teach and create conducive environments for inquiry; and
(g) how teachers thinking affects the quality of learning for understanding.

Activities within the scope of the course included earthworm exploration, lights and lenses, pond water study, electricity and magnetism, chemical reactions, density, and the physics of flight. Observations were made about the reaction of the students. Initially, when the students were tasked with exploring the earthworms, they were apprehensive. They exclaimed that they didn't want to get their hands dirty and that earthworms were gross. The instructors then initiated a class discussion about how the students' attitudes toward exploring will affect the motivation and attitudes of their future students. It was discussed that however they view the topic, that sentiment will be passed on to and adopted by their future students.

Data Sources/Evidence

Data were collected from various assignments including critical analysis cards, lottery project reflections, teaching-experience (practicum) designs and observations, conversations, inquiry-based project reports and field study analyses. The most prominent material used was the critical analysis card. This is because the nature of the assignment allowed for the students to make connections between theory and practice and to reflect critically on their own approach to teaching. Some topics of reflection include students' development as a professional, their ability to see implications for professional practice and children's learning; their ability to identify and analyze fundamental assumptions that affect science, schooling, and teaching; and their ability to identify, analyze, and contend with their own assumptions about these and related topics. The thread of significance is how the teachers' attitudes will influence their future students.

Results/Conclusions

Data were coded for emerging themes. The most frequent themes are listed. Illustrations are abbreviated as this is a summary paper.

THEME	EXAMPLE ILLUSTRATION
Student Natural Inquiry	"All experiments in the classroom begin with 'what if?' questions." "Children are just curious by nature and have the tendency to ask questions."
Different Way of Thinking	"At the start of the project, I felt helpless. I felt totally incapable of thinking out of the box." "I am weak when it comes to critical thinking. I worry that this will prove to be a hindrance with my teaching. I have not done very much of it in my life and am not very good at it."
Classroom Community	"When we can learn from each other, the invisible feeling of equity inside the classroom appears and everyone respects each other for who they are." "Discourse between students fosters a community within the classroom."
Self-Reflection	"After the students leave, we discuss how the lesson went. We note anything that went wrong and try to come up with a solution to fix it for the next week. We talk about ideas to implement in the following class and discuss each child's progress."
Inquiry	"This kind of inquiry was not all that new to me. I remember my eighth grade science teacher giving us a problem and then asking us to try and solve it. I can still remember when he asked us to categorize the elements. He did not show us the periodic table, but gave us information on each element. After I categorized all the elements in my own way, he showed us how they are put down on the periodic table and I had the exact same thing. I had confirmed what the scientists had found. I felt so smart!" "I think self-esteem and confidence are important aspects of inquiry science." "Inquiry in science promotes independent learning and discovery allowing students to branch out from traditional experiments with right and wrong answers."
Resistance	"What concerns me tremendously is the amount of inquiry emphasized in our class and the lack of attention toward state standards, for which we will be held accountable when we become teachers." "This project has been difficult because I m so used to having more direction." "When I was given the lottery task, I just laughed. I didn't care about the actual question. I just cared about getting it done for a grade." "You need to show the students that no matter what they do or how they behave, the teacher is always in control."
Engagement	"We kept them engaged by asking questions at every turn. They came up with answers that amazed us!" "As I was sitting there watching this happen (young students conducting an experiment), I saw science and

	most importantly, I saw inquiry. These five year olds were making predictions!" "Through exploration, children are allowed to use their creativity and focus on their passions because they are able to explore many thoughts and easy of conducting an experiment. With this idea there may be mo right or wrong answer but several different conclusions depending on the direction of the exploration."
Learning Styles	"I believe that some students will prefer to discover the information, while others would rather learn from their friends or the teacher. Under these flexible conditions, I believe that students will be most receptive to learning and willing to explore."
Student motivation	"Let students answer their own questions. This will make them more excited about science." "I had some serious doubts about my abilities as a teacher because I had never done it before (use inquiry in teaching). I feel a lot more confident now."
Student Frustrations	"The school systems are really making me angry. I want to fight what they are doing in the science programs, but I don't know where to start. How am I supposed to go up against them, when I am just one person? I really want to use inquiry and student discovery in my classroom, but I am afraid the district will tell me not to."
Change	"Inquiry is difficult to implement especially when people are not used to it. Most American schools have not used this method in its entirety and minds needs time to change in the processing of information. Change does not happen overnight." "As teachers, we are constantly learning and changing ourselves according to the realizations we make through our experiences."
Power Structure	"I have difficulty giving all control to the students, and I know that will be one of the hardest points for me when I teach."
Reflection/Self-Assessment	"The first thing I need to do as a teacher is to not label my students." "At first, I was uneasy about being thrown in to working with the kids in such an unstructured manner. Then I educated myself on the topic and I felt that I had expanded my knowledge on several fronts."[1]
Connections to Daily phenomena	"I also enjoyed going on the field trips in order for us to be outside and actually visualize and feel the environment as we do our exploring. This is especially important for young children to make the connection and experience it for themselves." "These experiments also activated my prior knowledge on the subject and also made me want to do extra research outside of class."
Cooperation	"The students worked collaboratively with each other, which allowed for a classroom community. Also, the project showed the need to help children construct, reconstruct and refine their ideas of how to build the boat and make it the most successful."
Ownership	"Experiments where we actually learn something that is meaningful to us are the ones that we design ourselves. We take ownership in the outcome."

1. In the course syllabus, all topics covered cited specific state standards that were addressed during those lessons.

Educational/Scientific Importance of the Study

While in pre-service teacher programs, students' previous ways of knowing and thinking can be challenged. During this new and sometimes uncomfortable period, students develop teaching strategies through their introspection and experiences. Within this research, the science methods class students taught middle-school students in a science teaching experience. For many of the university students, this way their first time practicing what they had learned in the program. Throughout the course of the semester and applying their new skills to a teaching situation on a weekly basis, the pre-service teachers explored and struggled with using inquiry. Some students said that though they were apprehensive to use an inquiry-based format, they found it suited the elementary school students because it allowed them to spotlight their natural curiosity. The elementary students responded favorably to inquiry as it was student-centered and not lecture driven.

Educators are frequently looking for ways to incorporate achieving state standards. Inquiry-based learning allows for this. This format opens dialogue among the students, between the teacher and the students and fosters reflection within each student. Teaching and learning opportunities occur at every point in the resistance-engagement continuum. These "built-in" conversations prompt the teacher to facilitate rich dialogue supporting the students' conscious engagement of inquiry-based learning. This is important because learning is shepherded by natural-occurring inquiry. Though many students may be resistant to this critical questioning, likely a result of their indoctrination into the United States' educational system, with practice, they may use inquiry as a viable and effective method of teaching.

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