10 Evaluating Action Research

After reading this chapter you should be able to:

10.1 Identify criteria for evaluating the quality of action research.

10.2 Apply the criteria for evaluating action research to a published article and/or your own action research project.

Whereas Chapter 8 showed teacher researchers how to ensure that action is planned with consideration of the findings of the study and the potential obstacles to implementing change and Chapter 9 described the writing process and suggestions for how to "get the word out," this chapter addresses the criteria for evaluating action research reports in terms of area of focus, research questions, locus of control, data collection, ethics, reflective stance, action, the relationship between action and data, and format. A published journal article is included at the start of the chapter for evaluation.

"Let's Talk": Discussions in a Biology Classroom: An Action Research Project

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Introduction

Action research has provided me with the opportunity to engage in professional development, enabling me to reflect on my teaching and determine whether I am living up to my values. In this action research project, I have been studying how my teaching has changed in order to facilitate meaningful discussions in the classroom, and I have been assessing how these changes impact my students. The motivation for this study came from my desire to have students make connections between what they already know and new knowledge they encounter in biology. By reflecting upon my teaching I discovered that I was doing most of the biology-related talking. As an undergraduate we

discussed the importance of a student-centered classroom and when I graduated I was confident that I would always be a student-centered teacher. It has been almost ten years since I received my undergraduate degree and I haven't always lived up to that value. By increasing my ability to facilitate meaningful discussions I hope to swing the pendulum back to the students. I teach biology to all tenth-grade students and believe that it is important that students are able to make connections between biology content we cover in the classroom and the world around them. By engaging in more discussions I believe students' learning will become more meaningful.

Context

During the 2003–2004 school year at Two Harbors High School I taught five sections of tenth-grade biology, one section of twelfth-grade Advance Placement biology and one section of eleventh- and twelfth-grade physics daily. Each class had approximately 22 students except AP biology, which had 8 students. My action research focused on my tenth-grade biology students.

Research Questions

How will incorporating more meaningful discussions into my biology classroom affect my teaching and the ability of students to learn?

Sub-questions

1. *How do I need to change my teaching to facilitate more meaningful discussions in my biology classroom?*
2. *Will having more meaningful discussions allow students to learn content at a higher level?*
3. *Will having more meaningful discussions help students make connections between biology content and the world around them?*
4. *Will having more meaningful discussions increase students' ability to make informed decisions regarding socially and/or ecologically significant issues?*

Theoretical Framework

This paper is about my journey as a teacher through action research. Action research is a process by which teachers attempt to study their problems scientifically in order to guide, correct, and evaluate their decisions and actions concerning their teaching and learning. Action research requires the researcher to be reflective of his or her practice. Through action research the researcher is striving to live his or her values in the classroom.

I feel it is important for students to make connections between what they already know and what we learn in class. To acquire a deep understanding of complex ideas (meaningful learning), students need to make connections between what they know and new knowledge that they encounter. Such an epistemology is referred

to as constructivism. One of the first philosophers to explain constructivism was Piaget. The idea can be traced back even further to Giambattista Vico in 1710 who proclaimed, "To know means to know how to make." He substantiates this notion by arguing that one knows a thing only when one can explain it (Yager, 2000, p. 44).

Through better discussions, students can develop a better understanding of the content being covered in class. As Lord (1994) suggests, "By attempting to explain what one knows about a topic to someone else, explainers test the fit of their understanding. Similarly, while trying to understand what a colleague is saying, listeners question and challenge their own understanding and try to fit the material into their already established cognitive foundations" (Lord, 1994, pp. 346–347).

Students must talk about what they are doing, relate it to past experience, and then apply it to their daily lives. By discussing topics that are relevant to students' lives but also contain the biological concepts students are required to know, students will construct their knowledge in a meaningful way. By monitoring these discussions, teachers can obtain immediate feedback. If one student is incorrectly explaining material aloud to another, the teacher can do immediate re-teaching. More optimistically, teachers can also give immediate praise.

Early on in my project I realized that it would be important to ask good questions and monitor student responses and cognition. There are three domains of learning: cognitive, affective and psychomotor. In 1956, Benjamin Bloom defined the cognitive (the mental process or faculty of knowing) domain for educators (Henson, 1993, p. 124). He developed a taxonomy for categorizing questions, objectives, or responses. His six categories can be divided into two groups, low order and high order. The low-order categories are the simplest and the least demanding, whereas high-order categories require greater understanding and are thus more demanding. Low-order categories are knowledge and comprehension. High-order categories involve application, analysis, synthesis, and evaluation. Asking higher-order questions challenges students to think while promoting learning, as higher-order questions require students to process information in ways associated with greater comprehension and understanding. In order for me to stimulate meaningful discussions, I need to ask questions of a higher order on Bloom's taxonomy. Simple knowledge-based questions elicit little discussion. Another important concept regarding questioning is wait time. It is recommended to wait three to five seconds after asking a question, and again after the response, in order to give students a chance to think and formulate a high-order response. A third important consideration in questioning is the use of Socratic dialogue. In Socratic dialogue, teachers respond to students' questions with questions. It is also very important that students ask questions. "If we want to engage students in thinking through content we must stimulate their thinking with questions that lead them to further questions" (Elder, 1998, p. 298).

After monitoring discussions for about a month, I discovered that the make-up of the group conducting the discussion is important, as people learn in different ways. The main learning styles are visual, auditory, and kinesthetic. Visual learners learn best by seeing, auditory learners learn best by hearing and talking, and kinesthetic

learners learn best by doing. People can possess any combination of these learning styles, but often one is dominant. Through discussions with a critical friend, I decided to try grouping students heterogeneously by their learning styles. Later on, after reading more literature, I discovered that many teachers have had success grouping their students heterogeneously by ability. I then tried arranging my students heterogeneously by learning style and ability in an attempt to improve discussions.

Another path my action research has taken me on is cooperative learning. Cooperative learning models also recommended that groups be arranged heterogeneously. In a study conducted on cooperative learning at the college level the researcher said, "We experienced first hand that homogenous teams are a prescription for disaster in a cooperative learning driven course. . . . It is important for students from different backgrounds to work together and learn from each other's perspectives and strengths" (Trempy, 2002, p. 32). To facilitate meaningful discussions, students need to work together cooperatively. This practice was reinforced by the results of a questionnaire I gave my students in which they stated that participation was important for quality discussions to take place. To address this concern, I began using some cooperative learning techniques. Cooperative learning is an approach that encourages students to collaborate with each other to achieve common learning goals. According to Johnson and Johnson (1985) one of the main elements of cooperative learning is "individual accountability," where every student is responsible for contributing to the group. This can be done by assigning and checking individual contributions to the group, assigning roles or jobs to every member, randomly quizzing every member over the material, and/or giving individual tests. Another essential element is "positive interdependence" when students feel they need each other in order to complete the task successfully. According to Holubec (1992), cooperative learning is also a style that leads toward higher-level thinking. When students are working together and discussing the material, they will work beyond the lower-order questions. Within discussion groups, students need to accept and learn from each other's opinions, strengths and contributions. Lotan's research found that students can be empowered by this type of group work. "Group-worthy tasks require students to share their experiences and justify their beliefs and opinions. By assigning such tasks, teachers delegate intellectual authority to their students and make their students' life experiences, opinions and points of view legitimate components of the content to be learned" (Lotan, 2003, p. 72).

The affective domain, which addresses students' attitudes and values, is also important in the classroom. Part of my research examined socially and/or ecologically significant issues, with the hope of encouraging moral growth in my students, helping them become more aware of their values and to allow them to make connections between biology and the world around them (between new and preexisting knowledge). In addition to making necessary connections, hopefully students will improve their critical thinking skills. Woodruff explains how discussing these issues can increase students, critical thinking skills, "Ethical thinking is neither a matter of pure intellect nor of gut feelings and prejudices. What is important here is one's reasoning and critical thinking skills. Thus, by strengthening and expanding these skills, the

student will be able to view our ever-changing biological world from a new perspective, and not be limited by the past or previous belief-systems" (Woodruff, 1992, p. 2).

In summary, through my action research and my desire to be more of a constructivist teacher, I have found it necessary to research good questioning skills, higher-order learning, learning styles, and cooperative learning.

Changes in My Teaching Practices

The main focus of my research is on small group discussions, as that is where more students can participate in a more comfortable environment. Though I didn't have a defined method of research as I began, I collected and analyzed data and made what I thought were appropriate changes in my teaching as I progressed through my action research. The following is a list of changes that I made.

1. *I increased the number of discussion opportunities in my classroom.*
2. *I administered a learning style inventory, then arranged students into groups heterogeneously based on their learning style, and later on arranged students heterogeneously by learning style and ability.*
3. *I increased the number of high-order questions. Throughout my research I tried to ask higher-order questions according to Bloom's taxonomy in hopes that students would increase their higher-order responses. When preparing discussion questions I referred to Bloom's taxonomy. Also, I tried to keep myself from directly answering a student's question, instead guiding them to their own understanding through an increase in Socratic dialogue.*
4. *I used more cooperative learning techniques. From the first questionnaire that I gave students I discovered that students wanted everyone to participate more, including themselves. I used roles or jobs within a group, the numbered heads technique, the round robin technique, and the jigsaw technique. In the numbered heads technique, the students were numbered off within a group and told that I would randomly pick a person from their table to answer a question. They must work together to make sure everyone understands the topic. The round robin technique is when each group has one paper and it is passed around the table for everyone to contribute to. I used this technique to review the plant kingdom. Students were instructed to make a dichotomous key as a group going around the table until the key was finished. The jigsaw method uses two groups, a "home" group (their original group) and the "jigsaw" group. First, students start in their home group to discuss the issue; then they break into their jigsaw group (students are numbered within their home group, then all like numbers get together to make the jigsaw group). Last, students return to their home group to share information they collected. While using cooperative learning groups, I had a student mention that discussions should be "worth more," referring to points, and it was suggested by a colleague to have students evaluate each other on their participation.*

In response to this I developed a rubric for students to evaluate each other on their participation.

5. *As a way to involve students in discussions, I designed and facilitated discussions on socially and ecologically significant issues. Ten of the twenty discussions focused on socially and/or ecologically significant issues. Some discussions involved scientific articles. First, students read the articles and answered questions independently. Then they discussed their answers to the articles using a cooperative learning technique. Another type of activity I used was dilemma cards, for example, "Deer Dilemma" modified from an activity in Project Wild where students had to respond to the ecological impacts that the growing deer population has in our environment and design a solution as a group. I used the jigsaw method for this activity.*
6. *Another way to involve students in discussions was by having them design and carry out labs as a group. I provided them with the question and with some guidelines—guided inquiry. Four of the twenty planned discussions were designing labs.*

Data Collection and Analysis

Data collection for this study came from several sources. To analyze this data I read through my journal on a regular basis, analyzed student questionnaires, and discussed results with my validation team while searching for themes within the data.

Teacher Journal

While reflecting on my journal entries I was able to verify the need for this action research project. In an early entry I was concerned about "down time"—students not engaged—and a couple months later was very excited about initiating a good discussion. Reading journal entries helped guide my teaching.

Student Questionnaires

Students responded to two questionnaires. The greatest benefit from the first questionnaire was that students let me know that participation was critical for group work success. One open-ended question on the questionnaire was: What can I (the teacher) do to improve discussions in the classroom? Eight percent of the students responded that I should make sure everyone participated. The second open-ended question was: What can you (the student) do to improve discussions in the classroom? Forty-six percent of the students responded that they should participate more. From this first questionnaire I also noticed that students want to make connections between what we are doing in biology and the world around them. Two students made the comment, "Have things we may run into later in life." One student seemed to be aware of the benefit of discussions to constructivism: "Have a weekly class discussion that involves not only what we learned but what we know."

chart 1 ▪ Triangulation of Data

Research Questions	Data Collection Techniques			
	1	2	3	4
How do I need to change my teaching to facilitate more meaningful discussions in my biology classroom?	Teacher Journal	Student Questionnaire	Student Interviews	Lesson Plan Book
Will having more meaningful discussion allow students to learn content at a higher level?	Audiotape of discussions	Student Questionnaire	Unit Tests	
Will having more meaningful discussion help students make connections between biology content and the word around them?	Audiotape of discussions	Student Questionnaire	Student Interviews	
Will having more meaningful discussions increase students' ability to make informed decisions regarding socially and/or ecologically significant issues?	Student Questionnaire	Mock situations where students use their biology knowledge and skills to address a social or ecological problem.	Student Interviews	

chart 2 ▪ Analysis of Biology Test

Date	Test name	Point total for higher-order question/ total point	% of points from higher-order questions	Number of tests analyzed	Students' average score on higher-order questions	% of points earned for higher-order questions
9/12/03	Microscope and Scientific Method	10/47	21%	111	6.7	67%
10/10/03	Eukarya Test	13/60	22%	95	8.1	62%
10/29/03	Animal Kingdom	7/22	32%	107	5.4	78%
11/11/03	Bacteria and Viruses	4/22	18%	99	2.6	65%

In the second questionnaire I noticed that students were still concerned about participation, but they noted several instances when discussions were better because everyone participated. For example, with the round robin virus articles a student said, "Everyone participated because they had different information." And with the deer dilemma some student comments were: "It got everyone involved and participating." "We had to decide something as a group." "We had good conversations." From the second questionnaire I also noticed that students enjoyed discussing socially and ecologically significant articles. A student said, "We shared our point of views and opinions on the article. So I learned others' thoughts on the article."

In summary, the questionnaires helped guide me in my research by showing how important it was to the students that everyone participates. I also discovered that students feel it is necessary to make connections between the biology content and the world around them and that they felt that engaging in these discussions helped them to do that.

Unit Tests

When analyzing my tests I used Bloom's taxonomy to determine whether questions were low- or high-order questions. Then I studied the students' responses to determine the percent of points earned on the higher-order questions. The purpose was to see if increases in discussions would lead to more points earned on higher-order questions throughout my research.

From this data I can conclude that I still need to work on writing higher-order questions. I believe the content type influences the amount and type of questions that are asked.

Audiotapes of Discussions

On seven different occasions I audiotaped discussions. Using Bloom's taxonomy I categorized the discussion questions that I designed prior to the discussions and questions that developed during the discussion. When I audiotaped more than one group, I averaged the number of high- or low-order questions.

From this graph I can see that I have increased the number of questions that I am asking as well as the amount of high-order questions that I am asking. However, because this graph combines different types of activities, I graphed the difference between high-order and low-order questions in graph 2.

As indicated by this graph, I am making progress towards asking more high-order questions compared to low-order questions over time.

Student responses from the audiotapes were also categorized using Bloom's taxonomy.

Again it is important to note that the six discussions in these graphs are from different types of activities. On 9/3 and 11/4 students designed and conducted their own labs within their discussion group. On 9/3 students had chosen their discussion groups, and on 11/4 they were arranged heterogeneously by ability and learning style. On 9/23 and 11/3 students read articles and answered questions independently and then discussed their answers. On 11/3 they answered their questions using the numbered together cooperative learning technique. On 10/2 students were analyzing data from a lichen field study. On 10/23 students solved the deer dilemma. On 1/7 students responded to an ethical dilemma based on articles they read about stem cell research.

I graphed the difference between high-order and low-order questions from graph 3 in graph 4.

I was excited when I unexpectedly noticed that students had more high-order responses than low-order responses when they were involved in student-centered activities. The three positive bars are from designing their own experiments and from the deer dilemma. Even though I increased the number of higher-order questions with the antibiotic article on 11/3/03, students responded with a higher number of low-order statements. However, I can also see that as discussions have increased, more is being said during the discussions.

Student Interviews

From the student interviews, I found that students believe and appreciate that I am trying to get everyone involved, but two of the four students were still concerned that everyone doesn't always participate. In response to the question "What do you like about my teaching?" one student seemed to recognize that discussions help her make connections, "You teach from the book but then we do other things and we discuss them. It sticks really well. When I first read the chapter I think I'tm never going to remember but after a while it all clicks together and by the end it's stuck in my brain." Three of the four students felt that having roles during discussions helped improve the participation, and one felt that it worked really well in the deer dilemma. All four students felt that grading students on their participation would improve discussions. Three of the four students felt that discussing socially or environmentally significant issues was meaningful to them. I asked the following question: We discussed a couple of socially or environmentally controversial issues—the deer population and the antibiotics. How do you feel about discussing these types of issues? Is it meaningful to you? One student responded, "I like to discuss them because it gives you more understanding of the world around you. Cause like I never knew there were so many antibiotic resistant bacteria. I learned a lot from that. And then with the deer it gave me different perspectives because I'tm not the deer hunting type so it gave me a different perspective of where people are coming from. And it is something you could relate to in your life." A second student responded, "Oh yeah I take what I think of it and then with the deer you gave us the things that we had to be, the thing that you gave me was not what I was originally thinking so it