

# Different Views on Inquiry: A Survey of Science and Mathematics Methods Instructors

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**Abstract.** The national science standards encourage the use of inquiry-based instruction to teach difficult scientific concepts. As part of a larger study to investigate teachers' views on the nature of inquiry-based instruction, a survey was administered to Science and Mathematics methods course instructors to determine their views on inquiry, as well as to explore the success and difficulties associated with teaching this difficult concept. In addition, we wished to obtain their views on the "5 E's"<sup>1</sup> method, an inquiry method specifically designed to promote conceptual change that is often taught as "the" method to utilize. Initial survey data suggests there are many different views among Science and Mathematics methods course instructors about the nature of inquiry. This paper discusses the difficulties encountered with the "5 E's" and teaching inquiry-based methods to teachers.

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## INTRODUCTION

The current political demands on the education profession require educators to follow national standards. In particular, secondary science educators are highly encouraged (within the time and budget constraints associated with public education) to teach science as an inquiry process in their classrooms.<sup>2,3</sup> Recent studies have investigated the impact these methods have on students' learning and how secondary educators implement these methods.<sup>4</sup> In addition, some work has been done to uncover the beliefs secondary science educators have about implementing inquiry in their classrooms.<sup>5,6</sup>

Researchers have discovered several key factors that influence an educator's practice. Research shows that "teachers teach the way they were taught".<sup>4</sup> More recent studies show there are competing belief sets about inquiry and that secondary science educators are inexperienced in scientific practices.<sup>5,6,7</sup> These factors have guided the development and altering of workshops and method courses for secondary science educators across the nation.

Based on Piaget's theory of learning, one method has been developed that is often taught as the best method of inquiry-based instruction. Starting with the original work done by Karplus and the "Learning Cycle" of Explore - Invent - Apply, the Biological

Curriculum Study lead by Anton Lawson put forth the "5 E's" method (see Table 1).<sup>1,8,9</sup>

**Table 1.** Portion of the BSCS Version of the Learning Cycle Instruction: Teacher's Role<sup>10</sup>

Phase of the model	What the teacher does that is consistent with the model
Engage	Creates interest, Raises Questions, Elicits responses that uncover what the students know or think about the concept/topic
Explore	Encourage students to work together without direct instruction, Asks probing questions to redirect the students' investigation, Provides time for students to puzzle through problems.
Explain	Encourages students to explain concepts and definitions in their own words, Asks for justification/evidence and clarification from students, Formally provides definitions/ explanations and new labels
Elaborate	Encourages students to apply or extend the concepts and skills in new situations.
Evaluate	Observes the students as they apply new concepts and skills, Assesses students' knowledge and/or skills, Allows students to assess their own learning and group-process skills,

This study is a preliminary step in understanding what beliefs and practices secondary educators have about implementing inquiry. Because of the strong influence of the methods course all secondary

educators are required to take, we chose to begin our study with the views of the secondary science and mathematics methods course instructors. By investigating these instructors' views on inquiry, we hope to discover why so many in-service and pre-service teachers appear to have such diverse methods of implementing inquiry with varying degrees of success..

The survey we administered was designed to determine the views on inquiry held by these methods course instructors as well as the success and difficulties associated with teaching inquiry-based methods. As a basis for comparison, we adopted the definition of inquiry stated by the NSES.<sup>11</sup>

Furthermore, because many reforms to the "5 E's" exist, we surveyed the instructors' views on the "5 E's" in order to obtain a relationship between their views on inquiry and the inquiry-based methods they teach.<sup>12</sup>

## METHODOLOGY

The first phase of our study consisted of an open-ended survey. The survey contained 14 questions (see Table 2) we designed to elicit the educators views on what inquiry is, how inquiry is related to conceptual change, and their views on the "5 E's" method.

The survey was administered through WebCT. For the first phase of the study, we selected seven science and mathematics educators at SIUE. Of these seven instructors, five submitted responses to the survey.

To analyze the survey results, we downloaded the responses from WebCT and then noted key themes from each survey as well as themes from each question. We then divided the themes into categories to illustrate the overall views on inquiry and the "5 E's" method.

## METHODS INSTRUCTORS VIEWS

After initial analysis, four major themes emerged: Views on conceptual change, views on inquiry, inquiry in practice and views on the "5 E's". Using these themes as a basis, we re-evaluated the survey results and pulled out common minor themes that emerged within the larger main themes. Two methods instructors who responded did not use the "5 E's" method and the other methods instructors had very similar views on the "5 E's".

### Views on Conceptual Change

As we stated in our survey, "one of the goals of instruction is to encourage accommodation or 'conceptual change'" (see Table 2). According to the literature, there are four conditions of accommodation.<sup>13</sup>

1. There must be dissatisfaction with existing concepts.
2. A new concept must be intelligible.
3. A new concept must be initially plausible.
4. A new concept should suggest further exploration.

The survey data showed that all five instructors had an understanding of conceptual change that was very similar to the definition given by Posner et al. The only variation to be noted is that some of the instructors' understandings were not as robust as the others. One instructor defined conceptual change as "show a need/purpose for the new knowledge." Compared to another instructor who said, "Recognized failure of the 'old' knowledge, presentation of robust new knowledge ..., reinforcement of new knowledge ...". The first instructor's response is not as detailed or well thought out. A dichotomy exists throughout the survey data between short simple answers and longer detailed responses.

**TABLE 2.** Question used in online inquiry survey

1	Are you a pre-service teacher, in-service teacher or a teacher trainer? If you are a teacher trainer, do you teach a methods course?
2	What schools are you associated with? (Please List all schools associated with)
3	One of the goals of instruction is to encourage accommodation of new knowledge or "conceptual change". What do you think is necessary to encourage "conceptual change"?
4	Do you use inquiry-based lessons in your classroom? If so, how often do you use these lessons?
5	Why or why not do you use inquiry-based lessons in your classroom?
6	What do you think are the characteristics of an inquiry lesson? Please describe.
7	If you could put the characteristics of an inquiry lesson into "stages", what would they be?
8	Do you use the "5 E's" in your classroom? Why or why not?
9	In your own words, describe each of the phases of the "5 E's"
10	Do you ever have confusion about what the "5 E's" mean and how to implement them? Explain.
11	Have you ever known another educator to have confusion about any of the phases of the "5 E's"? If so, explain.
12	What do you think are the strengths of the "5 E's" as a lesson planning method?
13	What do you think are the weaknesses of the "5 E's"?
14	Do you have any other comments concerning inquiry-based lessons?

## **Views on Inquiry**

By far, the most enlightening data from the survey is the differing views of inquiry provided by the various instructors. The instructors' views of inquiry were divided into two categories, views of inquiry as discovery and views of inquiry as accommodation.

### *Inquiry as Discovery*

In their responses to the survey, the instructors developed their own definitions of inquiry. One view they clearly expressed was that inquiry-based lessons are discovery. One methods instructor stated that "the most essential characteristic is that somewhere the assignment is open ended and allows/requires the student to make decisions". Another instructor stated that "discovery of concepts in place of being told" is a characteristic of inquiry-based lessons. This definition seems to be consistent with the definition provided by the NSES that inquiry is a multifaceted activity very similar to the process of scientific research.<sup>2</sup>

### *Inquiry as Accommodation*

In addition to the view of inquiry as discovery, the methods instructors stated that inquiry was a form of accommodation. The methods instructors provided very lengthy responses that included statements such as "an inquiry lesson should promote conceptual change" and "students thinking through what something means in a way that gives them some ownership of the lesson". These statements describe a broader view of inquiry than what is presented by the NSES.<sup>11</sup> In addition, throughout the survey the instructors mentioned that they had difficulty answering the questions because their views differed for different instructional situations.

## **Inquiry in Practice**

As part of our investigation, the data was analyzed to determine why the instructors use inquiry. Because the responses varied by instructor, they were divided into strengths and weaknesses. By far, the methods instructors felt there were more strengths than weaknesses of inquiry-based lessons.

### *Strengths of Inquiry*

The methods course instructors stated many strengths of using inquiry instruction in the methods classroom. They stated that inquiry "models the way I would like the pre-service teachers taking those classes to teach", models "science as a discipline" and

"requires students to be engaged". Overall, the methods instructors stated that using inquiry methods in their classrooms promoted conceptual change in pre-service teachers. Inferring from their responses, the inquiry methods used changed the pre-service teachers' conception of teaching from their previous model to the concept of inquiry as the method for teaching science; the objective of the course.

### *Weaknesses of Inquiry*

Despite the overwhelming acknowledgement of the strengths of inquiry, the methods instructors noted a few weaknesses. One instructor stated "I personally don't feel that any one of [the inquiry-based methods] is comprehensive enough to use in all situations." The idea that no one method is comprehensive enough to use in all situations is expressed in various places in all five surveys. Furthermore, a different instructor, when asked about inquiry methods replied, "I'm tempted to give the cheap answer 'the 5 E's'", illustrating the instructor's opinion that there is more to inquiry than the "5 E's" cover.

## **Views on the "5 E's"**

When analyzing the survey responses, two of the instructors responded they were unfamiliar with the "5 E's" method. One of these instructors stated they "do not classify items into these categories," and the other had not heard of the "5 E's" method before. Despite this, all five responding surveys demonstrated some understanding of the phases of the "5 E's" as defined by the BSCS (see Table 1). Unlike the views on inquiry, the methods instructors describe more weaknesses than strengths of the "5 E's" method.

### *Strengths of the "5 E's"*

The methods instructors' overall opinion of the "5 E's" was that it is a convenient tool to construct inquiry based lessons. They stated the "5 E's" are a "well prescribed method for enacting conceptual change" and the method "naturally lends itself to use of inquiry". This view was stated clearly as "(the "5 E's" have) some merit in helping me frame a lesson plan so as not to forget some of the basics of helping student learn." Although this was the only stated strength of the "5 E's" it was implied that there were other strengths.

### *Weaknesses of the "5 E's"*

The surveyed instructors stated several important views when asked about the weaknesses of the "5

E's". Table 3 summarizes the comments they made. From these comments, it is clear that an educator who uses the "5 E's" method for inquiry-based lessons must be aware of these difficulties and design instruction to accommodate for them.

<b>Table 3.</b> Weaknesses of the 5 E's
It is not always easy to clearly separate the stages.
An instructor may be fixed on a particular interpretation of the phase.
There is a linear sequential flow to what is inherently a cyclic and recursive process.
It is difficult to keep the class on the desired track while validating the student's desire to explore.
There can be an abrupt disjunction when the course progresses to the next objective.
One form or model is never good in all situations.

## CONCLUSIONS

In general, the methods course instructors expressed several strengths of inquiry as a method of instruction but at the same time had several comments about the difficulties in implementing the "5 E's" method. Furthermore, a common theme expressed by all five instructors is that there is no one prescribed method that works in all situations. One instructor stated,

*"[Methods course instructors] have to watch out for our teaching of the term "inquiry." All too often, we give the impression with "inquiry lesson" that the whole lesson is designed and implemented by the students' planning, organization, etc. As most models of inquiry show, [inquiry] can be done at various levels. Education should NOT become an exercise in always using the highest stage of inquiry."*

This survey solicited the views of only five methods instructors. Also, the science methods instructors who participated in the study are part of the PAC<sub>B</sub>ER group at SIUE and are familiar with both survey administrators. To obtain better results, additional survey data should be taken that polls a larger population of science and mathematics methods course instructors as well as pre-service and in-service educators.

In addition, the methods course instructors stated a different view of the term inquiry than the NSES.<sup>11</sup> How can methods course instructors teach inquiry methods when there are so many different definitions of inquiry? Additional data could develop a more robust definition that would help educators design inquiry-based lessons. Furthermore, there have been several proposed modifications to the "5 E's" as they were originally written.<sup>12</sup> Do these modifications overcome the weaknesses uncovered by this survey? Can secondary science educators learn inquiry methods when there are difficulties with the methods

they are being taught? Further studies of methods course instructors, pre-service and in-service educators could provide some insight.

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