SCAFFOLDING IN THE CLASSROOM: TEACHING STUDENTS SO THEY CAN STAND ON THEIR OWN

by

LAUREN MCCALL

(Under the Direction of David Jackson)

ABSTRACT

This study deals with the use of scaffolding in inquiry-based approaches to teaching about physics concepts and science teaching skills. Data analyzed include interviews with student and instructors and participant observations in both Physics and Science Education class sessions. Major themes identified include teacher and student responsibility, the hands-on minds-on aspect of inquiry, communication through group work, use of questions in the inquiry-based classroom, student initiative, and students' perspectives on the teaching methods.

INDEX WORDS: Scaffolding, discovery learning, programmed instruction, inquiry-based learning, zone of proximal development, Socratic Method.

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LAUREN MCCALL

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LAUREN MCCALL

Major Professor: David Jackson

Committee: Ji Shen
Steve Oliver

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
May 2010

DEDICATION

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I would like to thank the many students in Dr. Jackson and Dr. Braxton's classes for allowing me to interview them. I would also like to thank Dr. Jackson and Dr. Braxton for letting me do my research in their classes.

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CHAPTER I. Introduction

In education there are many different philosophies and methodologies for teaching students. All the different viewpoints have the end goal of helping students to be able to think on their own, but what is the best way to get there? The purpose of this study was to gain an enhanced understanding as a teacher of scaffolding, how scaffolding can play a part in the inquiry-based classroom, and how to balance responsibility during certain types of scaffolding. The definition for scaffolding used in this study is to "allow support for a student to think for his or herself" (Hogan & Pressley, 1997, p. 2), within a social constructivist perspective:

> The social constructivism perspective views scaffolding interchanges as constructive all along the way, with meanings continually being created inside the heads of the speakers. This whole class perspective reflects a tradition of soviet psychology which holds that an individual's thinking is profoundly influenced by participating in forms of social practice. (Hogan & Pressley, 1997, p. 88).

Through the research on scaffoldings use in the inquiry-based classroom, various definitions of "inquiry" were apparent. For example during one of the interviews the interviewee mentioned if you get several science teachers in a room their definitions of inquiry or constructivism probably would differ widely. Inquiry-based learning came about in the 1960s with some ideas originating from earlier periods, most prominently in the work of Jerome Bruner (e.g., 1960) who expanded on the general philosophy of John Dewey (e.g., 1910). Inquiry-based learning emphasizes constructivist views of learning and came about during a progressive time of education in the United States. Part of the inquiry-based learning has a basis in the Socratic Method, which is a form of inquiry and debate between individuals with opposing viewpoints based on asking and answering questions to sometimes lead to realizations of latent knowledge. Among international authors, Lev Vygotsky, Paolo Freire and Jean Piaget are credited with also having their work influence inquiry-based learning (Hogan & Pressley, 1997).

In the inquiry-based classroom, programmed self-instruction and discovery methods are aspects of this method. Programmed self-instruction and the "discovery method" are very different instructional procedures. Kersh (1964) defined discovery method as:

> Learning takes place with little or no direction from the teacher so that when the learning objective is attained it may be said that the learner "discovered" it. By contrast, programmed instruction characteristically guides the learner one small step at a time toward the instructional objective in such a manner that the learner typically does not have to search far in his efforts to ascertain what is being taught (pp. 1-2).

In this study inquiry was defined as a hands-on and minds-on type of learning. The teacher facilitates learning and is not necessarily a vessel of knowledge. In inquiry-based learning, students often work in groups, and communication is a big part of figuring experiments or problems out through discussions, testing out ideas with group members or leading questions. Inquiry-based learning also helps students to not just know facts but also to develop analytical skills along with experimental skills.

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CHAPTER II. Review of the Literature

The primary source for the view of scaffolding used in this study is *Scaffolding students' learning: Instructional Approaches and issues* (Hogan & Pressley 1997), in which scaffolding is described as an alternative to

> The traditional recitation format (in which teachers ask students questions, the students respond, and the teacher evaluates the answer) is one in which the teacher becomes the students' conversational partner. The teacher provides verbal scaffolds – supports that enable students to build powerful thinking strategies and conceptual understanding. With prompting and supports, students become facile at thinking aloud to construct and clarify ideas. They become aware of how, not just what, they are thinking as the teacher highlights and labels their processes. (pp. 74-75)

Some of the questions Hogan & Pressley (1997) brought up dealing with certain teaching methods include:

- What were the teacher's goals, strategies and knowledge?
- Did any learning occur during the interchange?
- If so what kind of learning happened and for whom?
- How did the learning occur?
- Did any of the group members learn by listening? By thinking aloud?
- How will the learning continue?
- Will everyone in the group eventually benefit from the conversation between a student and his teacher? (p. 76)

Hogan & Pressley (1997) also discuss a student's zone of proximal development (ZPD) which is the area of potential growth in the learner (p. 77). Interaction of teacher and child in child's ZPD helps ensure the child's success and it also extends the child's competence into new territory (p. 78). The interactions create new meaning outside the heads of the two interacting people through the creation of a shared meaning or intersubjectivity (p. 27). They also discuss how the teacher's cues and prompts succeed in causing the student to think (p. 81).

The essential elements of scaffolding as described by Hogan & Pressley (1997; as adapted from Applebee & Langer, 1983; Wong, 1994; Wood et al., 1976) are as follows**:**

- Pre-engagement
- Establishing a shared goal
- Actively diagnosing the understandings and needs of the learner
- Providing tailored assistance
- Maintaining pursuit of the goal
- Giving feedback: Teachers can make students' comments more meaningful by reacting to and elaborating on them. Meanwhile as one student thinks aloud, his or her thoughts and exchanges with the teacher are witnessed by the rest of the class members, who are learning the scientific communal practices and social norms being modeled during the interchange.
- Controlling for frustration and risk
- Assisting internalization, independence, and generalization to other contexts (pp. 82-83)

Along with this, another important point Hogan & Pressley (1997) made was

> One way to manage the numbers problem is to organize students to work in groups as often as possible. This allows the teacher to scaffold groups rather than individuals, thereby making it feasible for each group to receive the teacher's attention during a single class period. Another approach is to provide groups with tools such as cue cards, question cards or question stems to help them scaffold one another. (p. 85)

Hogan & Pressley (1997) define the "demands on teachers" as:

- Extensive insights into individual learners
- Teachers need to know what a child already knows
- Know curriculum well (p. 87)

A distinctive feature of this discussion is that the teacher does not judge the student's thinking, but rather engages with it to expand the surface of ideas, and eventually to move students toward deeper understanding. While scaffolding the discussion, the teacher is supporting students' own thinking rather than compensating or substituting for a lack of thinking. (p. 96)

Hogan & Pressley (1997) also discussed what students do as they participate:

- Articulating and clarifying ideas
- Relating new ideas to prior knowledge
- Connecting their own thoughts to others ideas
- Elaborating on ideas and
- Providing explanations (p. 97)

Another document that influenced this research was *Directed Discovery vs. Programmed Learning* (Kersh, 1964), which provides a useful conceptual outline of early thinking about inquiry:

Bruner suggests that learning by discovery benefits the learner in four ways:

1) his ability to learn related material is increased

2) his interest in the activity itself is developed, rather than in the rewards which may follow from the learning

3) his ability to approach problems in a way that will more likely lead to a solution is developed

4) he tends to more easily retrieve or reconstruct from memory material which he has learned (p. 2)

Kersh (1964) also discussed early research dealing with discovery learning:

One explanation for the superior performance of learners in discovery groups (as reported in such studies as Kersh, 1958, 1962; and Gagne', 1961) may be given in terms of operant conditioning. The learner, when required to discover solutions to problems without help, sometimes engages in a kind of exploratory behavior described hereafter as "searching behavior. "When by familiar processes of operant conditioning, the searching behavior is reinforced during instruction; it will be learned along with the solution to the problem (i.e., the subject- matter content). (pp. 5-6)

By contrast, Kittell reported an experiment which employed a word task with sixth-grade subjects. Learners in the discovery group were first given examples of the principles involved and then instructed to discover as many other principles as they could from other word sets. They were instructed to underline the word that did not belong with the others of a particular set and were informed immediately upon selecting a word whether or not it was correct. If right, they proceeded to the next problem set; if wrong they tried again. They were instructed to guess if they did not know the answer. On the average they discovered less than three principles out of fifteen. Since they were reinforced only when they underlined the correct word, and so few principles were learned, this must have had relatively few success experiences. (p. 4)

A more subtle perspective on inquiry-based learning came about when Dr. Jackson had a guest speaker, Dr. Lee Meadows of the University of Alabama at Birmingham, come to his class. This provided a view of the entire spectrum of inquiry-based learning. Dr. Meadows' first activity was a "brainstorming" session in which he asked groups of students to generate questions that they had about inquiry teaching, based on their limited experience up to that point. Figure 1 reproduces the notes and questions generated by my group in that session.

Dr. Jackson's guest speaker Lee Meadows
Inquiry Style Teaching
When Dr. Meadows came he asked us to come up with some questions that we had dealing with inquiry style teaching. Mine were

How do you make sure everyone is on the same page?
How do you make sure you are meeting the standards?

Are labs and hands on activities connected to inquiry? Then what is the difference?

Structure
Think about what is happening in inquiry

Verification labs can be inquiry
What's the difference between hands on and inquiry?
Amount of student thinking required

Cookbook instruction is not inquiry

Thought
Process
Content

What does an inquiry teacher do in the lab?
Guides and facilitates so students trust the evidence
Orchestrates science discourse so students can develop explanations of data that match the ones of science.

In a non inquiry classroom the teacher does the explanation

What would you do if you had two guys right on a lab and three wrong?

It's about what the evidence shows not the authority.
Challenging group ideas-explanation and results
It does nothing to test and grade if this does not involve the inquiry they do in class

Figure 1. One group's notes from the "Brainstorming about Inquiry" task

This was followed by a lecture/discussion in which Dr. Meadows presented examples of a range of levels of inquiry, as shown in the class handout/display in Figure 2.

De-Mystifying Inquiry: Developed by Lee Meadows, Ph.D.

These thoughts are from *Inquiry and the National Science Education Standards,* page 29,Table 2.6. The table can be used to indicate the range of inquiry from open-ended inquiry to guided inquiry to cookbook labs. This whole document depends on you having a working knowledge of the 5 Essential Features of Inquiry from page 24 through page 28 of Inquiry and the NSES. You might want to skim through those pages for a quick review before going further here. Setting the stage for this analysis are the levels on inquiry as reported in "Simplify Inquiry" from the October, 2005, issue of *The Science Teacher* (Rezba, Auldridge, and Rhea, 2005)

Levels of Inquiry in an Effervescent Antacid Tablet Activity

Confirmation: Students confirm a principle through an activity in which **the results are known in advance**. "In this investigation you will confirm that the rate of a chemical reaction increases as the temperature of the reacting materials increases. You will use effervescent and antacid tablets to verify this principle. Using the following procedure, record the results as indicated, and answer the questions at the end of the activity."

Structured Inquiry: Students investigate **a teacher-presented question through a prescribed procedure**. "In this investigation, you will determine the relationship between temperature and the reaction rate of effervescent antacid tablets and water. You will use effervescent antacid tablets and water of varying temperatures. Using the following procedure, record the results as indicated, and answer the questions at the end of the activity."

Guided Inquiry: Students investigate **a teacher-presented question using student designated/selected procedures**. "Design an investigation to answer the question: What effect will water temperature have on the rate at which an effervescent antacid tablet will react? Develop each component of the investigation including a hypothesis, procedures, data analysis, and conclusions. Implement your procedure only *when it has been approved by your teacher.*"

Open inquiry: Students investigate topic-related **questions that are student formulated through student designed/selected procedures**. "Design an investigation to explore and research a chemistry topic related to the concepts we have been studying during the current unit of chemical reactions. Implement your procedure only *when it has been approved by your teacher*."
(As printed in "Simplifying Inquiry"; *The Science Teacher*: October, 2005; p. 30-33)

Figure 2. Dr. Meadows' class handout/presentation summarizing Rezba, Auldridge, and Rhea's (2009) categorization of level of inquiry.

The first method in an inquiry classroom researched for this study was the use of questions, which grew out of the tradition of Socratic Method as described by Hunkins (1972):

> For over two thousand years since the Greek philosopher Socrates used a method of questioning to arrive at a definition, the question has been a part of teaching. The question is common to the various scientific strategies or processes. Individuals ask questions to identify the reason or reasons for search. Individuals ask question to direct their search and to synthesize information. Individuals ask questions to evaluate conclusions resulting from investigation. Questions are used in scientific investigation to provide additional information and guide in achieving new insight. Using the question to assist one's investigation is a new use of the question in the schools. In the past, teachers primarily questioned to ascertain if

students were learning book content and to check if students were attending (pp.1-2).

Hunkins (1972) also addressed the different types of concepts students learn while in the classroom:

> Information can be grouped to form what have been called concrete concepts and abstract concepts. Concrete concepts are learned from observation. The learner can see these concepts or at least the phenomena from which these concepts evolve; he can manipulate these concepts to study relationships (p. 4).
>
> In learning concepts, the learner is asking questions. He asks questions that direct his attention to significant elements and to relationships among those elements. The abstract concept is the second type; this is the concept by definition. These concepts exhibit relationships. Individuals cannot learn these concepts by observation in the way they learn concrete concepts. Rather they must learn such concepts by definition primarily through verbal means. These concepts also can be called relational concepts (pp. 4-5).
>
> Gagne indicates that we do not know how many situations one needs to learn a concept. How ever, it is evident from the example that the child must be involved in his learning. But the child needs to encounter many situations of the concept in question in order to experience the range of situations in which the concept exists (pp. 5-6).

The importance of questioning can be seen in the various techniques used to teach certain lessons which will be covered in the second assertion in the results of this study.

Hunkins also addressed the benefits of the process approach of learning in inquiry-based classrooms:

> In schools emphasizing the process approach, students don't just learn concepts the use them. Once a certain concept is attained, the teacher provides students with opportunities to apply the concept to new situations. In such a way the student achieves a much broader basis for dealing with his world (1972, p. 6).

This is seen in the inquiry classroom where students learn methods or concepts and apply them in different situations.

Hunkins also discussed inductive and deductive teaching and the place of problem solving in the classroom, "The term 'heuristic' refers to the approach one takes in solving problems. Heuristic questions are capable of directing pupils' discovery or problem-solving approaches," (1972, p. 13) and the importance of teachers having a strong understanding of a subject area:

> Effective materials and potentially stimulating situations will be of no value if the teacher lacks skills in formulating questions….Of course, the teacher can use questions as lesson motivators; questions can supply the focus for an investigation. (Hunkins, 1972, p. 29)

Questions used in the classroom can be classified in several ways. The categories of educational objectives as developed by Bloom (1987) (knowledge, comprehension, application, analysis, synthesis, and evaluation) were also well summarized by Hunkins:

Knowledge
1. Knowledge of specifics
2. knowledge of ways and means of dealing with specifics
3. knowledge of universals and abstractions in a field

Intellectual abilities and skills
Comprehension
1. translation
2. interpretation
3. extrapolation

Application
Analysis
1. Analysis of elements
2. analysis of relationships
3. analysis of organizational principles

Synthesis
1. Production of a unique communication
2. Production of a plan or proposed set of operations
3. derivation of a set of abstract relations

Evaluation
1. Judgments in terms of internal evidence
2. judgments in terms of external criteria (1972, 35-37)

Hunkins (1972) also covered ways to formulate effective questions. Knowledge of the student is central to planning what types of questions to use with particular students (pp. 62-63). Consideration of goals is also important for formulating questions. In the discovery-curriculum, we want our questions to spur students to active search; we wish our questions to encourage students to begin to understand their world (p. 64).

Questions incorporated into strategies can have four possible overall functions centering, expansion, distribution, ordering.

> The first two centering and expansion are guiding functions by which the teacher assists students to either focus on material at a particular cognitive level or to engage in divergent thinking at a particular cognitive level. The distribution function is a management function aimed at involving students in their learning. The fourth function, ordering, relates to classroom control and maintaining an environment conducive to productive student learning. The centering works to

> bring together students thoughts. Centering is usually employed in the introductory stage of a lesson when we are attempting to get students to attend to the topic of study (Hunkins, 1972, pp. 78-79).
>
> In the centering function, of a question strategy the teacher attempts to direct students to actively formulate questions for investigation (Hunkins, 1972, p. 81). Expansion the second questioning strategy function, directs students to expand or extend their thinking. It can exist at the same cognitive level stressing depth or it can aim at raising the cognitive level of the students' reactions to information. The expansion function requires increased student precision and greater student involvement in investigation. The expansion function often emphasizes the higher cognitive levels. Students are guided to analyze data not only to identify elements and relationships but to apply information learned in one situation to other situations (Hunkins, 1972, p. 82).

Hunkins provided examples for seeing how questions are used when teaching students about the scientific process, with test, in labs and other parts of the class.

CHAPTER III. Research Methods

This was an interpretive study and the type of qualitative research done was based on "grounded theory." The type of method used for analyzing the data was selective coding and this was chosen because the core concept researched in this study was scaffolding. The relationships between scaffolding, the various forms it came in, and the other concepts were important to this study. Through out the process of collecting data, and having interviews the information collected was compared and contrasted. The area where questions and perspectives were changed as the class went on was through the interviews and literature.

The classes observed during this study were a science methods course and a physics course for middle school science educators. The classes were made up of all females except for one male. They meet three days a week for three hours each time. At the beginning of the semester Dr. Jackson and Dr. Braxton gave out course syllabi that discussed what their course objectives were for the class. Their objectives summed up an understanding of the subject they were teaching and for the students to be able to teach the subjects or use the methods in their own classrooms.

During the semester several interviews occurred with students and teachers in the classes. Two of the students, Stephanie and Janis, where interviewed together twice. During the interviews, the first one was to get an idea of where the teachers and students stood in the class. Afterwards the interviews involved seeing the students' reactions to the teachers and the teachers' reactions to the students. As the semester went on information that was missed at the beginning of the semester was clarified, for example opinions on where the balance of responsibility for learning came between the students and the teacher. In order to collect data, I had to take on several roles including being a participant, observer and interviewer.

CHAPTER IV. Results

Instructor Objectives

Dr. Jackson's approach to teaching in his classroom was an inquiry-based method using a hands-on minds-on approach. In Dr. Jackson's class, he taught students in a variety of ways because he thought most students were likely to learn more over time through this. He also thought students understand topics more thoroughly and maintain a positive attitude if they are not always taught just in one way, for example lecturing all of the time. Some of the main objectives in his class were to have the students involved in active thinking, to prepare the students so they have the proper content knowledge for teaching, for these future teachers to understand the misconceptions their students may have, and for them to understand the proper way to test their students.

In Dr. Braxton's class, his goals for the students were to have an excellent conceptual understanding of the physics concepts covered in the classroom. This included force, motion, structure and properties of matter, heat, temperature, sound, light, electricity, magnetism and modern physics if the time permitted. Through out the semester a difference in what Dr. Braxton expected of his students and what his students wanted out of his teaching was seen. One of the interviews provided a deeper insight into Dr. Braxton's philosophy on learning physics and possibly why his philosophy and the students' philosophies sometimes clashed.

Teacher and Student Responsibility

As mentioned before sometimes there were inconsistencies in what the teachers wanted the students to know and how the students sometimes thought the teacher should be teaching them. One of the interview questions that grew out of this was when it comes to learning where does the responsibility of the student and the teacher meet. (Quoted questions from the interviews will be in bold, and the responses will be italicized.)

One of the responses was,

> *Oh that's a good question; um I think the responsibility of the student and the responsibility of the teacher meet when everyone is doing what they are supposed to be doing. For example if the teacher is teaching in the best way they can and is seeing that the students understand. I think the student meets when they are actually doing the homework, actually understanding it and retaining it making sure they do the homework and are making sure that they really understand it. I think that is were it meets* [Janis November 11, 2009]

Most of the answers centered on the responsibility of the teacher being to set up the environment in the best way for the student to learn. Most of the answers for the students centered around the student's responsibility being to do their best when it comes to learning or to get the help they need if they are having trouble.

Dr. Jackson's response expanded on what a teacher needs to be able to do in the classroom,

> *…. but you always have to constantly readjust your ideas of what's appropriate and what's likely to work well based on feedback, or in terms of assignment or in terms of what you see in the classroom. That you get about what your particular current group of students seem to need or in some cases seems to want.*
> *And to the extent you have students who may not have the greatest inherent motivation there is a certain amount that you can or should do to try to motivate your student or try to incorporate tricks that you may have up your sleeve to try to*

get them interested when they may not otherwise be interested or to get them to pay closer attention when they otherwise would not do that. That's what trying a certain amount of that is out of your control [Dr. Jackson October 19, 2009].

<u>The use of questions in an inquiry-based classroom</u>

Through the literature used in this study the use of questions was revealed to be an important part of the scaffolding method. Questions are used in lectures, demonstrations, test, and labs among many other activities. In the physics class there was a lot of knowledge based questions and synthesis based questions Dr. Braxton wanted the students to answer. The students often had a hard time with these questions and got frustrated with them. Many of the students said they needed time to internalize the way the physics formulas worked, but the class moved so fast often they couldn't understand it. In Dr. Braxton and Dr. Jacksons' classes, when the teachers would do demonstrations, often they would use questions to lead students into a clearer understanding of what was going on and the physics involved.

One example is during a demonstration when the teachers were trying to lead the students to answer the question of how a ball moves when it is dropped by a person sitting on a moving cart. (The following reconstruction is based on field notes and is not a verbatim transcription.) During the demonstration Dr. Jackson and Dr. Braxton were up at the front Dr. Jackson pushed a cart across the room. He turned to the students and asked, "When you push a cart it moves when you stop moving it it comes to a rest does that violate Newton's 1st law?" One of the students raised their hands and said, "No it doesn't because it has outside force acting on the cart. Dr. Jackson asked, "What's another name for that?" The student answered, "Friction". The next demonstration involved pushing a cart with a ball on top of it. Dr. Jackson asked, "Does the ball move compared to the room?" A student raised their hand and said, "No that it only moves compared to the cart."

Then Dr. Jackson asked for a student to come up for the next demonstration. Dr. Jackson told the students to watch as he pushes the cart and she drops the ball and see where it lands. The student sat on the cart and Dr. Jackson pushed it across the room. Then she dropped the ball and Dr. Jackson asked, "Where did the ball drop?" A student raised their hand and said beside it. Dr. Braxton asked, "Why did the ball drop beside the cart?" Then the student said because it has the same velocity as the cart. Dr. Braxton also asked, "When the ball dropped which direction did the ball go?" Another student raised their hand and replied, "The same direction as the cart." Dr. Jackson said, "If there was a person riding on a bus and it passes by and sees what is happening. What would they see?" A student raised their hand and said they would see the ball going straight down. This demonstration led the students to the conclusion that the ball had a constant velocity motion.

Questions were used in a variety of ways in Dr. Braxton and Dr. Jacksons' classes. Dr. Jackson had the students create multiple choice questions when discussing creating test for their students. During one of the interviews a students mentioned this.

> **Did you notice anything Dr. Jackson has done that stands out to you?**
>
> *When he asked us to make multiple choice questions he didn't say this is how I make multiple choice questions. You make multiple choice questions by listing four choices you do this you do that. It was we figure out how to make multiple choice questions we looked at good examples and bad examples and we learned from it that way. We learned by doing. I learn when I make mistakes* [Stephanie September 26, 2009].

Another example of the use of questions in the class room involved the Socratic Method.

I noticed that Dr. Jackson sometimes asks questions to lead you into other answers does that sometimes help?

Yeah, I think that helps a lot because he doesn't give us the answer. He makes us think and when you figure things out for yourself you learn more because when someone else tells you, you forget. Like if I don't know that this is a fact I will write it down and never look at it, but if I am asked how do you feel or what do you think I get it right because I thought of it on my own, but if I get it wrong I know its because I thought this or I thought that. And it makes sense that I got it wrong. [Stephanie August 25, 2009]

This is a shift during the interviews from Stephanie to Janis. Janis' response branched off of what Stephanie was talking about and seemed to be more of a constructivist view on learning.

You make your own connections because everyone thinks differently and everyone learns differently. I think differently than Stephanie thinks so if someone lectures you, you have to think their way and then when you think that way that may not be the best way for you to make the connection with the material. [Janis August 25, 2009]

<u>Hands-on Minds-on</u>

The interviews and class observations provided an opportunity to analyze the use of questions in the class and how the teachers, in particular Dr. Braxton, liked to use questions. This connected to his use of hands-on minds-on activities which increased as the semester went on. At first Dr. Braxton used plenty of physics problems in the classroom and this tested knowledge and synthesis. Dr. Braxton connected these abstract thoughts to hands-on activities which answered questions of (not always explicitly) application, analysis and comprehension. This provided a view of his philosophy on teaching which did have modifications as the semester went along. At first there were a lot of problems and not as many hands on experiences, but as the semester went on Dr. Braxton added more lessons teaching students from a variety of angles and activities through hands on experiences.

Has doing more hands on stuff helped with the students learning?

> *I think so a lot of them mentioned that there are a lot more hands on questions, and a lot of them mentioned you have to have hands on experience for physics problems. And to understand abstract concepts, I do think you have to have abstract concepts they are necessary not optional, and to have mathematical presentations and the abstract concepts in physics you have to have a grasp on these things. Then transform those things back into concrete experiences and observations. So when I observe other people teaching and some doing hands on activities, lots of concrete observations, and visual learning, but they just stop there they don't move to the abstract level. Which I disagree with, I think students have to have you know both to reach a deeper understanding* [Dr. Braxton October 26, 2009]

Group work

Through out the semester in science methods and physics, the students worked individually, as a class and in groups. Of course some groups worked faster at the labs then other groups, but this sometimes did make it interesting when it came to the actions students would take in the class. When I was working with one group in particular, during one of our first labs things were going well until other groups appeared to be done. Then one of the group members suggested we just make up the answers. I was a little taken back by this considering the other students knew I was doing research on the class. In this particular group, I found sometimes the members were hesitant to discuss what they thought the group should do to solve a problem or work on an experiment.

The hesitancy appeared mainly at the beginning of the semester and as it went along the student started to work more efficiently as a group. None of the groups really ever broke apart to work with other people in the class. They mainly worked with the people at their table. One of the questions asked during the interviews was if there were any drawbacks to working in groups and most of the answers involved when students do not get along with each other. One answer in particular dealt specifically with what group members did or did not feel comfortable doing.

> *Well in every group you're going to have someone who is going to work harder and someone who is not so that is always the drawback to group activities or like in our science night experiment we had to work with worms and I don't mind touching worms but my partner didn't like that so that's kind of an obstacle its not a big deal but its an obstacle you have to overcome when working with a group* [Stephanie November 18, 2009]

> *What I like in this class is that you can choose whether you want to work in a group well at least in Dr. Jackson's class you kind of have that freedom because a*

lot of times you pick the people you work with but a lot of times n schools the stick you with people and initially its cool but then you come to find out they are a slacker they don't care and your pulling all of the weight and I feel like the people in this program I have never worked in a group where I felt like people were not pulling their weight they were doing the best they could if people didn't understand someone else would help them understand and tell them this is how this works and everybody helps each other out and so I really haven't found to many drawbacks in this class because we have the freedom of choosing [Janis November 11, 2009].

After I worked with the one group that made up the answers to the lab, I asked Dr. Jackson what a teacher can do in those situations. He talked with me about how most of the time students will not make up answers because they realize their grade is at stake so they will do their best work.

Communication is a big part of inquiry-based learning and is also largely involved with group work so one of the questions for the interviews was, "what can you get from working in a group that you can't get individually?"

Well you can get different ideas from people. Your individual smaller ideas once out can grow to bigger ideas and you can bounce ideas off each other, and it can make something so much more successful. For example if something isn't working you could be like oh that doesn't work because you have that background *knowledge. Like I don't expect this to work because they've tried it or I do expect this to work because they said it's a good idea* [Stephanie November 18, 2009]

I received another answer similar to this through a different question and it also reinforced the importance of group work.

What has been beneficial in Dr. Braxton's class?

Probably working in groups and being able to talk it out between ourselves because if I don't understand the concept and someone else does it helps me because maybe they can explain it to me better …[Maddie November 9, 2009]

<u>Student Initiative</u>

Something else addressed through the research was how the students own study or work habits changed throughout the semester and how the teachers teaching styles changed through the semester. The answers from the students provided a view into how their own initiatives in their education changed. The reason this question was asked was because part of a teacher's goal in teaching is to help the students be able to go and look for stuff on their own; to not just wait to be given an answer but to actively search for them.

How have your own personal methods of studying or learning changed?

For me things have definitely changed I am not a visual person at all. Like in my undergrad I was an environment science major. I had to learn animals and critters it was not very mathematical but I would go to the library and memorize things and study but with this I have to work problems I have to pull out *simulations I get together with people and talk things out. Its more talking to other people and us as a group coming up with an answer when before it was just me. I was in the lab I was staying up until 2 in the morning I had my note cards but this is a lot different* [Janis November 11, 2009].

I've lost a lot of motivation My study habits haven't really changed I've just kept doing what I've been doing. I've been reading the book and mainly studying and trying to keep up with the homework [Stephanie November 18, 2009].

Part of the reason for this statement may have dealt with the fact that it was the end of the semester and students tend to get stressed out during this time.

Well I mean in all honesty with this class I've had to because this class moves to fast for me and when he ask do you have any questions I just don't have the time to process what he said, and I don't have time to think about it because he's moved on to the next question or the next whatever. Even in the beginning of the class I got on line and I printed out all kinds of stuff because I couldn't understand certain things. Should I do problems in the textbook, should I do them online, should I do them all? For me its really hard because the thing is I have more interest in this then when I first started I want to understand it, but I think it is too fast for me especially with the fact that I have other classes [Anne October 19, 2009].

*I see physics everywhere now. I am riding in the car and I am thinking about how traffic things are related to my car ride and it actually makes me want to teach physics because it is hard for me and really hard for students but it makes me feel like we relate to each other. I do well I try to read more because if I read after the lecture it makes more sense then if I read before so I can kind of relate his terminology to their terminology and I can get it. [*Maddie November 9, 2009].

Part of Dr. Jackson and Dr. Braxton's teaching involved connecting physics to every day events student's encounter.

So you have been taking your own initiative and done your own learning?

Yeah he assigns the reading the night before but I do the reading the night after because it helps me figure it out. The first class I was reading first and had no idea what was going on, but then we would talk about it and I would kind of know what was going on. Then I would go back and read it again, and I would understand it better. So that makes me think that is just the way that some kids learn compared to other kids. So maybe instead of assigning reading the night before maybe reading could be assigned both nights [Maddie November 9, 2009].

Through this question in the interviews, an increase in student initiative to go out and find information was seen. As seen through Maddie, students were also able to take what the teachers gave them and use them in the way they learn best. It also showed students understood they will not necessarily be given the answer to questions which is part of the method in inquiry-based learning. This also allows students to be stretched and to grow. Some students did say the class moved to fast or thought the way they studied before was fine so why should they change their study habits.

<u>Students' perspectives on the teaching methods and on what helped with their learning</u>

The questions that helped show how scaffolding was particularly used in the classroom and what was or were not helpful were:

How have Dr. Jackson and Dr. Braxton's teaching changed throughout the semester? or What has been beneficial about Dr. Jackson and Dr. Braxton's teaching?

The answers to these questions provided insight into how the teaching in the classroom affected the students and what they found most beneficial from the teachers.

> **What teaching techniques or classroom activities have been the most beneficial to your learning?**
>
> *Janis: Dr. Jackson's experimental method. Trial and error making connections oh this didn't work this time but what if I did this* [Janis September 26, 2009].
>
> *Stephanie: Oh yeah the same is for me I liked when we were making a multiple choice assessment it helped out a lot because you learn as your doing it and you do it yourself as an assessment and it works as an assessment and I also learned as I did it and I've been learning be doing hands on things*[Stephanie September 26, 2009].

These answers showed that students wanted an opportunity to try problems on their own so they could fully understand what was going on.

Did you notice anything Dr. Jackson has done that stands out to you?

Stephanie: The way when he asked us to make multiple choice questions he didn't say this is how I make multiple choice questions. You make multiple choice questions by listing four choices you do this you do that. It was we figure out how to make multiple choice questions we looked at good examples and bad examples and we learned from it that way. We learned by doing. I learn when I make mistakes [Stephanie September 26, 2009].

What has been beneficial in Dr. Braxton's classroom?

…, we actually got to do it and learn it on our own. He wasn't like this is why this tape is attracted to the other tape. Instead it was like you figure out when the tape is going to be attracted to each other and when is it not [Stephanie Sept 26, 2009]

These answers during the interviews showed students wanted a chance to learn topics on their own to not just be given the answer but to be guided towards the answer.

In the first interview we talked about some characteristics of Dr. Jackson and Dr. Braxton's teaching, have you noticed any change in their teaching methods since then?

Janis: Dr. Jackson is still the same, very collaborative I want you to figure this out on your own but I am going to lead you in the right direction. I feel like Dr. Braxton is getting better with having things hands on and examples that we can *see. I had a problem before where we were given a lot of math but now we have simulation labs he will bring in other people to talk to us it has gotten a lot better this second half of the semester. I feel like it is hard but I am retaining it a lot more I can understand electric current a whole lot more than I could understand velocity and plutonium mechanics* [Janis Nov 11, 2009]

The second question dealing specifically with the teachers was,

What hasn't been beneficial to your learning?

Well probably let me see for me the lectures don't always help me because he's just up there talking and not showing anything, and I am a more kinesthetic visual learner. And sometimes if he draws something or puts something up there hands on I will understand it, but a lecture by itself does nothing for me [Maddie November 9, 2009]

In your opinion is there anything that would help you learn better?

In Dr. Braxton's class I think it might be a better idea if he explained things before we actually do it because sometimes we are taking notes and its like what are we taking notes on? So if he would summarize things more or give us a little intro it would help me because I like to know what were doing because you have an idea behind what you're going to do [Stephanie November 18, 2009].

These two answers showed students needed a chance to process the information they take in during class, and they also enjoyed learning in a variety of ways instead of just through lectures.

What hasn't been beneficial in the classroom what is holding you back?

Stephanie: Pretty much when we sit in class all 2hours and stare at the board and it is very hard for me right now to look at the notes and understand what I was writing. That doesn't make sense and there's no problems we can try, and then all of a sudden we are graded on these problems but we haven't learned how to do them we haven't been given examples. That is the hardest thing for me just taking notes and not understanding what your taking notes on. I know the physics professors understand it, but I don't understand it in the way they do. I look at it and I'm like uh this is just a bunch of letters [Stephanie September 26, 2009].

Janis: I couldn't agree more there are so many times when I have taken all of these notes in class and later I look at it and I have no idea what I'm looking at I can't interpret it at all. We don't really get any processing time because I need the time to look at it and say this is what I'm looking at I need time to look at it myself and create my own processing time [Janis September 26, 2009]

> *Yeah because maybe you need time to figure something out while another group needs more time to figure something out. We are running a marathon and we need to take it slow* [Stephanie September 26, 2009]

Overall with the scaffolding techniques used in this inquiry-based classroom the variety in teaching methods did help students retain what they learned compared to a strictly lecture style classroom or strictly hands on classroom, as seen through the students and the teachers responses. Part of this may have had to do with teaching the students in various ways. The teachers didn't teach just labs all of the time or just group work. Students had several opportunities to work in different ways allowing them to think, "Oh I have never thought about this concept that way before".

CHAPTER V. Discussion and Limitations

Through the interviews and research on scaffolding and inquiry-based learning I was able to see an improvement in the students' initiatives when dealing with their learning, through the teachers challenging the students and helping them to understand the process and skills needed to learn certain topics. The students learned through various perspectives on certain topics, through not being given the answer to question but being asked certain questions, group collaboration, and by being challenged to grow on their own.

Something else really distinct during the research was how certain lessons or teaching methodologies helped certain students. This made me think about different learning styles including tactile, auditory, visual, and kinesthetic. During the semester in science methods and physics one of the methods of teaching that was highly emphasized in the literature for scaffolding techniques was teaching lessons to a variety of students in several different ways instead of teaching just one way for example lecturing. The various ways the teachers taught in the classroom included

- lecture
- demonstration
- group work
- computer simulation
- sample problems

Through out the semester in Dr. Braxton and Dr. Jackson's class there were several lessons taught in different ways. During the class, I thought this was because of the different learning styles. Dr. Jackson told me he taught lessons in various ways because these students could use them in their future classrooms and also because students are likely to learn more in the long run from teaching lessons from in a variety of ways. They understand concepts more, and maintain a positive attitude if we don't do all lecture, all hands on or all group or all individual.

Through the interviews my assertion that teaching to a variety of learners is better then just lecturing was reinforced by the students.

> **What activities do you think that they have made helpful with the learning differences?**
>
> *Like for this half for the electric currents you have problems to figure out, then we have role playing and for visual learners you've got the simulations and for the interpersonal learners they get to talk things out. I feel like we've been doing a lot of things in this class now that help with different learners besides sitting and listening to him lecture I know that helps with auditory learners but it doesn't help with anybody else* [Janis November 11, 2009]
>
> **That's really true he has been teaching in several different ways.**
>
> *Yeah because he'll do a little auditory teaching, or well do role playing or well go to the computer lab and the simulations work really well and allows people to do things themselves. But it also helps with tactile people because they can put things together I'm not tactile but that's okay. I know Morgan she had a really hard time last semester but since we've gotten to this part she has been doing really well*

because she likes to put things together and see how they connect so it helped her

[Janis November 11, 2009].

Even though it is important to realize certain people learn better in certain ways it is also important not to categorize people and assume they can only learn in one way.

Some of the factors in this study possibly affecting the results include the class was made up of all females except for one male. The length of the class was three hours, and even though the students received breaks this did play a role in students' attention spans. If the students were in the class for a shorter amount of time the lectures may not have been so confusing.

References

Bloom, B. S. (1987). *Taxonomy of educational objectives: Cognitive domain*. New York: Longman.

Bruner. J. S. (1960). *The process of education*. Cambridge, MA: Harvard University Press.

Dewey. J. (1910). *How we think: A restatement of the relation of reflective thinking to the education process*. New York: Heath.

Hogan, K. & Pressley, M. (Eds). (1997). *Scaffolding students' learning: Instructional Approaches and issues*. Brookline, MA: Brookline Books.

Hunkins, F. P. (1972). *Questioning strategies and techniques*. Boston: Allyn & Bacon.

Kersh, Bert Y. (1964). *Directed discovery vs. programmed instruction: A test of a theoretical position involving educational technology*. Monmouth, OR: Teaching Research, Oregon State System of Higher Education. (ERIC Document Reproduction Service No. ED003616)

Rezba R. J., Auldridge, T. and Rhea, L. (2005). Simplifying inquiry: Levels of inquiry in an effervescent antacid tablet activity. *The Science Teacher*, *75*(5) 30-33.

Appendix A: Sample Lecture/Discussion outline from Dr. Jackson's class

Aristotle dropping stuff and seeing what hits first. Weight doesn't matter.

What affects it?

Air resistance

Has to do with mass or weight compared to air resistance

But they have different force

F=Ma

May have different mass but constant acceleration

Why does a penny move when you stop?

Newton's 1st law

Has little friction so pretty much no force is moving the penny forward

When you push a cart it moves when you stop moving it it comes to a rest does that violate Newton's 1st law?

No has outside force on it (friction).

Demonstration- ball on cart

Does the ball move compared to the room?

No only moves compared to the cart

Demonstration

Teacher on cart drops ball on cart where does it land?

-Beside it has same velocity as cart

-same direction

For a person on a bus what do you see?

-The ball goes straight down

Constant velocity motion

What happens when you throw a ball up in the air on a bus?

Will the ball come back down or trail off behind you?

It moves in a parabola

But to the person on the bus (cart) it moves straight up and down.

(It is beneficial to have every student in your class to get to do this physically.)

Actual motion is relative to you. For example if someone is riding on a cart the class is moving backwards. The students were having some problems with average velocity from pg 56-57 in their book. So they asked for sample problems but Dr. Braxton reminded them to look at the answers then come to his office hours.