situation. A teacher's ability to help students to name a problematic situation and, at the same time, frame it utilizing their background and prior experience, can help to determine the level of success or failure his/her students experience.

Once the problem has been named and consequently framed, it is now time for the process of investigation to begin. However, in order for the learning to be meaningful and for understanding to develop, the students must be able to rename and reframe the situation as information is gathered (Schön, 1987; Loughran, 2002). The ability of students to frame and reframe an event stems from their ability to investigate this situation reflectively.

B) How Do We Know That Which We Know?

Sometimes, the most difficult thing to do as a teacher is to try to make viewable the things we do without thinking. Even when an explanation is attempted so that the tacit may become visible, the very description of what is being done will in turn contradict what has actually occurred (Schön, 1987, p. 24). It is this knowledge that Schön refers to as *knowing-in-action* (Knowledge that we know but are unable to explain how we know it or what it is). There is a great deal of tacit knowledge involved in physics education that, unknowingly, may cause our students to miss important concepts. We must be careful to understand what our students may, or may not see, in our lessons. It is only after something has been learned that we are able to execute, adjust, reexamine, evaluate, or predict without actually having to "think about it."

This idea of knowing-in-action came up in my own teaching a year or so ago during a lesson on circuits when I had made the assumption that students were able to logically "see" that the current in a series circuit must be the same through all components. I had made the assumption, incorrectly, that they understood that charges are conserved and that the electrons moving through the wire are not "used up" (a common misconception well documented by Arnold Arons (1997)). What I did simply because "that is how you do it," was not visible to my students. In this case, a disconnect occurred where students were not able to see the why of what I was doing and therefore were unable to understand the analysis of the circuit. Part of the reflective process is looking at what you know and determining how it is that you know it (Schön, 1987).

C) The Reflective Cycle

During the learning process, there are a number of avenues one may undergo in the acquisition of new knowledge. For the majority of individuals, the term reflection is used as a post-event activity where the actual outcome of an event is juxtaposed against the intended outcome. This is the process of looking back to determine if the intended outcome was achieved, referred to as *reflection-on-action* (Schön, 1987, p. 26). This could manifest in terms of test result analysis. The teacher looks at the tests results and is able to get a clear picture of how effectively the material was covered. This could also arise as a journaling activity where the teacher looks at which areas of the presentation were effective and which areas of the presentation were ineffective.

One reflection-on-action technique that can be utilized is a LFM (Learn From Mistakes) guide where students are given the opportunity to earn points back on a test by engaging in reflective analysis of the question they answered incorrectly. In this activity students were able to take the questions they missed and engage in a process of reframing, problem re-identification and then completed the problem based on their new frame. When the students began to evaluate their mistakes and were confronted with the outcome of their intended results, they began to reframe the questions in a way that demonstrated understanding the relationships among concepts (Pinkerton, 2005).

Lesson planning can be tedious at times, but any teacher will tell you that effective classroom procedures start with proper planning. As a teacher, it is a common to sit down before an activity is to be performed and begin mapping it out. This could consist of pulling required materials, mapping standards to activities, and researching common student preconceptions. In this process the teacher is engaged in what Schön calls *reflection-for-action*. These are the actions that help to guide our instruction and dictate what we do before it happens. At this stage it would be beneficial for the teacher to make use of resources identifying common student preconceptions so that they can be addressed in the lesson (a good example of this would be Teaching Introductory Physics by Arnold Arons).

On the student end of reflection-for-action anticipatory sets, student discourse, among other activities can be used to get the student thinking about what they believe will happen, and more importantly, why they believe it will happen. One place in particular I have found that this type of activity works extremely well is in tackling Newton's 3rd Law. When students are given time to think about the interaction between two objects they set up a situation where they have constructed an expected outcome and have begun the process of question framing. However, the frame in this example is controlled in large part by the teacher's choices. In this instance, variety is essential. Situations should include as much variety as possible. Different mass combinations and different motions (constant motion or accelerated motion) can be used to really flush out the students preconceptions. By allowing students to develop a hypothesis regarding the outcome of an interaction they have also tied themselves to the intended outcome. The problem becomes much more personal as they become invested in the solution.

Reflection can be used to look back on an event and determine how effective it was, or it can be used to plan the actions of a particular event. However, a great deal of what shapes our actions comes with the thinking we do at the very moment of action. This is the type of analysis and decision making that is seamlessly integrated into the action itself. In this type of action we are engaged in *reflection-in-action* (Schön, 1987, p. 26).

Take for instance the pendulum activity described before. It has been well shown that many students believe that the mass of the pendulum, its initial angle and the length of the string will all contribute to the time it will take to swing back and forth (Arons, 1997). In this case the students have already created a frame around the question and have begun anticipating the expected outcome through a process of reflection-for-action. However, as the results begin to fall into place, I have seen many students stop for a minute and begin discussing the results during the course of their action. The students recognize that the expected outcome is not achieved and they are forced to rethink and possibly reframe the question as the results play out before them; they are reflecting-in-action. At this point the students may begin to reframe the question in their mind and alter their beliefs about what should occur.

During the course of a lesson, the teacher will undoubtedly be involved in the process of reflection-in-action as student preconceptions begin to present themselves and their framing of reflection-on-action are all utilized to bring about a complete and total reflective experience. In order to do this I will be examining the Reaction Board Lab used in my ~~Regents~~ Physics course.

The Reaction Board Lab is typically done about half way through the year and is used as a capstone activity after the students have finished the units of Projectile Motion, Energy and Momentum. My reason for choosing this activity in particular is that it has several different concepts involved and requires the students to look back over multiple units in order to properly frame the question and evaluate the outcome. The reaction board itself is a modified ballistic pendulum where the event is the result of an explosion rather than a collision (see Fig. 1). In the apparatus, the match allows the rubber band to be fired without any outside influence. Ultimately, the students are asked to find the amount of energy stored in the rubber band. However, no lab procedure is given to them. ~~Let's see how the reflective process can be modeled in this activity.~~ delete (?)

In order for this activity to happen with as little resistance as possible, there are several things that must be done prior to this activity so that the students are not overwhelmed. Since the lab does not have specific steps or procedures that are to be followed, students should have experience with designing and executing their own labs. The more exposure you can give your students the better. I typically begin from the first day having students design their own labs by making observations, listing factors affecting the phenomenon, and then designing a procedure to investigate those factors. In this sense, I am practicing the process needed to solve the reaction board. I have found that when the students are more comfortable with working independently (without teacher guidance), then they are likely to focus more deeply on the concepts behind the phenomenon.

include it in their frame. My reflection-in-action has helped to tailor the activity to meet the student's particular needs; namely to include the platform in their frame.

Before the heavier ball is shot off, the class once again pauses to discuss what they think will happen. During this discussion three viewpoints usually emerge. Some of the students believe the new demonstration will result in exactly the same outcome as the first situation. Other students will state that they think the ball is going to be shot more slowly, but fail to indicate the recoil of the platform (Their explanation resides on the increased mass of the ball which will gain the same amount of energy and therefore have a lower velocity). The remaining students think that the ball and platform will both be shot out in opposite directions. Each of these predictions has buried within it important ideas regarding the students' ability to name and frame the problem; much more than the first demonstration. The first group of students had framed the event without including any consideration of conservation of energy. The second group recognized that energy is conserved in the explosion, but have failed to see that the resulting motion is also governed by conservation of momentum. The third group is able to see the explosion as the result of conservation of momentum and conservation of energy though they may not use those terms exactly. It is essential that the teacher take the time to reflect-in-action on the students' beliefs so that he/she can address these misconceptions and remove the learning block that can arise. Students must *believe* in their results, not just *accept* them.

After the steel ball is shot off, the class meets again to discuss how their prediction matches the actual outcome of the explosion. In this discussion I have found it beneficial to ask the students why their initial ideas were confirmed in one demonstration, but were not able to understandings as contradictory to their own experience. Also, the information presented may depend on a base of knowledge the students simply have not yet acquired.

I don't believe that it is the intent of education to simply impart knowledge on our students. In both schools that I have worked, the mission statements included the idea of lifelong learning. If this is the real goal of education, shouldn't we be looking at the process of education and the role of the educator as more in line with that of coaching? I doubt that any educator looks at their job as nothing more than imparting knowledge onto their students. I know in my classroom, I hope that my students have not only learned the concepts behind motion, energy, electricity, waves, etc but that they also learned how to think critically and divide complicated tasks into core components. I hope that my students have learned how to take in information, categorize this information, and develop a plan of action for solving the problem. I hope that my students have learned how to self-evaluate and recognize their strengths and weaknesses. In all, I hope that most students have learned the reflective skills they need to become a profound learner.

period missing here, etc.

Ultimately, in education we are looking to build a legion of independent, knowledgeable, and skillful students that are able to learn for themselves and can function independently from us. In order for this to take place we must not only look at our profession as that of teaching, but we must also approach it as a process of coaching.

A) The Student-Coach Interaction

Teachers cannot simply tell their students what they know. Their own words can serve to misrepresent or under-explain that which they know and understand. Also, in order to understand what the teacher is saying, the student needs to know what it is that the teacher is

For this to work though, the student must be willing to listen to the teacher and then apply their understanding for the teacher to see. This could be done by looking at another object in projectile motion (different from the original), and see if the student applies the concept correctly.

There are several problems inherent in the act of instruction that can impede the student's ability to understand what is being said. First, the directions given by the teacher may be ambiguous. The student may not fully understand what is being said and are therefore, is unable to demonstrate what is being asked of them. Second, the directions may not be sufficient or with enough detail to allow the student to understand. This would be analogous to hearing every third word in a conversation and then being asked what it was about. You may be able to piece together some of what was said, but the overall meaning or concept behind the conversation would be completely lost. Lastly, the directions may be strange, unfamiliar or incongruent with the student's current understanding. In this case it would be difficult for the student to comprehend since the material itself is largely foreign to them (Schön, 1987, p. 103-104).

If the students were using LoggerPro, but did not have mastery over how to use the software, the learning process could shut down. If the student does not understand the term trajectory or peak this could impede their ability to correctly analyze the situation. Also, if the motion of the object is not recognized as that of projectile motion or is in opposition with their understanding of projectile motion, the student is not likely to develop the concept correctly (This can be seen when students are looking at the motion of a ball throw vertically upward. no cap. here

The lack of a parabolic motion can keep students from seeing the situation as that of projectile

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