**Utilizing Reflection in the Physics Classroom**

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**Abstract:**

Reflection is a process that has been widely promoted but, in many cases, poorly defined. Many advocate the use of reflection and reflective practices in the classroom, however few give clearly defined guidelines for how this should be done. It is the goal of this paper to discuss my own experience in learning what it means to be reflective, to discuss some of the benefits of reflection in the physics classroom, look at the characteristics of reflective practices, and give some reflective methods proven to increase student understanding.

**I. My Experience and My Evolution in Reflection – Reflecting on Reflection**

Anyone involved in education these days has undoubtedly heard the term reflection and has been told at one time or another to practice it in their classroom. I know in my own situation the idea of reflection has been a common theme thrown out in both the school district I work in and the teacher preparation program I am working through. Many have called for the use of reflection in my classroom and in my own practice. However, what is meant by reflection and, more importantly, how it can be incorporated into the classroom, has not been easily seen. For me the process has been more of a “trial and error” method where I embark on what is to be a reflective journey, but without clearly identified guidelines as to what it is that I should be doing.

 In many of my classes, I was asked to participate in reflective practices by doing anything from a reflective journal to a personal evaluation. In each of these cases, what “it” was and what I was supposed to be doing weren’t very clearly defined. In some cases, I would do whatever I could think of that seemed to fit the structure of the assignment and then cross my fingers and hope for the best. For the most part this method seemed to bring with it some fantastic results. In most assignments, if I just wrote about myself and discusses the things I felt I could improve upon, then I got a good grade. This was much of the experience I had with reflection (Though there are some notable exceptions). With this feedback mechanism, I began to equal “being critical of myself” with “being a reflective person.”

 Reflection for the purpose of a grade proved to be different than reflection for the purpose of practice evaluation. When I was reflecting for class, it appeared that I was trying to do what would get me the best grade and had very little, if anything, to do with what would help me to improve or grow as a professional. When it came to reflecting on my own teaching practices, where a grade was not the intended outcome but rather the improvement of my ability as a teacher, I found the process to be much more difficult and the idea of what reflection is to be less clearly defined. I tried many things in my quest to be a reflective educator. I was critical of myself, I focused on my strengths, I tried to be objective about my methods, and I sought out the advice and opinions of others. In the end though, I was no better off than I was before. It was hard to be a reflective teacher when one has little understanding of what it meant to be reflective.

 My efforts were not totally in vain. Through this process of trial, error, evaluation, and reinvestigation I was unknowingly embarking on a reflective journey. It was very similar to when I first learned to swim. I was simply thrown into the pool and expected to swim. As my arms began to swirl around me, feet fluttering violently beneath me, all the while convincing myself that I would never learn to swim, I somehow managed to keep my head above water and in the moment of calm I was able to realize that, though it may not be pretty, I was in fact swimming. This was my experience in learning to become a reflective person. You feel very unsure of yourself. You don’t really know if you are doing it right or what it is that needs to be done. However, through this intellectual discomfort you begin to experiment and evaluate. When all is said and done, you suddenly realize that without knowing it you have become a reflective person.

 One of the biggest obstacles in becoming a reflective individual resides on the belief that there is one correct route. However, this belief that you are not doing things correctly, that you need to fix the way that you perceive reflection can, in the end, be the catalyst for becoming a reflective professional. When you first learned to ride a bicycle it was important to have a number of unsuccessful attempts. Since, when one has figured out every way to not succeed, the one will have a better idea of what it means to be successful (Assuming that the intended outcomes are linked and evaluated against the actual outcomes).

 The remainder of this paper will serve as a summative report for an individual looking to integrate reflective practices into their teaching practices. It is not intended to be a complete listing, but rather, a highlight of some of the basics surrounding reflection. Hopefully, it will begin to make visible the tacit knowledge that most individuals assume you know when asking you to become more reflective.

**II. Vocabulary and Terminology – Ideas from Schön**

 **A) Naming and Framing**

 The need for reflection in practice has been well document since the time of Dewey. However, what has been missing from much of this work is a clear and concise outline for how it is that one becomes a reflective individual. The very idea of what reflection is can vary widely from person to person, and simply being told to reflect is not good enough to encourage reflective actions (Loughram 2002). With the release of The Reflective Practitioner, Donald Schön provided a complete and comprehensive source for what it means to be reflective and how it can be incorporated into one’s practice. In order for a person to become a more reflective professional, we must first look at what it is that will help to construct these reflective practices.

 In order to first embark on a reflective journey, one must be confronted with something that is problematic. This problem, or difficulty, serves as the catalyst for the need to reflect upon a situation. However, in order to properly reflect on a given situation the problem itself, must be correctly identified (naming) and then put into an appropriate context (framing). This process of naming and framing is undoubtedly impacted by the prior knowledge of the individual and the context in which the problem arises (Schön, 1987, pg 4).

In the physics classroom, students may be introduced to an important event such as pendulum swinging back and forth. Depending on the background of the students, and possibly the instructor, the problem itself may be viewed through different lenses of knowledge. In my experience, I have found that many students struggle to isolate what it is about the event that is of interest (naming). Secondarily, the description of the problem can take on a wide variety of views depending on the background of the individual. Some may just see it as similar to a playground swing where as some more advanced students will see it as an oscillatory motion that repeats itself over and over. Even more astute students will possibly see this as the interplay between kinetic and potential energies. In any case, the problem description is dependent on the background of the individual. Therefore, the problem frame itself can vary from person to person.

From the perspective of the teacher, each of these frames gives a great deal of insight into the students’ level of understanding and ability to frame the problem at hand. This can serve as the problem for the teacher in which he/she frames the students’ understanding so that instruction can be individualized to deal with specific areas of concern or areas of strength. The answer to a question can at one time show profound understanding as well as lack of understanding. Often, the way in which the teacher frames the question can greatly impact the quality of the student’s answer (Schön 1987, pg 5). In this situation, both the student and teacher are simultaneously engaged in the process of naming and framing of a problematic 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 their 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 that which is done without a great deal of thought viewable to our students. 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, pg24). 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 in 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). That which I did simply because “that is how you do it,” was not visible to my students. In this case, a disconnect occurred in which 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 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, pg 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 in which 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 are LFM (Learn From Mistakes) guides in which students are given the opportunity to earn points back on test by engaging in reflective analysis of the question they got wrong. In this activity students were able to take question they missed and engaged in a process of reframing, problem identification and completing the problem based on their new problem identification. 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 thing to sit down a couple days 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 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).

At 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 that 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 an expected outcome and have begun the process of question framing. However, the frame in this example is controlled in large part by the choices the teacher makes in the sets up that students will look at. 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.

Reflection can be utilized 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 in a situation of *reflection-in-action* (Schön 1987, pg 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). In this case the students have already created a frame around the question and 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 reflection-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 the problem at hand gives insights into their particular strengths and weaknesses. The teacher may notice that students incorrectly believe that heavier masses will fall faster than lighter mass and this will cause the period of a pendulum to decrease since the heavier object is traveling faster. For the teacher, this indicates a very clear misconception that students may have included in their particular frame. In order to complete the learning process the teacher must be sure to address this preconception in the activity so that the results of the activity are palatable for the students (LOOK FOR RESEARCH ON THIS). The teacher’s reflection-in-action will allow them to move with the thoughts and actions of the student to tailor an activity to meet their particular needs.

The advantage of reflection-for-action and reflection-on-action is that the necessary judgments do not need to occur on the spot and the individual has the time and opportunity to think about, and research, the issues at hand. However, the process of reflection-in-action happens on the spot and the individual must draw upon their repertoire of knowledge in order to frame or reframe the question in light of new evidence. As the knowledge base of the individual increases, so does their ability to recognize the need to reframe a particular problem (Schön 1987, pg 66-67). If a teacher does not recognize, or set up the situation to allow students to explain, that students believe heavier masses fall faster than lighter masses, then their framework may not contain the information needed to put the situation into proper context. If this is the case then the students may be reluctant to accept the masses lack of affect on the period due in part to the fact that it is direct opposition with their understanding (or frame). Likewise, if a student’s frame and knowledge base does not allow them to recognize the fact that the mass isn’t affecting the period of the pendulum they will not immediately recognize the fact that the problem needs to be reexamined and reframed to take into account this new information. Surprise and a break from the routine sets up the situation to evaluate one’s beliefs an recognize the possible need for change, or at least to reframe the problem (Schön 1987, pg 28). Experience by itself is not sufficient to produce learning. It is the reflection on our experience that leads to learning (Loughran 2002, pg 35).

 **D) The Ballistic Pendulum – Putting the Process Together**

 **E) Where Reflection Can Go Wrong**

**III. Teaching As Coaching**

**IV. Tools for Instruction Evaluation**

 **A) TUG-K, FCI, MBT**

 **B) RTOP (Reformed Teacher Observational Protocol)**

 **C) IRTAR (Inventory of Reflective Teaching via Action Research)**

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