The Use of Inquiry-Based Education in the Science Classroom
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Submitted June 2001

Introduction

As we have entered the 21st century, science and technology are going to be leading the way and moving at an extremely rapid pace. As educators, we need to ensure that all of our students are keeping up with the national standards as well as the standards that have been set by other leading countries. According to the National Science Standards, “Inquiry into authentic questions generated from student experiences is the central strategy for teaching science.” Inquiry-based education is not a new idea; it is rooted in the philosophy of John Dewey. If we want to improve our students’ level of questioning and problem solving, we must begin to incorporate inquiry-based education into our classroom. The study of science is based on the concept of asking questions. Therefore, finding answers to those questions and then looking for new questions based on the answers found should be rather easy to implement into a science classroom. For the past two years, I have been trying to incorporate inquiry-based lessons and activities into my classroom. The more practice an educator has in completing these types of lessons, the better they will become. A teacher will also improve the types of questions they ask and challenge their students to a higher level of thinking. I have not turned my class into a completely inquiry-based classroom yet, however, each year I do move closer and closer to achieving that goal.

Background

The concept of inquiry-based learning stems from the philosophy of John Dewey. John Dewey believed in a completely student-centered classroom. One of Dewey’s beliefs was that “students must be involved in setting objectives for their own learning” (Noddings). To engage students in an inquiry-based activity, students must be introduced to an idea or concept through a demonstration or reading that will encourage questioning by the students. The questions the students come up with then become their individual objectives or goals. Because the students are determining the course of the class, the class becomes student-centered.

There are five major steps in the inquiry-based learning cycle. The first step is to engage the student. When engaging students, the teacher must find something that can provoke both students’ interest and their questioning ability. Students must learn to ask questions as they did when they were in elementary school.
The second step in the inquiry-based learning cycle is to have the students explore the questions they have presented. An effective way to explore those questions is through scientific investigation. Students need to formulate a hypothesis, create a test or experiment, and record all data from that experiment. After that has been completed, the next step, step three, is for the students to explain their results. This can be done in many different ways such as a journal entry, a class presentation, a lab report, or publishing information on a web site. After answers are found to the students’ questions, the students need to elaborate on what they have learned. This elaboration process is step four. The students can do this by asking new questions or applying what they have learned in the context of technology. The last piece of the cycle, before it begins to repeat itself, is step five, the evaluation piece. Students are to assess their own work based on predetermined indicators, examine their own strength and weaknesses, and use peer evaluation. Since this is a learning cycle, the pattern should continue throughout the year.

During the course of the year, I had all of my students complete a number of inquiry-based activities that surrounded our curriculum. The students’ ability level ranged from low to those labeled talented and gifted. For this research project I focused on how these activities were implemented in a class that consisted primarily of students who spoke English as their second language.

Methodology

There are two distinct types of assignments that can be handed out in a science class. The first is the “cookbook” lab or activity in which the students follow procedures and answer questions at the end of the assignment. Sometimes those types of assignments are necessary because they facilitate efficient comprehension of information. However, the drawback to using “cookbook” lab assignments is that the students are not taking any ownership over what they are learning. Therefore, the information they receive from the activity is not meaningful to them since these assignments do not encourage students’ questions. During inquiry-based education, you must make the students feel like scientists completing this experiment for the first time. The teacher must allow them to find problems in their procedures and make necessary corrections. In order for the assignment to be authentic, the students must feel like they are contributing to the scientific community. The nature of science is to question and find answers to those questions. This is the basic concept behind inquiry-based learning.

The way that I run my inquiry-based activities slightly differs from what the theory and research suggests. I usually start my inquiry-based activity with a problem that the students need to solve. I then give them a list of materials or display the items that they may choose to solve the problem. There are two reasons that I proceed in this manner: (1) there is a lack of materials so I must present them to all students to share, and (2) my students seem to respond better when I focus them on a concept. After they have the list of materials, the students, in-groups of three or four, come up with a possible hypothesis to the question and an experiment to test that hypothesis. Each group also needs to
determine how they are going to collect the data and how they are going to interpret that data. The students then need to present their finding to the appropriate audience. In some cases the audience might be the teacher, their peers, or possibly somebody outside the school. Finally, the students need to evaluate their work as well as work completed by their peers.

Example Activities

Example 1. The Balancing “Spork: The first inquiry-based activity that my class completes when they come back to school is the balancing “Spork”. A “Spork” is a spoon and fork combined. The Problem: How can a spoon, fork and a toothpick balance on a beaker, when the toothpick can only touch the glass and the spoon and fork can only touch the toothpick? The students are handed the materials and put into groups of two. They then try to find a way to complete the task. Once the task is complete, they are required to write a procedure explaining how the task was completed. The students must also draw diagrams of the apparatus, along with any observations they make. With very little guidance from the instructor, each group needs to draw conclusions from what they have observed. If they cannot come up with a conclusion, they need to come up with questions as to why this is able to occur. Some students are able to understand the concept behind the balancing act while others struggle for a little while and finally understand when each group presents their findings to the class.

Example 2. When the winter season is upon us, one of the main problems schools have is snow/ice-related closings. Therefore, my second activity directly relates to the closing of school due to ice on the roads. The Problem: Your town is asking us to test three different types of salts to be used on ice-covered pavement. Which salt substance melts the most ice and is the most cost efficient? The materials: Three brands of salt X, Y, Z, the cost for each, three ice cubes in paper cups, funnels, screen wire, beakers, graduated cylinders, triple beam balances, spoons, etc.

The students are then to determine a procedure that they are going to follow. They must also create a data table in which they are to record their data. After all of the data has been collected the students are to prepare a letter to the Department of Transportation, explaining the choice they have made based on the evidence and data they have collected. Not only do the students need to take into consideration the amount of ice each brand melted but the cost of each salt.

Reflections

At the end of almost every activity that I complete in my class, especially new activities, I like to get an idea of how the students enjoyed the activity and what they got out of the lesson. I usually wait about a week before I ask them because I truly want to see what they remember about the lesson and what stayed with them. At the beginning of the year, many of the students have problems with these types of activities because they are not used to them. I was
especially surprised when many of the higher ability students had problems with
the activities. Those students explained to me that they just what to know what
to do so they can complete the task and answer the questions. Some of them
did not grasp the idea of being given a problem and then coming up with a test to
solve it. This returns to the idea that if you want to introduce inquiry-based
learning into your classroom, you have to first change the students’ conceptions
about what science is and how you can go about learning science.

Many of my students were able to succeed at the tasks, particularly the
students that had limited English language skills, since they did not have to follow
any oral or written directions The result was that these students were able to
come up in just about all of the inquiry-based activities we completed during the
year. According to David Haway,

It seems particularly important that inquiry-orientated teaching may be
especially valuable for many underserved and underrepresented
populations. In one study, language-minority students were found to
acquire scientific ways of thinking, talking, and writing through inquiry-
orientated teaching. CITE

Students who speak English as a second language generally had more problems
completing the assignments in which directions were written in paragraph form or
in a procedure like form. As we completed more and more assignments the
students became more comfortable with completing these types of tasks and
began to practice science as it was meant to be practiced.

One of the fundamental goals of inquiry-based learning is to give meaning
to the content that we teach to the students. If we want our students to leave our
classrooms with the knowledge they need to succeed in life, then we must teach
them. In an explanation by Nell Noddings on the philosophies of John Dewey,
Noddings explained, “an experience has to be built on or connected to prior
knowledge.” Teachers need to find out where our students are and begin each
lesson and continue from there to investigate the questions the students raise,
rather than blindly pursuing the objectives the teacher decided on at the
beginning of the class. Since the students are asking the questions, the students
inherently demonstrate that they have a vested interest in finding the answers.
Students have many questions, though sometimes they are just scared to ask
them. As a teacher, you need to ensure that your students feel comfortable
enough to ask any question in your class regarding the topics being covered.

Conclusion

After reflecting on the assignments that I have given during the course of
the year, I have decided that next year I am going to take the inquiry-based
learning a little farther. For at least one unit a semester, I am going to have my
classes come up with their own problems to investigate rather than providing
them with the problem to test. I think by not only having them come up with a
topic or question that they are interested in, but also coming up with the test to
try-out their hypotheses, the students will gain a greater sense of ownership over
the activity. Inquiry-based learning activities are extremely crucial to have in a
classroom. However, these types of activities are not the only lessons a science
teacher should use in the classroom. Inquiry-based learning activities are just
something a teacher should incorporate into their teaching style. These types of
lessons will not only improve your students’ questioning and problem solving
ability, but it will also increase their interest level in science and in your class.

The benefits for inquiry-based learning are not only for the students. As a
teacher, you take on the role of a mentor to help the students with their
experimental design. Additionally, teachers have the opportunity to ask their
students open-ended questions that encourage their students to explore many of
the different levels of thinking.