Inquiry Analysis of “The Physics of Optics”

Alison L. Sullivan

Wilkes University

 In inquiry-based learning, there is a continuum of various types of inquiry that spans from teacher-centered to student-centered. These take the form of *structured*, which is teacher-directed, *guided*, which is teacher-student directed, and *open* which is student-directed. There is also *multidisciplinary inquiry*, which is a method that incorporates multiple curricular disciplines within one unit of study. When viewing particular segments of the video *“The Physics of Optics”* presented in the Teaching High School Science section on The Annenberg Learner website, (2013), we see examples of inquiry in a few of these forms.

 *“The Physics of Optics”* depicts a high school physics teacher teaching a class of eleventh and twelfth graders, the physics of lenses, light, and vision using inquiry-based learning. In the first segment of this video, we see structured inquiry that is teacher-directed. The teacher directs the class to give examples of what they know, what they think they know and what they want to know about vision. The students apply and use information to share what they know and what they want to know. This is teacher-directed inquiry as the teacher directly asks students questions to explore what they know. He tells the audience that he wants them to connect the information they know about mirrors and the new information about lenses to make learning happen. He describes his purpose, for this inquiry lesson, is to “elicit prior understandings and [try] to get a sense of what they know, then [build] on that knowledge so the students can effectively retain the information.”(Annenberg, 2013)

 In the second segment, we see more structured, teacher-directed inquiry as the students again apply and use information they know to try to answer question after question the teacher poses to them. He asks them, “What do I have to do [to the overhead projector] to focus the image?” (Annenberg, 2013) The students use what they know to come up with solutions. He repeats their ideas of “turn the knob”, and asks, “Up or down?” and “move the overhead” and asks, “Forward or back?” He tells them to discuss their ideas about these questions with each other. He never tells them the correct answer but instead demonstrates how the overhead makes things bigger and asks them yet another question to consider, “What else does?” Another teacher-directed class discussion ensues and he asks more questions such as, what makes things bigger *and* projects onto a screen, what devices make images smaller and what devices make images the same size? He guides this discussion to prepare them for his next directed activity.

 In the third segment of the video, students use candles (as light), a paper (as a screen) and a lens to discover how to make images larger, smaller and the same size. We see guided inquiry that is shared by the student and the teacher and there is less scaffolding. The students work in groups to find out how to make an image smaller, larger or the same size as the object. During their investigations, the teacher repeatedly asks students questions, leading them to discovery of answers. He always directs them to find out what the answers are. He does not tell them if an answer is correct or not. He describes the teacher-student sharing of inquiry when he explains how one student tried different things, which he never would have done, if he had demonstrated the activity. The student was learning along the way he says by “controlling the apparatus” herself. We see him sharing the inquiry when he repeats what the students answer and questions them to find out something else. He says, “Tell me how you solved the problem.” (Annenberg, 2013) He constantly questions this group, as they explore, while other groups in the lab investigate independently. At the end of this segment, the teacher tells us that the students are making the jump between lenses and mirrors, connecting their past learning to the new experience.

 In the fourth segment there are a few types of inquiry happening. The teacher explains that they have proven that the mathematical equation for a lens is the same as the equation for a mirror. Here there is multidisciplinary inquiry as they are connecting math to their science activity using the science lab to show the equality of these two equations. They are also given a teacher-directed task to prove that the two equations are equal using the same materials, candle, lens and paper. This is structured inquiry when the students apply and use information they know to make the determination. They work in pairs, investigating, discussing what they are doing, questioning each other and trying different strategies. One student exemplifies the teacher-directed inquiry feature of applying and using information when she states that when students have questions, “Our teacher tries to let us figure it out by using topics that we already know instead of just dictating answers to us.” (Annenberg, 2013)

As the activity continues we see more teacher-directed inquiry as the teacher looks at what the students are doing and guides them with suggestions to make their data more useful. He tells them to gather more than just two data points to graph as that always makes a straight line. He suggests they get six or seven points to graph to make an accurate line of data. We also see guided inquiry as students use less scaffolding support and use their science and math skills in a more advanced level to apply the information they are learning. In their small working groups, they ask each other questions, clarify information, reinforce their own learning, and work collaboratively. At the end of this segment, the teacher returns to structured inquiry as he asks them to graph the data they charted. He connects the equations to their experiments and encourages them to “think about physics the way a physicist thinks about physics”. He reveals that his big goal for this inquiry is for the students to “connect an experiment to theory and use the information about lenses to understand something bigger [which is] how it relates to human beings and human evolution.” (Annenberg, 2013)

In the final segment a teacher-directed, high quality, structured task is given, where students must apply and use information they have learned in their previous study, as the teacher poses this challenge to them. “…design an eye…so that no matter how far or close it is to an object, the object is always in focus. Design a human eye.” (Annenberg, 2013) This time, the students work in larger groups to create their eye. The teacher tells us he wants the students to try to use, apply and transfer the information they have to a system they don’t understand, the human eye. Once the students start working, the inquiry has less scaffolding and becomes guided-inquiry. Students work together to discuss, draw images, share what they know and collaborate. They use the equations they proved and worked with previously to help them develop their human eye.

We see the inquiry as teacher-student sharing when the teacher asks groups to explain what is going on. They have to articulate their methods and tell why they are doing each step. He encourages them to explain using the physics they already know. He tells them to explore as many possibilities as they can to see what will work best and encourages perseverance. We also see that he uses multidisciplinary inquiry in this segment as he asks them to refer to other content knowledge they have such as biology and mathematics to help create their eye.

Throughout this video, we see structured, guided, teacher-directed, teacher-student shared and multidisciplinary inquiry taking place. Using multiple types of inquiry is purposeful and successful for this physics teacher. This video shows me that I can mix the types of inquiry I use. In my second grade classroom, I use structured, teacher-directed inquiry, multidisciplinary inquiry, guided, and teacher-student shared inquiry. As this teacher did, we start many science and social studies units with a KWL activity. We also do a lot of sharing and asking of questions. Some posed by me and some by the students. We have gone into unplanned directions when an interesting question comes up that we cannot resist exploring. My students also connect old learning to new learning and have some “aha” moments. My students see the value of what we study if they can use it to learn something new and connect to something in their own life. This video was a good example of inquiry, in various forms. It helped validate my preference for mixing different types of inquiry within units of study.

References

The Annenberg Learner. (2013). Teaching High School Science. *The Physics of Optics*. [Video]. Retrieved from: <http://www.learner.org/resources/series126.html?pop=yes&pid=1414>

EDIM 513: Inquiry Based Learning Instructional Media. (2010). Unit 3, Topic B:  Essential features in classroom inquiry. [Online course topic]. Wilkes Barre, PA:  Wilkes University.

EDIM 513: Inquiry Based Learning Instructional Media. (2010). Unit 3, Topic C:  Types of inquiry based learning. [Online course topic]. Wilkes Barre, PA:  Wilkes University. Wilkes University.