Effective Methods Incorporating Inquiry into Teaching

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Effective teaching methods incorporate inquiry based learning (IBL). Education reforms over the past 40 years stress the importance of IBL relative to learning in science (DeBoer, 1991). There is significant literature and research to support the benefits and need of IBL, and the concept is well developed in Paulo Freire's Pedagogy of the Oppressed. However, reform efforts have apparently not resulted in broad range activities that involve students in inquiry based learning (Trumbull, Bonney, and Grudens-Schuck, 2005). This paper explores effective methods incorporating inquiry into teaching.

A clear concept of IBL is an essential prerequisite. IBL is considered a question driven approach to teaching that involves active, student-centered learning (Spronken-Smith, Bullard, Ray, Roberts, Keiffer, 2008). It is a philosophical approach to learning that contains some essential attributes, but may also contain additional characteristics. Some essential attributes include an active approach to teaching and learning, is question driven, uses an inductive approach, is student/learner-centered, teacher-facilitated, and is constructivist in nature. The additional characteristics may include collaborative, field-based, and resource-based approaches (Spronken-Smith, Bullard, Ray, Roberts, Keiffer, 2008). Students assume a high degree of responsibility for learning and generating knowledge.

The professional development of teachers is necessary to initiate and sustain IBL. In 1995, a study was funded to develop curriculum materials to promote IBL called Classroom Feeder Watch (CFW). The developers created a project based upon bird

biology, and the study was broad in nature. The data from the study did not support the claim students learned inquiry abilities as a result of participating in the design activities (Trumbull, Bonney, and Grudens-Schuck, 2005). A number of reasons were considered. The teachers "incomplete ideas about science inquiry or lack knowledge and experience in promoting student's inquiry activities" suggest the need for more professional development of teachings in guiding IBL.

In addition to professional development necessary to teach inquiry knowledge, it must also consider teachers' core teaching conceptions (Lotter, Harwood, and Bonner 2007). Teacher beliefs can act as filters. Inquiry and the use of it can take on different meanings to different people. Teacher views on science can also differ. Constructivist teachers may have views that are more amenable to inquiry than those with empiricist views (Lotter, Harwood, and Bonner 2007). Other teacher views of student's abilities and effective teaching itself can constrain or support IBL (Lotter, Harwood, and Bonner 2007). Professional development should consider variations in core concepts and lead to the use of inquiry in teaching.

Communication and feedback promotes IBL. In the 1995 CFW study, many of the students did not understand why the study was actually being performed, and that submitting their data would actually contribute to scientific findings. Conclusions were the project itself was too abstract, and lacked context. Students tend to process information more effectively if they believe it is relevant to some application and making real-world connections.

IBL is enhanced by high levels of content knowledge however attained. In the CFW study, the biggest deficit was the lack of appreciation of content knowledge. “How hard could it be to attract birds? Not very hard for people who know a lot about birds” (Trumbull, Bonney, and Grudens-Schuck, 2005).

If IBL is “student-based exploration of an authentic problem using the processes and tools of the discipline” then students must possess the science process skills required to conduct inquiry (Wilke and Straits, 2005). Process skills will include formulating questions and hypotheses, evaluating data, designing experiments, making predictions, researching, etc. In addition to content knowledge, teachers must teach the process skills necessary to conduct a full scale inquiry investigation (Wilke and Straits, 2005). For example, a student may be able to make observations but unable to come up with a hypothesis or a prediction. A student who can evaluate data, but not design a valid experiment may evaluate false data. There are many benefits to teaching these process skills independently. They can be easily identified and developed in depth with a narrow focus and they can overcome time restrictions that deter more intense inquiry projects. Furthermore, each individual process skill can be interwoven into subject matter; and students learn science content while developing an ability to conduct inquiry (Wilke and Straits, 2005).

It is important to teach inquiry itself along with teaching subject matter using inquiry. Louis Nadelson asked his students to explain their lack of enthusiasm and aversion to inquiry-type assignments, and they answered they did not know what to do (Nadelson, 2009). A study was conducted with one of the goals to examine the assertion that

teaching inquiry itself is needed by most high school students (Tamir, Stavy, and Ratner, 1998). The subject consisted of three groups. Group A specialized in physics and/or chemistry in a curriculum that did not emphasize inquiry; group B studied biology in an inquiry oriented curriculum; group C studied biology as well as the underlying concepts of inquiry. Group C performance was superior and supported the assertion teaching inquiry itself is necessary in an inquiry-oriented environment students (Tamir, Stavy, and Ratner, 1998).

Teachers and students alike must have an understanding of the various levels of inquiry so they do not develop false perceptions about what genuine research involves. Four levels of inquiry are proposed (Schwab 1962), with levels 3 and 4 more likely to construct knowledge and develop ideas. The source of the question is provided in levels 0 – 2 and open to the learner in level 3. Data collection methods are provided in level 0 and 1, and open to the learner in level 2 and 3. The interpretation of results is provided in level 0 and open to the learner in levels 1 – 3. When determining the scope of the inquiry and the activities involved, the teacher must consider the abilities of the students and their prior knowledge, and choose activities to build upon these (Nadelson, 2009). "Placing novice learners in authentic inquiry environments without structured and targeted support can increase frustration and decrease learning" (Nadelson, 2009. Previous Earth Expedition field inquiry projects ranged from level 0 to level 3, and the level 3 projects were definitely more challenging, and groups consisted of trained educators. Levels 0 and 1 do not constitute the process of scientific research and participation in level 2 and 3 projects can be overwhelming (Nadelson, 2009).

Nadelson goes on to suggest a more effective technique for developing inquiry called “scaffolding.” Students are guided through the inquiry process (led toward a final outcome) while allowing for independent investigations. Anxiety is reduced and students can focus on achievable outcomes, and develop skills necessary to transfer knowledge to other concepts (Nadelson, 2009).

In order for IBL to be effective, teachers must take on a facilitator role (Spronken-Smith, Bullard, Ray, Roberts, Keiffer, 2008). Some practical suggestions for teaching staff include asking open-ended questions, supporting students, encouraging students to reflect on their experiences, monitoring progress and ensuring that students understand, challenging student thinking, and developing an atmosphere of trust (Kahn & O’Rourke 2004). Questioning techniques are important, and should stimulate ideas, discussion, genuine interest, and allow for feedback. Teachers are encouraged to experiment; a teacher’s role is to stimulate curiosity and learning.

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Questions

1. Does "teaching to standards" preclude the use of inquiry? Is some synergy possible by incorporating inquiry into more traditional teaching?

2. What has been the most rewarding inquiry project undertaken in your classroom or teaching environment? The most frustrating or challenging?

3. What types of community projects and venues are available to initiate IBL involving a broader range of learners than found in a classroom?