Inquiry-based learning

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Inquiry-based learning or **inquiry-based science** describes a range of philosophical, curricular and pedagogical approaches to teaching. Its core premises include the requirement that learning should be based around student's questions. Pedagogy and curriculum requires students to work together to solve problems rather than receiving direct instructions on what to do from the teacher. The teacher's job in an inquiry learning environment is therefore not to provide knowledge, but instead to help students along the process of discovering knowledge themselves. In this form of instruction, it is proposed that teachers should be viewed as facilitators of learning rather than vessels of knowledge. Even though this form of instruction has gained great popularity of the past decade, there is plenty of debate about the effectiveness of this form of instruction.

Inquiry-based learning is an instructional method developed during the discovery learning movement of the 1960s. It was developed in response to a perceived failure of more traditional forms of instruction, where students were required simply to memorize fact laden instructional materials (Bruner, 1961). Inquiry learning is a form of active learning, where progress is assessed by how well students develop experimental and analytical skills rather than how much knowledge they possess.

This type of instruction has great popularity, but like other approaches to education, its effectiveness is open to debate.

Contents

Inquiry-based learning in science education

Inquiry-based learning has been of great influence in science education, where it is known as Inquiry-based science, especially since the publication of the U.S. National Science Educational Standards in 1996. Since this publication some educators have advocated a return to more traditional methods of teaching and assessment. Others feel inquiry is important in teaching students to research and learning (e.g., see Constructivism (learning theory)).

Scientists use their background knowledge of principles, concepts and theories, along with the science process skills to construct new explanations to allow them to understand the natural world. This is known as "science inquiry".

When students are learning using inquiry-based science they use the same ideas as scientists do when they are conducting research. Students become 'mini-scientists.'

Philosophy

The philosophy of inquiry based learning finds its antecedents in the work of Piaget, Dewey, Vygotsky, and Freire among others.

Dewey’s theory of learning is that optimal learning and human development and growth occur when people are confronted with substantive, real problems to solve. He believed that curriculum and instruction should be based on integrated, community-based tasks and activities that engage learners in forms of pragmatic social action that have real value in the world.

The focus on the teacher as expert is central to Vygotsky’s learning theory. He proposed that cognitive development is the product of social and cultural interaction around the development and use of tools of a cognitive, linguistic and physical nature. Learning occurs in a Zone of proximal development where authoritative tool users – teachers acting as mentors – initiate and lead students as novices into the use of technologies. This structured introduction into using tools is called *scaffolding*. Work should be structured around projects that demand students engage in the solution of a particular community-based, school-based or regional problem of significance and relevance to their worlds.

Freire’s work is premised on the assumption that the most authentic and powerful pedagogy is one that focuses on the identification, analysis and resolution of immediate problems in learners’ worlds. Hence, his approach is referred to as a problem-posing and problem solving pedagogy. Freire argues that any pedagogy must be of demonstrable relevance to the immediate worlds of the students and it must enable them to analyse, theorise and intellectually engage with those worlds.

Open Learning

An important aspect of inquiry-based science is the use of open learning. Open learning is when there is no prescribed target or result which students have to achieve. In many conventional traditional science experiments, students are told what the outcome of an experiment will be, or is expected to be, and the student is simply expected to 'confirm' this.

In open teaching, on the other hand, the student is either left to discover for themselves what the result of the experiment is, or the teacher guides them to the desired learning goal but without making it explicit what this is. Open teaching is an important but difficult skill for teachers to acquire.

Open learning has many benefits. It means students do not simply perform experiments in a routine like fashion, but actually think about the results they collect and what they mean. With traditional non-open lessons there is a tendency for students to say that the experiment 'went wrong' when they collect results contrary to what they are told to expect. In open lessons there are no wrong results, and students have to evaluate the strengths and weaknesses of the results they collect themselves and decide their value. Because the path taken to a desired learning target is uncertain, open lessons are more interesting and less predictable then traditional lessons.

Open learning has been developed by a number of science educators including the American John Dewey and the German Martin Wagenschein. Wagenschein's ideas particularly complement both open learning and inquiry teaching. He emphasized that students should not be taught bald facts, but should be made to understand and explain what they are learning. His most famous example of this was when he asked physics students to tell him what the speed of a falling object was. Nearly all students would produce an equation. But no students could explain what this equation meant. Wagenschien used this example to show the importance of understanding over knowledge.

Characteristics of inquiry-learning

- Inquiry learning emphasizes constructivist ideas of learning. Knowledge is built in a step-wise fashion. Learning proceeds best in group situations.
- The teacher does not communicate knowledge, but is rather there to help students to learn for themselves.
- The topic, problem to be studied, and methods used to answer this problem are determined by the student and not the teacher.

Examples of inquiry-based science

- Students develop a method to find which antacid tablets are the best at neutralizing acids.
- Students learn about inertia and movement by studying what affect rolling of marbles on different surfaces has.
- Students work in groups to build bridges to hold marble weights. By doing so they discover how to build strong bridges.
- A special case of inquiry learning is problem-based learning (PBL). Students are assigned to teams and provided with an ill-defined problem. Teams must organize themselves, define objectives, assign responsibilities, conduct research, analyze results, and present conclusions. The problems are purposely “ill-defined,” causing team members to work collaboratively to define specific issues, problems, and objectives. Such tasks mimic the problem-solving skills that professionals engage in, whether repairing automobiles, or treating cancer patients. Problem-based learning employs open-ended questions that are not limited to a single correct answer. The questions elicit diverse ideas and opinions and require students to work as a group. Problem-based learning naturally integrates various fields of study as students search beyond the traditional curricular boundaries to develop solutions.

Debate

> “ After a half century of advocacy associated with instruction using minimal guidance, there appears no body of research supporting the technique. In so far as there is any evidence from controlled studies, it almost uniformly supports direct, strong instructional guidance rather constructivist-based minimal guidance during the instruction of novice to intermediate learners. Even for students with considerable prior knowledge, strong guidance while learning is most often found to be equally effective as unguided approaches. Not only is unguided instruction normally less effective; there is also evidence that it may have negative results when student acquire misconceptions or incomplete or disorganized knowledge ”
>
> — Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching by Kirschner, Sweller, Clark

[1]

Mayer (2004) asked the question, should there be "a three strikes rule" given discovery-based instruction? He points out that discovery-based teaching practices have been with us since the discovery learning movement of the 1960s, and says that there has been little evidence to support this practice. He describes this as the constructivist teaching fallacy (Mayer, 2004, p15). He suggests that constructivists often take the learning-by-doing mantra to mean learners learn most efficiently via this method, while there is little evidence to support this notion, quite the contrary in fact. Kirschner, Sweller, and Clark (2006) [2] review the literature and have found that although constructivists often cite each others' work, empirical evidence is not often cited. Nonetheless the constructivist movement gained great momentum in the 1990s, because many educators began to write about this philosophy of learning.

Inquiry-based science has been increasingly promoted as a mainstream teaching approach, especially since the publication of the 1996 Standards in Science Education document. However, there are many critics of inquiry-based science.

Science testing has become increasingly important with the No Child Left Behind program, and the rewriting of the National Assessment of Educational Progress to emphasize facts. This has led to a decrease in emphasis on inquiry as a method of teaching science and a fall back to more traditional 'chalk and talk' methods.

Hmelo-Silver, Duncan, & Chinn cite several studies supporting the success of the constructivist problem-based and inquiry learning methods. For example, they describe a project called GenScope, an inquiry-based science software application. Students using the GenScope software showed significant gains over the control groups, with the largest gains shown in students from basic courses. [3]

Hmelo-Silver et al. also cite a large study by Geier on the effectiveness of inquiry-based science for middle school students, as demonstrated by their performance on high-stakes standardized tests. The improvement was 14% for the first cohort of students and 13% for the second cohort. This study also found that inquiry-based teaching methods greatly reduced the achievement gap for African-American students.[3]

Based on their 2005 research, the conservative Thomas B. Fordham Institute concluded that while inquiry-based learning is fine to some degree, it has been carried to excess[4].

References and further reading

1. ^ Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching Paul A. Kirschner Utrecht University, The Netherlands, John Sweller University of New South Wales, Richard E. Clark University of Southern California (http://www.cogtech.usc.edu/publications/kirschner_Sweller_Clark.pdf)
2. ^ http://www.cogtech.usc.edu/publications/kirschner_Sweller_Clark.pdf Kirschner, P. A., Sweller, J., and Clark, R. E. (2006) Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist 41 (2) 75-86
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See also

- Action learning
- Jerome Bruner
- Learning
- Minnesota State University, Mankato Masters Degree in Experiential Education
- Jean Piaget
- Problem-based learning
- Progressive inquiry
- Science education
- Scientific Literacy

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