Discovery Learning vs Traditional Instruction in the Secondary Science Classroom; The role of Guided Inquiry

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Position Paper

In the face of education reform, science classes present a unique challenge. The secondary science classroom has a long tradition of regularly incorporating laboratory activity into the curriculum. As research promotes a shift in the cognitive structure of the learning environment, science teachers must address the question of how to modify and adapt their laboratory based approach to best serve their students. Researchers and teachers alike argue the issue of discovery based versus traditional instruction. The ideological dichotomy created by both sides suggests that this is a matter of "either/or" implementation. In reality, the answer is "neither".

The semantics alone demonstrate that these two methods are on polar ends of the educational spectrum. Traditional instruction, as the name implies, focuses on how the instructor teaches. This teacher-centered approach explores various methods of imparting knowledge from the teacher to the student. Discovery learning, on the other hand, promotes a student-based philosophy in which the instructor takes on the non-traditional role of mentor or coach, leaving the students to discover solutions for themselves.

The first method, and the more well known among the two, tends to come to the mind of many adults when reflecting on their own educational experiences. Traditional instruction is just that: traditional. Researchers who have studied the role of traditional instruction demonstrate much consistency in their definitions. In one of the earlier comparative studies, the idea of the "passive-student" (Hake, 1997, p. 64) was introduced. Years later, traditional instruction had a nearly identical connotation when defined as, simply a "lecture and questioning method" (Sungur & Tekkaya, 2006, p.310).

Traditional instruction is reminiscent of the popular perception of school in America. Students are instructed by the teacher to study the textbook. The teacher provides information to the students, including concepts, facts, terms, and diagrams. Class periods are lecture based and involve note taking, usually through the use of a chalk board or white board. In this instructional style, it is expected that students will answer questions generated by their teachers. (Sungur & Tekkaya, 2006)

The latter the method came into light with the introduction of constructivism into mainstream educational practice. Constructivist theory is the basis for discovery learning. Under both constructivism and discovery learning, educators subscribe to the idea that "knowledge cannot be transferred from one person to another" (Domin 1999, p. 1). Instead, a student needs to experience an event in order to make it truly meaningful. In a constructivist classroom, the role of the teacher is less defined than with traditional instruction. The teacher is no longer the focal point of the classroom. Instead, the would-be instructor is now seen as a "facilitator, mentor coach, or consultant" (Honebein p. 22). Additionally, the role and expectations of the students are transformed. Under constructivist theory, the emphasis is not on the amount of content that a student manages to retain, but it is on the manner in which the students learns, or constructs knowledge. (Honebein)

These competing theories are demonstrated in the laboratory of the science classroom. Traditional instruction tends to favor labs with a predetermined outcome. Such labs provide students with recipe-like instructions and are used to verify a result that is already known. Sometimes these activities are appropriately referred to as cookbook labs. These activities, often called verification labs, exemplify deductive thinking, as students apply a known principle to verify the assertion. Conversely, discovery learning classrooms favor exploratory labs, or those with a result that is unknown to the students and possibly to the teacher as well. Students then use inductive thinking to construct, or "derive a general principle" (Domin, 1999 p.1) based on their experience. (Domin, 1999)

While it is obvious that these methods represent two opposing philosophies, one would be surprised to know the intensity of the argument that each side presents. When it comes to developing and implementing curricula, individuals are emotionally invested in their beliefs, and rightfully so. The decision to subscribe to either traditional instruction or discovery learning will have a great impact on school climate, teacher moral, academic success, and student motivation.

Proponents of traditional instruction pride themselves on their ability to view education in a realistic manner. The primary argument cited by traditional instructors and their supports against discovery learning is a matter of allocation of resources. Both time and materials are often in short supply. Teachers who have experimented with discovery learning state that they dislike the approach because it is not feasible with "increased pressure to cover sufficient content for end of year high-stakes test" (Mastropeiri et. al., 2006, p.135).

Mayer, a stark proponent of traditional instruction, claims that the discovery-learning school of thought is misinterpreting the meaning of constructivism. Referred to as the "constructivist fallacy" (Mayer, 2004, p.15), Mayer states that discovery learning experts believe that the only way to encourage active learning is through active teaching. Conversely, Mayer's stance is that constructivist learning can be achieved in multiple manners of teaching, including traditional instruction; not just unguided inquiry. (2004)

Those in favor of discovery learning counter Mayer's arguments by highlighting the need for conceptual change in all students. Understanding of science content in particular requires that each student works overcome his or her preconceptions. In light of high-stakes test, as mentioned above, teachers need to ensure that each and every student learns science. Flaws in traditional instruction exclude most students from the learning process. Often times, science textbooks are written to a reading level that does not correspond with that of the student. In these cases, a text-based curriculum becomes esoteric. Further, traditional instruction only allows one student to be actively engaged at a time, while discovery learning unites students and content simultaneously. Additionally, scientists will agree that discovery based learning replicates a true scientific experience for students. (Domin, 1999, Mastropeiri et. al., 2006)

As such, these arguments create the dichotomy of the over-simplified and realistic versus the impossibly idealistic curricular implementation. While both sides of the anecdotal arguments appear to be convincing within the context of the academic environment, the research tells a different story. Experimentation with discovery learning in the classroom has produced several positive results. While not indicative of learning per say, the study conducted by Sungur and Tekkaya demonstrated the favorable outcomes of discovery learning. It was found that students partaking in a discovery style of learning spent much more time on task and claimed to be more motivated that a similar group receiving the traditional method. Most educators will agree that student interest and achievement tend to have a directly proportional relationship.

A study conducted by Hake (1998) focused particularly on introductory physics and found similar results. It is known that conceptual understanding is vital to obtaining a working knowledge of Newtonian physics. The findings of Hake’s study confirmed the suspicions of the pro discovery-learning contingent. Hake found that discovery learning “enhanced problem solving skills” (p. 70). Additionally, there was no connection between perceived skill of the instructor and ability to implement successful traditional instruction. “Even the best professors were unable to impart conceptual change” (p. 70) when using the traditional method. Hake’s data demonstrated that enhancing conceptual understanding in an introductory physics class using only traditional, lecture-based methods is bound to be less successful than discovery learning. (Hake, 1998)

In light of such data, one may question why traditional instruction was implemented in the first place. However, traditional instruction should not be immediately discounted. Traditional instruction still had its devote followers, and they would not back down from the debate. Mayer, for one, refused to accept the acieration that discovery learning, in its purest, unrestricted form, could realistically benefit students.

Opponents of constructivism claim that students are unable to construct their own knowledge without the necessary background experiences. When students enter introductory science classes, they rarely have relevant and correct experiences with the topic. Thus, letting the students loose in the classroom will only result in an increase in misconceptions. Often times teachers spend as much time, if not more, trying to clarify misconceptions than they do teaching actual content. Students who lack the necessary background knowledge will not only perpetuate their misconceptions, they will ground their conclusions in false pretense. Discovery learning could actually be a detriment to learning. Upon further investigation, Mayer introduced the universally beneficial middle ground; guided inquiry.

Guided inquiry has the benefits of traditional instruction: it is both cost efficient and goal oriented. This method also has benefits of discovery learning: students experience and explore learning in a collaborative manner. Additionally, and notably, guided inquiry method is proven successful both in terms of academic and cognitive learning.

Guided inquiry is the feasible and logical solution to this ongoing debate. Guided inquiry is a process in which students are provided with both direction and freedom in the classroom. Teachers provide coaching and modeling by using “guided discovery methods” (Mayer, 2004 p.15). This method is particularly applicable in the science classroom. As discussed earlier, the laboratory implications of a curricular change will have a very influential impact on the course as a whole. With guided inquiry, students retain the discovery learning advantage of developing true scientific thought processes. They will also benefit by building their knowledge based on a combination of facts, theories, and experiences.

Mayer's 2004 study compared all three methods now included in the discussion. Results based on retention and transfer of information as well as ability to apply learning was tracked. In both cases, discovery learning came in last. This corroborates the claim that discovery learning is just not efficient in the current classroom model. While its theory and implications for learning are innovative and promising, the context of education has not yet developed the environment necessary to support discovery learning. Traditional instruction out performed discovery learning by only a small margin. Students in the traditional cohort did not demonstrate engagement or investment with learning. Such results demonstrate that today's educational needs cannot be net with textbooks alone. (Mayer, 2004)

Guided inquiry is the timely solution to this debate. Education reform is currently in limbo, caught between cognitive change and high stakes testing; between budgets and achievement; between experience and efficiency. Guided inquiry is a solution that is amiable to students, teachers, administrators, and parents alike. Students will have the cognitively beneficial learning experiences, while teachers can incorporate all of the necessary content. Research (Mayer, 2004) shows that test scores are likely to improve, thus appeasing the administration. Parents are likely to be pleased with the combination of student achievement and increase in demonstrated problem solving skills.

While most people view guided inquiry as the middle of the road compromise, this is not necessarily the case. When implemented properly, guided inquiry is a method within itself based on sound research. This method was certainly not created to please the masses. Instead, it was created to independently enhance the learning experiences of students. Guided inquiry is the logical, effective solution that is often overlooked in the debate of instructional styles.

Sources

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