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Science Literacy: Is Classroom Instruction Enough?

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ABSTRACT

Exploring science literacy and how this term encompasses an array of aspects in students' lives is beneficial in the diverse field of science. Science literacy is examined and the concept of adolescent literacy in secondary science classrooms explored. The term adolescent literacy refers to an adolescent's ability to make meaning of context both in and out of school (Berhman, 2003). The article also explores the way in which text is read, print text vs. internet, as well as some ways to improve scientific comprehension and scientific interest among secondary students.

> We don't even know what skills may be needed in the years ahead. That is why we must train our young people in the fundamental fields of knowledge and equip them to understand and cope with change. That is why we must give them the critical qualities of mind and durable qualities of character that will serve them in circumstances we cannot now even predict. (Gardner, 2006, para.1)

The thoughts represented in this quote by John Gardner (2006) give some insight into the need for emphasizing content literacy in secondary content area classrooms as a way of equipping students to be able to read and comprehend. Students need tools to comprehend an ever changing world, and comprehension is the basis of learning. Ideally, students should be free to think and explore educational avenues without being burdened with comprehension barriers. Some of these barriers can be broken by teaching students literacy strategies in all content areas to aid students in their ability to comprehend educational texts.

When discussing education, it is impossible to get around the subject of literacy. The need for literacy can be seen everywhere. Relating everyday life to solving problems is one of the purposes of scientific literacy (Ebenezer & Conner, 1998; Koch, 2005). State and federal education departments develop standards mandating at what level students of certain grades and ages should be literate. After much deliberation, plans for designing science content are determined by professionals at each specific grade level. Literacy can be simply stated as one’s ability to read and write (Olson & Truxaw, 2009), or more specifically stated as one’s ability to use written text in an individual’s everyday life (Maclellan, 2008).

Maclellan (2008) went even further by stratifying literacy into information literacy, critical literacy, academic literacy, societal literacy, and dialogic literacy. Information literacy is the ability to recognize and utilize information to accomplish a specific purpose. Critical literacy involves one’s understanding of texts as they relate to each other. This process involves a person critically examining the validity and reliability of information presented. Academic literacy directly pertains to teachers as well as students being literate in the academic world. This type of literacy involves the research and writing of texts in order to contribute to an overall body of knowledge. Societal literacy deals with an individual’s ability to participate in a large institution such as an educational institution or some form of government. The last form of literacy is dialogic literacy, in which the act of learning and information processing is two-way. In dialogic literacy, different perspectives lead to different outcomes. These varying forms of literacy seem to greatly overlap and end in the ability to function in everyday life. Aiding students in achieving these forms of literacy should be a goal of science educators because having a scientifically literate citizenry is vital to our nation’s success and progress. All educators for that matter should be concerned with increasing content area literacy. Many teachers strive to increase comprehension by using strategies such as predicting, inferring, connecting, summarizing, visualizing, and questioning (Fisher, Grant, & Frey, 2009). For instance, since prediction is based on evidence, it is necessary to have science content literacy for determining outcomes (Wolfinger, 2000).

Educators should enable, in all ways possible, students’ learning both in and out of the classroom. All strands of literacy, as stated by Maclellan (2008), are important in the scientific field. They can all contribute to the use and understanding of the scientific domain. Literacy should not be limited to only reading and language classrooms. Instruction for increasing students’ literary abilities should be ongoing in all content areas. According to Vacca and Vacca (2005), the definition of content area literacy is the “ability to use reading, writing, talking, listening, and viewing to learn subject matter in a given discipline.” (p. 10). When dealing with content area literacy, Olson and Truxaw

(2009) researched a few interesting points on text and comprehension. In their study, they selected 13 science and 11 mathematics preservice teachers. The researchers had the students read a nonsensical text about the relationship between increasing global temperature and decreasing number of pirates (of course these variables have no dependency on each other). Some students accepted the text as fact because it contained scientific language and structure; some students accepted the text as fact because it came from an authoritative figure. Another aspect of the research was to determine how students comprehended different forms of text, either online or written text. It was found that students tended to read printed text more carefully than internet text. However, it was noted in one instance that internet text was read more critically (Olson & Truxaw, 2009). This could be very useful information for a teacher when considering the nature of an assignment. Online opportunities, for example, provide unique opportunities for faculty interaction through timely responses and cooperative learning (Graham, Cagiltay, Lin, Craner, & Duffy, 2008).

Place-Based Learning

The idea of place-based learning is also important to consider when teaching in a specific domain, like science. Place-based learning involves the relevance of learning to the world around us (Leslie & Matthews, 2009). The need for inquiry in science is well documented and is a must for learning and understanding the scientific domain (Buck, Bretz, & Towns, 2008). According to Haury (1993, para. 7), "In its essence, then, inquiry-oriented teaching engages students in investigations to satisfy curiosities, with curiosities being satisfied when individuals have constructed mental frameworks that adequately explain their experiences. One implication is that inquiry-oriented teaching begins or at least involves stimulating curiosity or providing wonder. This is no authentic investigation or meaningful learning if there is no inquiring mind seeking an answer, solution, explanation, or decision."

Students must be encouraged to ask questions as well as be guided to which questions to ask. This view of learning lends itself to the constructivist view of learning. Place-based learning is also a method of inspiring students (Leslie & Matthews, 2009). This inspiration is often achieved outside the classroom but started inside the classroom. Content instruction should enable a student to have self-perceptions of autonomy and competency. Lavigne, Vallerand, and Miquelon (2007) believe that a teacher's behavior and students' perceptions are often associated with the choice to pursue a scientific career. The number of graduates with mathematics/statistics, computer science and engineering degrees in the United States made up only 11.8% (Lavigne et al., 2007). The more competent a student is in a subject, the more likely they will pursue a career in that field, and literacy is a way to increase that competency in all areas.

Specific to the field of science are the acts of information seeking and inquiry. Science is a universally known inquiry based subject. Processes involved in this information seeking, according to Julien and Barker (2009), are generating a hypothesis, devising a plan for data collection, and gathering evidence based on the analysis of that data. Julien and Baker contend that when science is presented as stagnant content, it is difficult for students to develop their own ideas, thus preventing them from making unique explorations and explanations. Teaching cannot simply supply a list of unchanging data spoon fed to the student. Science is an ever-changing field of study; therefore, the presentation of content should and must adapt and change as well.

Scientific and Adolescent Literacies

Being scientifically literate can mean different things to different people. Baram-Tsabari and Yarden (2005) classify characteristics of "true" scientific literacy as logic and reasoning, understanding experiments and their function in science, realizing the implications of evidence, critical thinking, and other fundamentals common to scientific investigation. The challenge is getting our students to this point of scientific literacy. Perhaps one way of accomplishing this is by having students participate in real-life situations.

Behrman (2003) conducted a study in an attempt to illustrate how change was needed in our view of content literacy specific to the sciences. Traditionally, content literacy involves printed texts from one source (usually a textbook) with few supplementary sources provided by the instructor (Behrman, 2003). Some literacy theorists question this narrow view of literacy and contend it should be expanded. A relatively new term related to secondary education and literacy is adolescent literacy. This term refers to one's ability to make meaning of context both in and out of school (Berhman, 2003). According to this definition, an adolescent's ability to make some sort of meaning as related to a body of content knowledge should not be limited to sitting in a classroom and absorbing information as dictated by one source.

An example of adolescent literacy in action is depicted in Berhman's (2003) study. A summer biology course was created at a local high school and offered as an elective that counted towards graduation. In an attempt to gain more than science-geared students, no prerequisites existed. Eighteen students enrolled. The class included both in and out of class activities, eighteen class meetings, and two and a half hour blocks in which five modules were used. These modules were microbiology, cellular biology, ecology, botany, and human biology. Students would visit sites specific to these areas and then complete group projects. There was no text book involved, thus students relied heavily upon the internet and the scientific authoritative figure at each site. Examples of topics discussed were microbes in the ocean from storm drain run-off, effects on the ecosystem of proposed tourist attraction, and parasitic infestation of local eucalyptus trees. There were also many different methods of presenting this information. Viewing methods included PowerPoint presentation by guest lecturers, a video, and several CD-ROMs. Listening activities included teacher lectures, guest lectures, and interviews.

The term adolescent literacy encompasses different forms of literacy and as a result, information is presented in various ways. According to *The Theory of Multiple Intelligences* (Gardner, 1983), students learn and retain information in different ways. Therefore, information must be presented in different ways to ensure students learn to the best of their ability. Levine (2003) states that students whose minds evidence learning differences have at some point been equipped to adapt. In order to determine learning differences, teachers should provide meaningful assessments in as many ways as possible. In a field as diverse as science, no one method of presentation or assessment is sufficient. Types of authentic assessment can provide real insight into the understanding realized by the student (Koch, 2005).

Fisher, Grant, and Frey (2009) suggest that scientific literacy goes beyond simple reading strategies. According to studies, science achievement is dependent on reading proficiency, which includes reading fluency (Cromley, 2009). The building of background is essential to scientific comprehension. Background knowledge can be attained through reading (Fisher et al., 2009). Tools aiding in gaining background knowledge include textbooks as well as various supplemental texts. Another, and perhaps forgotten, way to gain background knowledge is to personally apply concepts taught in the classroom (Fisher et al., 2009). If a student can learn how science applies to the real world and then actually participate in those situations, it will make those concepts vivid and real in their lives. This active participation will likely create and sustain an interest in the scientific content. Many times interest is a key component of success since students tend to perform better in subjects in which they are interested.

Concluding Thoughts

Direct teaching strategies to increase all aspects of literacy are essential to students' comprehension, especially with respect to scientific content. For science instruction to meet the demands of a changing field, students should be challenged in classroom and out. This varied method of teaching will increase literacy rates in science related content. More study is greatly needed in this area because a balance is necessary between in class instruction and out of class, hands on activities. Students are in danger of becoming ignorant of the outside world if all learning time is spent in the classroom. Further implementation of hands on activities in the science curriculum and research of such strategies will greatly increase educators' abilities in their tasks of adequately educating today's adolescents and increasing adolescent literacies.

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