Assessing the Skills of Future Citizens: The Literacy Survey
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Introduction

A primary goal of many introductory geoscience courses is to provide students with the necessary knowledge to make informed decisions about societal issues that encompass geologic components, e.g. silting dams, opening mines, building in earthquake zones. Unfortunately, close examination reveals that most courses address these students with a wealth of scientific content, but do not assist them with developing the tools (literacies) necessary to master fully scientific content. In addition to the necessity of helping students develop life-long practices for applying scientific knowledge to societal issues in a logical, systematic and effective manner. Although specific scientific disciplines have complex literacies not only to the scientist, but to the citizen as well and consist of tasks that allow individuals to interpret and manipulate facts, data and observations. In addition to these fundamental literacies, each science has a set of special or technical literacies unique to that discipline. For the geosciences, we are interested in the ability to imagine objects in space, deal with spatial data and conceptualize geologic change over a variety of time scales. When combined the fundamental and technical literacies allow an individual to take scientific knowledge and turn it into scientific understanding. Employing this scientific understanding to address societal issues requires yet a third set of literacies, i.e. citizenship. The citizenship literacies permit an individual to use their scientific understanding to evaluate the impact of resource extraction and use on a variety of communities from a range of perspectives, e.g. economic, social, cultural, etc.

The Courses

Although our literacy survey is used in a variety of courses, the one described in this poster is for GEOL3300: Earth Resources. This upper division class is for both geology and non-geology majors and examines the geologic formation, production mechanisms and use consequences of a wide variety of Earth resources. Historically, the class has been a 50/50 mixture of majors and non-majors with the non-majors from diverse fields as international studies, art, business, music, geography and engineering.

Because of the breadth of the topic and the desire to incorporate better treatment of the citizenship literacies, Earth Resources will be split into two independent courses (Earth and Mineral Resources; and Energy: A Geologic Perspective) beginning in the fall of 2005. These new courses will maintain the format of the current course but will cover each subject in greater depth.

The Literacy Concept

Like any other profession, science has a set of literacies that must be mastered before scientific problems can be addressed in an effective and successful manner. Although specific scientific disciplines have some special literacies, all share some common ones. These fundamental literacies are valuable not only to the scientist, but to the citizen as well and consist of tasks that allow individuals to interpret and manipulate facts, data and observations. In addition to these fundamental literacies, each science has a set of special or technical literacies unique to that discipline. For the geosciences, we are interested in the ability to imagine objects in space, deal with spatial data and conceptualize geologic change over a variety of time scales. When combined the fundamental and technical literacies allow an individual to take scientific knowledge and turn it into scientific understanding. Employing this scientific understanding to address societal issues requires yet a third set of literacies, i.e. citizenship. The citizenship literacies permit an individual to use their scientific understanding to evaluate the impact of resource extraction and use on a variety of communities from a range of perspectives, e.g. economic, social, cultural, etc.

The graph below plots the percent of income versus percent of a country’s population. Use it to compare the income distribution between these countries.

Citizenship Literacies

Despite the view of some scientists and technocrats, the scientific answer to a social problem or issue, e.g. nuclear power, may not be acceptable for a variety of reasons. Finding a workable solution to such issues requires examining them from a variety of viewpoints, scientific, political, social, economic, cultural, etc. The citizenship literacies are a group of skills that allow citizens to take their scientific analysis of an issue and temper it with the realities of life. These citizenship literacies allow students to place resource extraction and use in a broader social context for considering historical background, population demographics, economic context and social and cultural structure. At the same time, critical thinking skills coupled with a broad geologic understanding of a resource allows individuals to identify hidden and shared costs, predict consequences and recognize potential impacts.

• ability to place resource use in social context
• capacity to use critical thinking to evaluate individuals specific resource issues

Summary

Literacies: Going from Scientific Knowledge to Scientific Understanding to Societal Application

Fundamental Literacies

Scientific investigations use large data sets, require assessing opposite the relative importance of different variables and necessary performing simple quantitative calculations. These skills encompass the fundamental literacies. They are crucial to all fundamental scientists. Although students are likely to have been exposed to these in their courses, they typically enter an introductory science course with a weak mastery of the fundamentals. This lack of confidence may reflect a lack of recent practice or failure to master them when first introduced. Commonly instructors implicitly assume students know these literacies and are comfortable using them. Unfortunately, most students reveal this lack of skills by asking the very questions that are the building blocks of geology.

Technical Literacies

The geoscientist investigates physical objects of varying scales that occupy space and change over time. Thus, one must be able to visualize large geographic structures that cannot be viewed directly as well as conceptualize how geologic processes acting over time can change such objects. Because of geology’s spatial nature, one must also be able to visualize a variety of map types. Students must “read” block diagrams, geologic-cross sections, and projection planes. Mentally, they need to be able to relate objects in space, visualize them apart and image their interiors. Unlike with the fundamental literacies, these skills have had extensive experience with these intellectual tasks. Yet, a quick scan of any introductory geology text demonstrates the importance of these literacies in understanding and applying geologic principles. Without explicit assistance with these skills, they represent a significant barrier to student success.

• power to read a table or interpret a graph or chart
• facility to make qualitative assessments
• capacity to perform simple quantitative calculations
• skill to read different types of maps, e.g. topographic, geologic, etc.
• ability to visualize in three dimensions
• capacity to conceptualize changes through time

Citizenship Literacies

• converting scientific knowledge to scientific understanding that can be used to address societal problems requires mastering a set of literacies
• literacies fall into three classes: fundamental, technical, and citizenship
• most students probably have been introduced to fundamental literacies, but they may have not used them for a while or ever mastered them
• technical literacies vary with scientific discipline and may be new to a majority of students
• citizenship literacies allow students to use their geologic knowledge to address societal issues associated with resource extraction or hazards
• our literacy surveys allow us to assess any improvement in the literacies students develop during our courses

Literacy Survey

At the course’s start and end, students complete a fundamental and technical survey in lab. It tests students’ skill level in each literacy component. The survey also asks them to assign a confidence level to each answer. The initial survey also collects student background data. Results and responses are recorded, and scales that are scanned for SPSS analysis. This survey has been administered three times in the past three years. To date, the citizenship survey has not yet been conducted. Preliminary leading with the FIPSE working group sampled 59 students enrolled in Earth Resources in 2003, 2004 and 2005. Initial survey results suggest: 1) students have limited mastery of literacies prior to the courses; 2) students’ confidence in their literacy abilities has little relationship to their actual level of ability; and 3) there has been some improvement in literacy proficiency after the course. The UW FIPSE project has provided us with the opportunity to identify the literacies students need to convert scientific knowledge into scientific understanding and to apply this understanding to societal issues of geologic importance. The course redesign explicitly aims to increase these literacies along with traditional geologic content. To assess the impact of our work, we have developed pre- and post-surveys that have been taken by students enrolled in Earth Resources in 2003, 2004 and 2005. Initial survey results suggest: 1) students have limited mastery of literacies prior to the courses; 2) students’ confidence in their literacy abilities has little relationship to their actual level of ability; and 3) there has been some improvement in literacy proficiency after the course.

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Assessing Literacy Proficiency: The Surveys

For each science, mastery of the technical and fundamental literacies along with scientific knowledge leads to scientific understanding. Armed scientific understanding, Amos with scientific understanding, individuals use the citizenship literacies to address societal problems in a systematic, rational and logical manner.

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