Investigating the Readability of Geoscience Reading Materials Assigned to Undergraduate Earth Science and Geology Students

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Abstract

While the readability of secondary school textbooks has received considerable attention, studies of the readability of college textbooks are less common and studies focused on the readability of college science textbooks and supplemental materials are rare and nonexistent, respectively. This proposed project will assess the readability of the textbooks, laboratory manuals, and supplemental materials (e.g., journal articles) used by geoscience faculty at UNC Charlotte to investigate whether the students have the appropriate reading skills for the materials being assigned. Readability will be calculated for common textbooks used in introductory and advanced Earth Sciences classes, the laboratory manuals for ESCI 1101, GEOL 1200 and 1210, and the six journals that are most commonly used as supplemental materials. Reading grade level will be calculated using the Flesch–Kincaid readability test and the results of each text, manual, or journal will be compared to the level of the course in which it is commonly assigned to identify materials that may be too challenging for the students. The results of the study will be shared with all faculty teaching Earth Science and Geology courses at UNC Charlotte. Faculty can then alter reading assignments to better match the reading level of their students and the laboratory manuals can be rewritten, if necessary, to better match the reading level of the intended audience. Additionally, the findings will be presented at the annual meeting of the Geological Society of America and published in the *Journal of Geoscience Education*, thus aiding faculty and students from outside UNC Charlotte.

Budget Request for SOTL Grant
Year 2012-2013

Joint Proposal? _____ Yes __X__ No

Title of Project   Investigating the Readability of Geoscience Reading Materials Assigned to Undergraduate Earth Science and Geology Students

Duration of Project   2 months

Primary Investigator(s)   Scott Hippensteel

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UNC Charlotte SOTL Grants Previously Received (please names of project, PIs, and dates)   None

Allocate operating budget to Department of   Geography and Earth Sciences

Account #	Award	Year One January to June
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	$ - 2,200
911250	Graduate Student Salaries	
911300	Special Pay (Faculty on UNCC payroll other than Grantee)	
915000	Student Temporary Wages	
915900	Non-student Temporary Wages	
920000	Honorarium (Individual(s) not with UNCC)	
921150	Participant Stipends	
925000	Travel - Domestic	1,500
926000	Travel - Foreign	
928000	Communication and/or Printing	100
930000	Supplies	
942000	Computing Equipment	
944000	Educational Equipment	
951000	Other Current Services	
	GRAND TOTAL	$ - 3,800

Attachments:

1.   Attach/provide a narrative that explains how the funds requested will be used.

       I am requesting a $2,200 stipend for the first summer session of 2013. Calculations of the Reading Grade Levels will be done by hand and will require an extensive time commitment. The pilot study for this project, which assessed a single textbook, required five hours for calculation of the RGL. This proposal will assess more than ten textbooks, three laboratory manuals and more than fifty journal articles. Time requirements for preparation of the findings for the Department of Geography and Earth Sciences and submission of a manuscript to the *Journal of Geoscience Education* are included herein.

       I am requesting $1,500 for costs related to submission of an abstract to the Geological Society of America's annual meeting in Denver, Colorado (Nov. 2013) and transportation costs. I propose to present the findings of this research during a geoscience pedagogy session.

       I am requesting $100 for publication costs associated with the *Journal of Geoscience Education.*

2.   Has funding for the project been requested from other sources? ___ Yes   __X__ No.
       If yes, list sources.

Office of the Dean

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November 6, 2012

SOTL Grants Committee
Center for Teaching & Learning
ctl@uncc.edu

Dear Committee Members:

I am writing to endorse Dr. Scott Hippensteel's application for a 2013 Scholarship of Teaching and Learning Award. It is my assessment that Dr. Hippensteel's proposed research *Investigating the Readability of Geoscience Reading Materials Assigned to Undergraduate Earth Science and Geology Students* addresses both fundamental requirements of the SOTL program: to fund instructional research projects that will benefit the UNC Charlotte teaching and learning community; and that the results of the proposed research will be shared among the UNC Charlotte teaching Community. Dr. Hippensteel's proposed project will assess the reading level of commonly used textbooks, laboratory manuals and assigned readings in several of the Department of Geography and Earth Sciences large section General education and LBST course offerings. The reading level of these materials will be determined through the use of the well tried Flesch–Kincaid readability test. This is a project that is well worth funding as ESCI 1101 Earth Science Geography, Geology 1200 Physical Geology, their related laboratory sections ESCI 1101L and GEOL 1200, and LBST 2213 Science, Technology and Society are all heavily subscribed general education requirements, enrolling approximately 600+ students/semester and typically have a high proportion of students who perform poorly or fail to complete the course.

As Dr. Hippensteel points out no formal quantitative assessment of the readability of Introductory Earth Science material has been performed and the potential impact of this research could significantly influence the textbook, laboratory manual and supplemental readings used by a number of instructors in the GEOES Department. By better matching the student reading level with written course materials this has the potential to significantly impact: student retention, progression, and graduation rates; increase student engagement; better reach non-traditional students, increase faculty-student interaction and improve learning outcomes. Finally, this project has the potential to impact instruction well beyond UNC Charlotte with Dr. Hippensteel proposing to disseminate his study results at the 2013 national Geologic Society of America (GSA) meetings in Denver, an event attended by several thousand university academics and all of the major text book publishers.

I am please to recommend this proposal for your consideration. Please let me know if you require further information.

Sincerely yours,

Nancy A. Gutierrez, Dean
College of Liberal Arts and Sciences

Specific Aims of the Proposed Project

A preliminary survey of Geoscience faculty in the Department of Geography and Earth Sciences indicated that instructors had a limited means of assessing the readability of textbooks, laboratory manuals, and supplementary reading materials that were being assigned in all levels of courses. Most instructors, as is true of instructors at most universities, relied on either textbook publishers or student feedback to gauge the appropriateness of reading materials. Textbooks written at an average reading level above the intended student population tended to be unpopular while those written at a high-school level appeared to be, according to one Associate Professor of Earth Sciences, "frustratingly simple". A proof of concept study to test the proposed methodology herein has already demonstrated that at least one textbook currently used in Earth History (GEOL 1210) is written at a reading level at least two grade levels above the intended first-year student population.

The underlying goal of this study is to assess the mean readability of the textbooks, laboratory manuals, and supplemental materials (e.g. assigned journal articles) for introductory (1000- and 2000-level classes) and upper (3000- and 4000-level) classes to determine if the reading assignments are appropriate for the students taking the class. Reading materials that are either too difficult (reading level of material exceeds level of the class) and reading materials that are too simple will be identified so that more appropriate assignments or selections can be made. This improves both the out-of-class learning by the students and should help reduce the apprehension of many non-science majors towards taking a required science class. Further, it will help all geoscience faculty select appropriate reading materials and, in doing so, benefit all students taking Earth Science or Geology classes. The results of the study will be especially beneficial to students enrolled in the growing Earth Sciences BA and BS and Geology BS

degrees because reading materials they see throughout the curricula will be assess to be certain they are being read at the correct time as the students' progress through the programs.

Literature Review

While the selection of level-appropriate reading materials in secondary public schools has received appreciable scrutiny, materials used in undergraduate college classrooms have not received the same degree of attention (Davidson, 1988). Rebottini and Smith (1990) provide an exception as they reported on the readability of college level reading textbooks. The authors found that the choice of textbooks by professors is often, unfortunately, a matter of availability and course content with little regard to reading level. Schneider (2011) found that a significant number of college textbooks have a readability above students beginning the first year of college and suggests the success of one public speaking textbook may be the result of its comparably lower reading level. Other factors influencing readability include the goals of the authors; one review suggested that textbooks seemed to be written for peer approval rather than for the students who will use them (Cline, 1972).

Reports critical of college textbooks and their prose are common (e.g. Tyson and Bernstein, 1988), yet fewer recent reports on the readability of college science textbooks are found in the literature and no reports on the readability of supplemental material (journal articles, for example) have been conducted. While textbooks are assigned or recommended by instructors in nearly all college courses, many faculty choose to supplement them with additional reading assignments. Further, some instructors substitute a series of papers in lieu of a textbook. One quality of all such reading selections and assignments that is rarely considered is the reading grade level (RGL) (Ruscher, 1984).

The RGL is usually expressed in years of instruction, with first year university students having an L of 12 (ideally) and graduating seniors having an L of at least 16. One criticism of readability indexes is that they are often derived from only small passages within a text (Coke and Rothkopf, 1970; McConnell, 1982; Ruscher, 1984). More accurate readability scores are obtained when at least 2500 words were analyzed (Coke and Rothkopf, 1970). Dukes and Kelly (1979) reported that an analysis of 300 word passages from the beginning, middle, and end of science textbooks provided "inadequate" results and instead they choose a sample strategy of thirty 100-word passages from throughout the textbooks.

The research in this proposal focuses on the readability of common geoscience supplemental reading materials such as magazine and journal articles, as well as laboratory manuals and textbooks, and represents the first attempt to assign RGL values to the geoscience articles commonly assigned in undergraduate geology, paleontology, and earth science classes.

Methods

Selection of materials for readability analysis

Courses at the University of North Carolina at Charlotte follow the traditional hierarchy of difficulty with 1000 and 2000 level courses offered to fulfill general education, introduction or liberal studies purposes. Upper-level 3000 and 4000 courses are typically more challenging and intended for students focusing study in a particular major or minor that have successfully completed the 1000 and 2000 level prerequisite courses.

A survey of the geology and earth science faculty in the Department of Geography and Earth Sciences at the University of North Carolina at Charlotte indicated that different types of supplemental reading materials are being used in 1000/2000 courses when compared with the

3000/4000 level classes. Reading assignments for the introductory courses are often from widely circulated, general science magazines such as *Discover*, *Scientific American*, *Science News*, and the American Geosciences Institute's *Earth*. These articles usually report on or discuss original research conducted by others and are not peer-reviewed.

A second type of article is selected for upper-level undergraduate courses: peer-reviewed manuscripts of original research or review articles in specific scientific fields or on a defined research topic. Journals mentioned in the survey of instructors included *Geomorphology*, *Palaios, Marine Geology*, *Sedimentology*, *Quaternary Research*, and, repeatedly, *Geology Palaeogeography, Palaeoclimatology, Palaeoecology* (hereafter *PPP*) and the Geological Society of America's (GSA) *Bulletin*.

Six magazines/journals were named more than any others in the survey of faculty and are chosen for readability analysis. In 1000- and 2000-level courses, and especially courses taken by non-science majors, articles from *Scientific American*, *Discover*, and *Earth* magazine are assigned. These courses include GEOL 1200 (Physical Geology), GEOL 1210 (Historical Geology), and LBST 2213 (Science, Technology and Society: The Earth Revealed). In the upper-level 3000 and 4000 courses the most popular journal selection include the GSA *Bulletin*, *Geology*, and *PPP*.

Assessing Readability

The RGL is predicted to be several grades lower for the *Scientific American*, *Discover,* and *Earth* magazines when compared to the three journals selected for the upper-division classes, GSA *Bulletin*, *Geology*, and *PPP*, as the former reading materials are used in classes primarily taken by first and second-year students. *Scientific American* and *Earth* magazines are commonly read by non-scientists and the general public, as well.

Readability will be determined using Flesch–Kincaid readability test, where:

RGL = 0.39 (total words/total sentences) - 11.8 (total syllables/total words) – 15.59

The RGL refers to reading grade level, with incoming college freshman having, ideally, >12 years of reading.   On this scale a text composed entirely of monosyllabic, single-word sentences would have the lowest potential RGL, of −3.40, and most college reading materials intended for undergraduates would fall preferably between 13-17. This proposal has an RGL of 15.4.

For computational purposes, all words and syllables will be hand counted and calculated. Coke and Rothkopf (1970) reported that more accurate RGLs were calculated when larger sections of material were analyzed (>2,500 words). To assure accurate determination of RGLs, more than 24,000 words will be assessed between the six magazines/journals providing an average count of >4,000 words and >200 sentences per magazine/journal.

Specific articles for readability analysis will be selected in the following manner: 1) For *Earth*, *Geology*, *PPP*, and GSA *Bulletin* a random number generator will be used to select articles from 2011 and 2012; 2) For *Scientific American* and *Discover*, a random numbers generator will be used to select articles from the magazines "themed" reading collections and special editions such as "Dinosaurs" or "The Oceans." These collections have been used in LBST 2213 Science, Technology, and Society: The Earth Revealed and GEOL 1210 Earth History during recent semesters.

For each article the final four sentences of each subsection will be analyzed. For *PPP* and GSA *Bulletin* these are usually the final four sentences of the Introduction, Methodology, Results, Discussion, and Conclusions sections.   For *Earth* and *Scientific American*, the subsections will be divided based on second order headings. This sampling strategy provides

reading passages from throughout the article and at least 16 sentences will be analyzed in each article.

For comparison purposes the RGL of several textbooks assigned in introductory and upper level classes at UNC Charlotte will also calculated. The textbook passages intended for RGL calculation will be selected using a random numbers generator and counted and calculated by hand using the same methodology as for the magazines and journals. Introductory paragraphs and concluding paragraphs will be omitted from the analysis as they have been demonstrated to not be indicative of the authors writing style (Flesch, 1974). Textbooks included in this analysis will include:

Title	Author(s)	Courses
Earth	Tarbuck and Lutgens	GEOL 1200 (Phys. Geol)
Earth Through Time	Levin	GEOL 1212 (Hist. Geol)
No Stone Unturned	Peters	LBST 2213 (Sci., Soc., Tech)
Intro to Oceanography	Thurman and Trujillo	ESCI 3105 (Oceanog.)
Bringing Fossils to Life	Prothero	GEOL 3140 (Paleont.)
Environmental Geology	Keller	GEOL 3190 (Env. Geol)
Coast. Proc. w. Env. App.	Dean and Dalrymple	GEOL 4140 (Coastal Geo)

Finally, the RGL will be calculated for the Department of Geography and Earth Sciences' self-published laboratory manuals to assess the appropriateness of the reading assignments for Earth Sciences-Geography (ESCI 1101) and Physical and Historical Geology (GEOL 1200 and GEOL 1210).

Evaluation

After readability analysis has been conducted on the textbooks, laboratory manuals, and supplemental materials, a spreadsheet comparing RGL and course level will be prepared. All journals, magazines, textbooks, and manuals with RGLs that exceed the course level will be identified, as well as materials which appear to be grossly simple for the intended student population. For computation of the RGL, the total number of words, total number of sentences, and total number of syllables will be counted for all reading materials and the average words per sentence, average syllables per word, maximum word per sentence, and minimum word per sentence will be calculated. For magazine and journal articles, the minimum RGL and maximum RGL for individual articles will be assessed and the standard deviation of RGL for all the articles in a particular journal will be calculated to provide insights into the consistency of readability of the journal.

Knowledge Dissemination

The aforementioned spreadsheet identifying inappropriate or challenging reading materials will be a key part of a readability report distributed to all faculty teaching Earth Science or Geology classes at UNC Charlotte. This is the first assessment of readability of textbooks, self (department)-published laboratory manuals, and supplemental materials in the natural sciences field; the results will be published in the most impactful pedagogical journal in the Earth Sciences: The *Journal of Geoscience Education.* Finally, the results of the study will also be presented at the annual meeting of the Geological Society of America in Denver, Colorado (November, 2013).

Human subjects, Extramural Funding

The RGL of incoming students to UNC Charlotte is assumed (or at least hoped) to be >12 years and no students will be tested. There is also no extramural funding for this study.

Timeline

This project will be conducted during the First Summer Session of 2012. Two months are allowed for hand counting and calculating of the statistics for the textbooks, laboratory manuals, and supplemental materials. The pilot study for this project, which demonstrated the lack of suitability for the GEOL 1210 textbook for first-year students, required approximately five hours of analysis.

Preparation of the spreadsheet to be disseminated to the Earth Science faculty will be conducted during the latter portion of the First Summer Session and preparation of the manuscript for the *Journal of Geoscience Education* and the presentation at the Geological Society of America will be completed before October 31, 2013.

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