Reading Skills of First-Year Students at a Technical College Compared to Textbook Readability in First-Quarter Courses

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Introduction

Textbooks are a critical part of the teaching/learning experience in most college courses. An appropriate textbook for a course is an important asset to students and faculty. In choosing a required textbook, instructors typically consider several criteria such as: content, organization, style, visual appeal, length, teaching aids, and personal preference. The readability level is an extremely important item which also should be considered in textbook selection.

Readability of textbooks is defined in the context of student reading skills. Several tests have been constructed to evaluate the reading skills of students. Similarly, many formulas have been developed to measure the readability of textbooks.

College instructors and administrators should be aware of and concerned about the reading skills of students and the readability of course textbooks, especially at the first- year level. This is even more important at open-admission colleges, which typically enroll a high percentage of students who do not have adequate academic preparation for college level work. This is the case at The Ohio State University, Agricultural Technical Institute (OSU/ATI), a technical college with about 650 students.

In a previous *NACTA Journal* article, Zimmerman and Houston (1994) reported on the reading skills of entering OSU/ATI students during 1990-1993 using the Degrees of Reading Power (DRP) test. The authors reported that the median independent DRP score for the population was 66 and concluded that about 50% of the students tested during the four years would have difficulty independently reading and comprehending high school academic and occupational textbooks, let alone college level textbooks. A first-quartile score of 58 suggests that about 25% of the incoming students would even have difficulty reading junior high level textbooks. DRP data for the 1994 OSU/ATI fall cohort indicate a similar level of reading skills (median and first-quartile scores were 69 and 61, respectively).

Currently, students entering OSU/ATI can enroll in any first-quarter course regardless of their reading skills. Therefore, as Zimmerman and Houston (1994) observed, given the wide range of reading skills among students enrolling in course work at OSU/ATI, both students and instructors are placed in a difficult situation. If textbooks and other assigned material are selected at the appropriate level of readability based on college and work force expectations, many of the students will be placed at a distinct disadvantage in successfully completing courses. On the other hand, if instructors select textbooks and other reading materials at a lower readability level to help those students with low reading skills or if they dedicate considerable class time to helping these students compensate for their inability to independently read and comprehend the assigned reading, they are compromising course content.

What is the readability of required first-quarter textbooks at OSU/ATI, and how does this compare to the reading skills of first-year students? This article reports on a study undertaken to provide answers to these questions.

Purpose and Objectives

The purpose of this study is to determine the readability of textbooks required in autumn quarter courses taken by first-year OSU/ATI students and to compare the results with known information about the reading skills of these students. The hypothesis is that the readability of first-quarter textbooks is above the reading level of a significant number of first-year students.

Specific objectives were to:

1. measure the readability of textbooks required in first-quarter (Autumn 1994) OSU/ATI courses in which first-year students enroll;
2. compare the readability of the textbooks with the known reading skills of first-year students for the 1990 - 1994 cohorts;
3. make specific recommendations based on the results.

Background Information

Readability Indices

Many readability indices have been developed to measure and compare the readability of textbooks. These indices are based on empirical formulas that include such factors as the number of: words per sentence, syllables per word, and unfamiliar words (those not on an established list). Many formu-

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las yield results expressed as "equivalent" grade levels. It is important to note that these are relative values and should not be interpreted as absolute reading grade levels. The Flesch-Kincaid and Gunning-FOG are two of the most commonly cited indices of this type and were used in this study.

Other indices have formulas that yield results expressed in units on a scale of zero to 100. The Flesch is one such index that is very commonly cited and was also used in this study. It is important to note that this index uses an inverse scale: textbooks with the easiest readability have the highest values. The DRP index (which is based on the Bormuth formula) is another example. It is a proprietary index developed by the College Board to be used with the DRP reading skills test discussed previously. DRP values were not directly measured for the textbooks in this study. However, the comparison of DRP values with the other readability indices proved useful as a part of this study.

Studies Involving College Textbooks in Which the Flesch, Flesch-Kincaid, and/or Gunning-FOG Indices were Used

Gallagher and Thompson (1982) analyzed the readability of 21 texts commonly used in basic junior level college courses in management, marketing, and finance using the Flesch index. The authors concluded that there was a wide variation in readability between the textbooks and that some textbooks may be too difficult for the intended audience.

Dunn (1983) evaluated the readability of 12 textbooks used in first-year level English courses and 13 textbooks used in first-year level mathematics courses at Kean College using five different readability indices. The author concluded that although the readability scores for individual textbooks will vary, in general the indices will yield similar results.

Graveel and Fribourg (1987) calculated the readability of 43 textbooks required for courses in the Plant and Soil Department at the University of Tennessee using eight different readability indices. The researchers concluded that some indices discriminated among textbooks classified for use in lower division, upper division or graduate level courses, and that word difficulty, sentence complexity, and scientific content are important in characterizing the readability of science textbooks.

Maddux, Candler and Johnson (1989) calculated the readability of 15 textbooks intended for use in college-level introductory educational computing courses using the Flesch index. The authors concluded that the textbooks were written at a low level for college textbooks perhaps due to the authors deliberately trying to simplify complex computer jargon.

Wood and Rosati (1990) measured the readability of ten textbooks commonly required in agricultural mechanization courses at agricultural colleges across the country using five of the common indices. They concluded that the textbooks were appropriate for students in grades 11-14. The researchers recommended that college instructors of introductory agricultural mechanization courses use the indices to evaluate textbook readability and that authors and publishers consider readability when writing and publishing textbooks.

Nixon and Helms (1991) examined the readability of 19 business communication textbooks commonly used in the first business course students take and 21 business policy textbooks used in capstone business courses for students about to graduate using nine different readability indices. The authors concluded that a wide range of readability scores existed among the textbooks and that the reading levels of some textbooks in the capstone course were much too difficult.

Table 1 Summary of Seven Studies of Textbook Readability in Which the Flesch, Flesch-Kincaid, and/or Gunning FOG Indices Were Used

Study				Flesch[1]		Flesch-Kincaid		Gunning-FOG	
Principal Author	Subject	Level	No	Mean	Range	Mean	Range	Mean	Range
Gallagher	Management	Jr	7	29.2	37.5-24.6				
Gallagher	Marketing	Jr	7	37.4	46.1-29.8				
Gallagher	Finance	Jr	7	36.2	40.1-32.6				
Dunn	English	Fr	12					13.3	7.2-19.6
Dunn	Math	Fr	13					15.1	12.5-20.4
Graveel	Agron	Fr-Grd	35	45.8	54.8-36.8	12.2	10.1-15.1	16.2	13.2-19.6
Maddux	Computer	Fr	15	56.0	67.0-45.0				
Wood	Agr Mech	Fr	10			9.8	8.2-14.2	12.7	10.3-16.0
Nixon	Bus Comm	So/Jr	19	50.4	64.2-38.6	11.1	8.6-13.6	14.6	11.1-17.3
Nixon	Bus Policy	Sr	21	36.9	67.6- 8.9	13.1	10.0-22.4	18.1	14.0-26.9
Hitcher	Agr	Fr	5					13.8	9.0-15.7
Hitcher	Agr	So	11					15.5	10.6-19.6
Hitcher	Agr	Jr	19					13.6	11.1-16.6
Hitcher	Agr	Sr	18					15.4	11.8-19.2
Hitcher	Agr	Sr/Grd	20					15.3	12.0-17.4

[1]Flesch is an inverse scale so low values represent higher reading levels.

Hitchner, Johnson, and Deeds (1992) determined the readability of 73 textbooks required in undergraduate agriculture courses at Mississippi State University during the Fall 1990 semester using the Gunning-FOG Index. Based on their results, the researchers concluded that the readability of the textbooks was appropriate; however, there were textbooks in specific courses that had extremely high readability levels. They also found that there was no significant relationship between course level and textbook readability, but that textbooks in sophomore-level classes may be written at too high a level. In their concluding remarks, the authors recommended a faculty workshop on textbook selection with emphasis on readability and further research to determine the match (or mismatch) between student reading skills and textbook readability.

Results of the studies discussed above are summarized in Table 1.

College Board Studies of Textbooks Using the DRP Index

Various types and levels of written material have been analyzed for reading difficulty in DRP units in several studies conducted by the College Board and summarized in the *DRP Handbook* (1986). Results for college textbooks in selected subject areas are listed in Table 2. DRP values for some college textbooks have been published in the *Readability of Textbooks,* 9th edition (1993). Unfortunately, none of the textbooks evaluated in this study were included in that publication.

Table 2 Readability of College Textbooks in DRP Units—*DRP Handbook* (1986) (Range of the middle 50%)

Subject Area	Reability
Humanities	64 - 68
Natural Science	69 - 72
Social Science	69 - 72

Procedures

The official university class schedule and curriculum sheets listing quarterly course requirements for each major were used to identify OSU/ATI courses offered Autumn Quarter 1994 in which first-quarter students could enroll. Using a list of required textbooks published by the campus bookstore, 37 textbooks were identified as required in the selected courses.

From each textbook, five prose passages with a minimum of 425 words (most passages had 450 - 600 words) were selected for evaluation. The passages were selected near: the beginning, one-fourth, the middle, three-fourths and the end of the textbooks. It proved much faster to make photocopies of the passages and edit out the headings, figures, sidebars, and non-prose material by cutting and pasting rather than scanning the passages directly.

Each edited passage was scanned using an optical character recognition program called Omnipage Professional. This software operated under Windows 3.1 on a 486-DX2-50 computer with 8 megabytes of RAM. A flat-bed scanner was also part of the hardware system. It took approximately 15 minutes to scan the five passages from each textbook. The scanned passages were saved in WordPerfect 6.0 format and spell checked to correct scanning errors.

The original plan was to use the Grammatik program in WordPerfect 6.0 to give direct values for the three reading indices. However, it was found that the number of sentences counted by Grammatik was sometimes inconsistent with the actual number in the passages. Therefore, Grammatik sentence counts were manipulated by removing periods so that they matched the manual counts before the indices were calculated by the software program.

The readability of the textbooks was determined using the Flesch, Flesch-Kincaid, and Gunning-FOG indices. The formulas are as follows:

Flesch; 206.835 - [1.015(average sentence length) + 0.846(number of syllables per 100 words)].

Flesch-Kincaid; [0.39(average number of words per sentence) + 11.8(average number of syllables per word)] - 15.59,

Gunning-FOG; 0.4(average number of words per sentence + number of words of three syllables or more).

The Grammatik provides the three readability indices in whole numbers. Although this is adequate for the Flesch index that has a range from 100 to zero, it does not provide enough differentiation for the other two indices that have limited variability. The Grammatik software prints out the average number of words per sentence and the average number of syllables per word with three significant digits. Therefore, the Flesch-Kincaid index was calculated to one decimal place using a spreadsheet. This process could not be used with the Gunning-FOG because the Grammatik program does not provide information about the number of words with three or more syllables.

Readability scores obtained for the five samples were averaged to obtain the readability of each textbook. The results are presented in Table 3.

Discussion and Conclusions

The Flesch, Flesch-Kincaid, and Gunning-FOG averages for all textbooks were found to be 48, 11.1, and 15, respectively. The average and range for all three indices are consistent with the results of other studies involving freshman level textbooks summarized in Table 1. Therefore, it can be concluded that the overall readability of textbooks required in first-quarter courses at OSU/ATI is appropriate and that most instructors are selecting textbooks with college level readability.

The average values for the three indices within each subject area in Table 3 are comparable to the overall averages with the exception of Engineering Technology. Several first-

Table 3 Readability of Textbooks Used in First-Quarter Courses at OSU/ATI (Ranked by Flesch-Kincaid Score Within Subject Areas.)

PRINCIPAL AUTHOR	TITLE	YEAR	FLESCH	FLESCH-KINCAID	GUNNING FOG
AGRICULTURE					
CAMP	ENVIRONMENTAL SCIENCE FOR AGRICULTURE	1994	35	12.7	17
TAYLOR	SCIENTIFIC FARM ANIMAL PRODUCTION	1992	42	12.0	16
FRANDSON	ANATOMY & PHYSIOLOGY OF FARM ANIMALS	1992	44	11.9	15
ESMINGER	SWINE SCIENCE	1984	46	11.8	16
SCHMIDT	PRINCIPLES OF DAIRY SCIENCE	1988	47	11.3	14
(PURDUE CES)	PORK INDUSTRY HANDBOOK	1993	46	11.2	15
EVANS	HORSES	1989	61	9.0	12
PLASTER	SOIL SCIENCE AND MANAGEMENT	1992	56	9.0	12
AVERAGE			*47*	*11.1*	*14*
BUSINESS					
BOONE	CONTEMPORARY MARKETING	1995	26	14.5	19
MASTRIANNA	BASIC ECONOMICS	1995	40	12.8	17
HERMANSON	ACCOUNTING PRINCIPLES	1992	38	12.6	17
ALBERTE	MICROCOMPUTER USE	1989	44	11.9	15
EISCH	WP6.0, A PRACTICAL APPROACH	1995	72	7.9	11
AVERAGE			*44*	*11.9*	*16*
COMMUNICATION AND SOCIAL SCIENCE					
RICE	INTIMATE RELATIONSHIPS, MARRIAGES, AND FAMILIES	1993	33	13.9	18
PETTIJOHN	PSYCHOLOGY, A CONCISE INTRODUCTION	1992	33	13.2	17
POPENOE	SOCIOLOGY	1993	38	13.2	17
McWHORTER	THE WRITER'S EXPRESS	1993	51	9.9	13
LANGAN	COLLEGE WRITING SKILLS	1992	62	8.9	12
AVERAGE			*43*	*11.8*	*15*
ENGINEERING TECHNOLOGY					
SHERWOOD	WOOD FRAME HOUSE CONSTRUCTION	1988	49	11.2	14
(VICKERS)	INDUSTRIAL HYDRAULICS MANUAL	1993	53	10.1	13
WALKER	EXPLORING DRAFTING	1991	52	9.7	13
ROTH	SMALL GAS ENGINES	1992	55	9.3	13
(DEERE)	PREVENTATIVE MAINTENANCE	1992	62	8.4	11
AVERAGE			54	9.7	13
HORTICULTURE					
FULTON	INTRODUCTION TO TURFGRASS MANAGEMENT	1993	43	12.1	16
SMITH	LANDSCAPE CONTRACTING TECH MANUAL	1979	48	12.0	16
DIRR	MANUAL OF WOODY LANDSCAPE PLANTS	1990	50	10.7	14
McMAHON	INTRODUCTION TO GREEN HOUSE PRODUCTION	1992	47	10.5	14
(ONA)	CERT. NURSERYMAN TRAINING MANUAL	1983	49	10.5	14
BRUNEAU	TURFGRASS PEST MANAGEMENT	1991	50	10.4	14
(ONA)	CERT. NURSERYMAN LANDSCAPE INSTALLER MAN	1983	56	9.9	13
ANDERSON	FLORAL DESIGN AND MARKETING	1988	57	9.6	13
AVERAGE			*50*	*10.7*	*14*
MATHEMATICS AND NATURAL SCIENCE					
STERN	INTRODUCTORY PLANT BIOLOGY	1994	42	13.2	17
SHUGAR	CHEM TECHNICIANS READY REF HANDBOOK	1990	47	11.3	15
MADER	INQUIRY INTO LIFE	1994	45	11.2	14
HOCUM	FUND OF GEN, ORGANIC, & BIO CHEMISTRY	1994	53	10.9	14
MILLER	BASIC MATHEMATICS WITH APPLICATIONS	1991	52	10.6	15
AUFMAN	PREALGEBRA	1994	55	9.2	13
AVERAGE			*49*	*11.1*	*15*
AVERAGE OF ALL BOOKS (37)			***48***	***11.1***	***15***

quarter Engineering Technology textbooks are written at a lower readability level. The study by Wood and Rosati (1990) for freshman level Agricultural Mechanics textbooks had similar results (see Table 1). This may be due to the lack of appropriate college level introductory textbooks.

Textbooks with Flesch, Flesch-Kincaid, and Gunning-FOG scores in the range of 55-65, 8-10, and 11-13 respectively, are written at a reading level lower than normally expected for college textbooks. At least one textbook in each of the subject areas in Table 3 had reability scores in this range.

At the other end of the spectrum, when the textbooks having the highest readability levels in Table 3 are compared to those in Table 1, most fall within an appropriate level of difficulty for introductory college courses. Interestingly, the four textbooks having the highest readability in Table 3 (one business and three social science) are required in courses which can be taken as electives any time during the degree program.

Although it is not possible to convert the results of the three readability indices directly to DRP readability index scores, indirect comparisons can be made. The *DRP Handbook* contains several short passages at listed DRP scores. These passages were scanned and the readability values for the three indices were calculated using the same procedure used for textbooks. It was found that the average textbook readability scores for each of the three indices would yield a DRP score of approximately 70. An average DRP readability score of 70 for OSU/ATI textbooks is consistent with values listed for college textbooks summarized in Table 2. This is additional support of the conclusion stated earlier that the overall readability of textbooks required in first-quarter courses is appropriate and that most instructors are selecting college level textbooks.

Students would need a DRP independent reading skill level of approximately 70 to independently read and comprehend an average first-quarter textbook at OSU/ATI. Students would need a DRP independent reading skill level of at least 60 to be able to read and comprehend those textbooks with the lowest readability levels in Table 3. As reported earlier, the median reading skill level of first-year students was 66, and the first-quartile level was 58. Therefore, the hypothesis that the readability of first-quarter OSU/ATI textbooks is above the reading level of many first-year students has been verified. The results also show that those students whose reading skills place them in the lowest quartile cannot independently read and comprehend even those textbooks with the lowest readability levels.

Common sense, good educational practice, and ethical considerations would dictate that entering students with reading skills below those required to independently read and comprehend first-quarter textbooks should not be allowed to enroll in introductory courses until they have improved their reading skills.

If instructors adhere to typical college expectations that students independently read and comprehend their textbooks, then many OSU/ATI students will have trouble succeeding. This may be a major contributing factor to students not completing their degrees.

Another concern is that some instructors will compromise academic standards by eliminating text material as an integral part of the course because a substantial number of students cannot independently read and comprehend the textbooks. Alternatively, the instructors may dedicate considerable class time to explaining material to those with low reading skills. Both of these approaches come at the expense of course content and adequately preparing students for technical careers.

Recommendations

1. Given that the hypothesis that the readability of first-quarter textbooks at OSU/ATI is above the reading skill level of many first-year students has been verified, it is recommended that a reading course be mandatory for all first-quarter students whose DRP independent reading skill level is below 66.
2. OSU/ATI elective courses using textbooks with high readability scores should not be open to first-quarter students.
3. An appropriate score on the reading test should be a prerequisite for most courses at OSU/ATI
4. Textbook publishers should measure the readability of their textbooks and make the results known in promotional literature.
5. Readability should be an important criteria in selecting textbooks. It should be at the appropriate level.
6. Colleges with a high population of students with low reading skill should devote resources to reading improvement programs.
7. Future research should measure the readability of periodical literature that graduates will encounter in their professions.

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