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# Readability of PTA Textbooks and Reading Comprehension Rates of PTA Students

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**Abstract**:

The purpose of this study was to determine if correlations exist between independent reading comprehension levels of students measured by the Nelson Denny Reading Test (NDRT), readability of textbooks used for instruction and the National Physical Therapy Exam (NPTE) in a Physical Therapist Assistant (PTA) Program.

Applications of NDRT, readability formulas, and textbooks were identified.

NDRT, course, and NPTE scores of 161 graduates of the PTA program were used. Multiple readability formulas were applied to five textbooks. Correlations were calculated.

Mean NDRT- total score was 14.67. Three of five textbooks had higher readability levels than the mean NDRT reading comprehension levels of students. A moderate positive correlation existed between NDRT and NPTE scores.

**Keywords**: Readability, Reading comprehension, textbooks, Nelson Denny reading test, Physical therapist assistant

## 1. Introduction

Collegiate level courses often rely on textbooks for providing both fundamental and supplemental knowledge to enrolled students. While the costs of these texts are rather significant, professors often consider the foundational knowledge contained within the texts to be invaluable and vital to successive completion of the coursework. Clearly, the independent reading comprehension

level of the incoming students plays an important role in college program completion as students must apply concepts and knowledge gained through independent reading to classroom lectures and activities. Annually accepting up to 30 students, the Physical Therapist Assistant (PTA) Program at Arkansas State University aims to maintain a low attrition rate while simultaneously achieving high success rates on the National Physical Therapy Exam (NPTE). Beginning in 2005, the program tested students' independent reading comprehension using the Nelson Denny Reading Test (NDRT) upon acceptance into the PTA program. The purpose of this study was to analyze the reading levels of the PTA program students. Reading levels of the textbooks adopted for use in the PTA program courses were determined based on readability formulas. Independent reading comprehension levels of students were correlated to the readability levels of textbooks to determine if a correlation exists which could impact success in the PTA program.

## 2. Literature Review

Upon review of the literature, many themes were presented relative to the assessment and validity of reading comprehension, the assessment of readability of textbooks, the challenges associated in these assessment methods, and the role of textbooks from both the student and the instructor perspective. Various formulas exist for calculation of readability. According to Burke, V. and Greenberg, D. (2010), most readability formulas calculate a grade level or score that represents the educational level needed to comprehend reading material at 50% to 75% comprehension. The Flesch-Kincaid formula uses Microsoft Word making it easy to use; however, the Flesch-Kincaid formula underestimates reading difficulty. Many formulas estimate readability and originate from children's materials. Furthermore, validation of formulas transpired using children, not adult readers. Readability formulas do not account for prior knowledge of a subject.

Higher education institutions commonly use the NDRT as a screening test to identify problems in reading according to Brown, Fischco & Hanna (1993). Furthermore, other uses of the NDRT include predicting academic success and measure progress after reading skills intervention. The NDRT test originated in 1929 and subsequently updated over the years. The test consists of two subtests, reading comprehension and vocabulary. A total of 38 questions comprise the reading comprehension subtest in the areas of humanities, social sciences and hard science. Students must read passages and complete comprehension questions related to the passages which include both factual and inferential questions. The vocabulary subtest consists of 80 questions drawn from high school and college textbooks of varying difficulty. Fuller, S., Horlen, C., Cisneros, R. and Merz, T. (2007) used the NDRT to calculate grade equivalents for reading comprehension in pharmacy students and used the Gunning Fog readability formula to determine readability of assignments. Results of this study found that pharmacy students' scored a 16.5 mean grade equivalent level after testing of the NDRT However, reading assignments, medical treatment guidelines and PCAT test all require reading levels higher

than the mean scored by this cohort of pharmacy students. For instance, reading assignments had a mean of 18.1 with a range of 16.3-19.5, medical treatment guidelines had a readability score of 19.2 with a range of 17.5-21.0. Readability of assignments was higher than the mean reading comprehension level of students determined using the NDRT. An additional purpose of this study was to determine if a correlation existed between the Pharmacy College Admissions Test (PCAT) and the NDRT scores. The strongest correlation was between the NDRT vocabulary subtest and the verbal PCAT test. Haught, P. and Walls, P (2004) found a positive, significant correlation between the NDRT given at orientation and the United States Medical License Exam (USMLE) Step I which is given at the end of the 2nd year of medical school. The NDRT describes reading abilities of college students in a study by Savage, R. and Wolforth, J. (2007) which included undergraduate and graduate students. A positive correlation was found between reading comprehension and cumulative GPA.

The Nelson-Denny Reading Comprehension test, although demonstrated to be effective, also draws its critics. Coleman, C., Lindstrom, J., Nelson, J., Lindstrom, W. and Noel, G. (2010) challenged the validity of the NDRT as a comprehension test. In this study, students at risk for learning disorders and students not at risk for learning disorders answered questions on the NDRT without reading the passages. Results indicated that students in both groups performed better than chance (1 in 5), which raises a question of validity. Prior knowledge of subjects may influence answers as much as actual comprehension of the passages. Haught, P., and Walls, P. (2004) and Fuller, S., Horlen, C., Cisneros, R., and Merz, T. (2007) found positive correlations to standardized tests with the vocabulary portion of the NDRT. A study by Wang (2006) examined the types of questions used on the NDRT. Questions were labeled as textually explicit (TE), textually implicit (TI) or scriptally implicit (SI). The NDRT has a higher percentage of TE questions. A high score on the NDRT may indicate a reader with good matching skill and good strategies for locating information not necessarily a reader able to comprehend meaning from implicit cues.

Textbook readability analysis provides another challenge. Durwin, C. and Sherman, W. (2008) compared textbooks in order to discover if textbook selection impacted comprehension. Students read or listened to a section of a textbook and answered reading comprehension questions without access to the passages using the Sentence Verification Technique (SVT). The examinee then selected the sentence that had the same meaning as one in the passage. A second group of students repeated this procedure using a comparable textbook with a similar readability level based on the Flesch Reading Ease formula. Comparable textbooks yielded no significant differences in reading comprehension levels between groups. Graesser, A., McNamara, D., and Kulikowich, J. (2011) developed the Coh-Metrix system, amultilevel analyses of text characteristics. This system included five levels of assessment: words, syntax, textbase, situation model, genre and rhetorical structure. This work suggested that with the use of this automated program providing a

comprehensive analysis of the readability of the content, textbooks could be selected depending of the educational goal whether it be to challenge or boost a student's reading ability. One of the most difficult to comprehend textbooks at all levels of education included science textbooks. According to Best, R., Rowe, M., Ozuru, Y., and McNamara, D. (2005), science textbooks often require inferences. However, students may not possess adequate prior knowledge of the subject to make inferences. Well matched prior knowledge and textbook information improves comprehension in science textbooks.

The role of the textbook has also been examined. Although instructors view textbooks as essential to learning, reading assignments are not always completed by students. Berry, B., Cook, L. Hill, N. and Stevens, K (2011) found that most students do not complete assignments and typically read the textbook when preparing for an exam. Similar findings were reported by Clump, M., Bauer, H., and Bradley, C. (2004). Of 428 undergraduate psychology students, 27.46% of assigned readings were completed prior to classroom information presented on the readings and 69.98% of readings were completed before students were tested over the information. Research cited by Clump, M., Bauer, H., and Bradley, C. (2004) indicated that students who do not read assignments are not engaged learners in class. When students are quizzed over the reading assignment in class they are more likely to complete the reading. Students were also more likely to complete reading when extra credit was given for summarizing reading assignments. Constanzo, R. (2009) examined the role and usage of textbooks of nursing students in the first semester and fourth (final) semester of a nursing program. Significant differences were not found in strategies for reading and studying textbook concepts. Literacy skills needed for transferring textbook-based knowledge to practical applications prior to admission to nursing school is important for success. In addition to the NDRT, miscues are a way to assess reading comprehension of students. Warde, B. (2005) reported that weekly reading assignments for a single college course may be 80 pages. In this study, a group of students with learning disabilities and one without learning disabilities were tested for miscues in reading. Miscues were placed in categories of graphically similar, self-corrected, no meaning loss and loss of meaning miscues. The group of students with learning disabilities had more miscues than the group of students without learning disabilities. There are few adequate norm-referenced tests which assess the reading skills of college students with learning disabilities. Miscue analysis can be used at any level of education since oral reading passages can be taken from textbooks used in the classroom.

Objectives of this study were to (1) determine independent reading comprehension levels of PTA students, (2) determine the readability level of textbooks used in the PTA program (3) determine if correlations exist between the reading comprehension rates of students and success on the NPTE, and (4) determine if textbook readability impacts success in the PTA program.

## 3. Method

Using data collected from graduates of the PTA program at Arkansas State University from 2005 until present date, analysis included descriptive statistics using means and standard deviations. Data points included NDRT scores, NPTE scores, cumulative PTA program grade point averages, and individual course scores for students that graduated from the PTA program (n=161).

Researchers determined overall readability of five textbooks adopted for use in the PTA program courses. The texts selected represent materials frequently assigned to students as individual reading assignments prior to course lectures. Formulas used for evaluation of the general readability of the text included Flesch Reading Ease, Gunning Fog, Flesch-Kincaid Grade, Coleman-Liau Index, SMOG, and Automated Readability Index (ARI). Variances in text features such as sentence length, sentence structure, repeating words, and percentage of unique vocabulary contribute to the determination of the readability levels of texts and also to the discrepancies among reading level determination formulas. To account for variances in text structure presented throughout the texts, three samples were collected from each book. Sample passages equaled 150 plus words from the beginning, middle, and end of the texts. Three separate samples were averaged in order to determine the overall readability of the text. Ultimate success in the PTA program means passing the NPTE and obtaining a license to practice. Successful completion of individual courses and graduation from the program are also measures of success. Pearson correlations were used to evaluate the relationship between the three grade equivalent scores of the NDRT and scores on the first attempt of the NPTE. The same statistic provided the relationship between the NDRT total reading score and each of the eight individual courses in the program as well as the overall grade average while in the program. Finally, the relationship between readability of the textbook and the mean score for the course was determined using the Pearson correlation.

## 4. Results

The mean for the NDRT total score was 14.67 with a range of 14.51-14.68 for subtests. Table 1 reports the mean and standard deviation for NDRT scores. Further evaluation of the NDRT scores reveals 79 out of 161 (49%) score below GE of 14 in one or more areas of the NDRT. Thirty-eight out of 161 (23.6%) score below GE of 12 (reading level of high school senior) in one or two areas of the NDRT while 9 out of 161 (5.5%) score below grade equivalency (GE) of 12 in all three areas of the NDRT.

**Table 1** Means and Standard Deviations for Nelson Denny Reading Test

| | n | M | SD |
|---|---|---|---|
| Vocabulary Section | 161 | 14.5168 | 2.21716 |
| Comprehension Section | 161 | 14.6857 | 2.64653 |
| Total Reading Score | 161 | 14.6714 | 2.08508 |

(Means are reported in Grade Equivalents - GE)

NPTE and vocabulary and comprehension subtests of the NDRT (.361, .339) showed weak positive correlations while total reading score (.428) showed moderate positive correlations. Table 2 presents the correlations between subtests of the NDRT and the NPTE.

**Table 2** Correlations between NDRT Scores and NPTE scores

| | Vocabulary | Comprehension | Total Reading |
|---|---|---|---|
| NPTE | .361 | .339 | .428 |

(Correlation is significant at the 0.01 level - 2-tailed)

Table 3 presents the Pearson correlations for individual course scores and the NDRT total reading score. Correlations were significant ($p<.01$); however, were weak ranging from .245 to .401.

**Table 3** Correlations between NDRT Total Reading Score and Individual Course Grades

| | NDRT Total Reading GE |
|---|---|
| Movement Science | 0.276 |
| Physical Agents & Massage | 0.401 |
| Musculoskeletal PT | 0.323 |
| Neuromuscular PT I | 0.245 |
| Neuromuscular PT II | 0.323 |
| Pathophysiological Conditions | 0.247 |
| Patient Care | 0.285 |

(Correlation is significant at the 0.01 level - 2-tailed)

The six readability formulas applied to the five textbooks yielded results for GE. While variability exists among the readability formula results in grade equivalents, the five textbooks consistently ranked the five textbooks from

difficult to easiest to read. The Gunning Fog formula results were used to correlate to class averages. Based on the Gunning Fog formula textbooks ranged from GE of 11.1 to 16.30 with three out of five textbooks used in lecture courses above the mean reading level of the students. Table 4 presents grade equivalent scores for readability formulas used. The Flesch Reading Score Ease rated textbooks as difficult to read for four textbooks and fairly difficult to read for the Health Services textbook. The grade equivalent calculated by the Gunning Fog formula for each of the five textbooks was correlated to the mean class average for the course in which the textbook used. As expected, as the reading level of the textbook increases, the mean class average decreases.

**Table 4** Readability of Textbooks

| Textbook | Gunning Fog | Flesch-Kincaid Grade Level | Coleman-Liau Index | SMOG Index | Automated Readability Index | L Linsear Write Formula |
|---|---|---|---|---|---|---|
| Fundamental Orthopedic Management | 16.3 | 13.3 | 15 | 12 | 14.7 | 14.4 |
| Pathology for the PTA | 15.3 | 13.1 | 13 | 11.3 | 12.9 | 13.7 |
| Neurologic Interventions for PT | 14.9 | 11.6 | 12 | 11.2 | 10.6 | 12 |
| Clinical Kinesiology & Anatomy | 14.1 | 11 | 11 | 10.4 | 10.5 | 12.2 |
| Health Services | 11.1 | 9.8 | 11 | 9.4 | 9 | 9.1 |

(Readability is reported in grade equivalents)

Examining the 5.5% of students who have NDRT grade equivalencies below 12, 4 of the 9 passed the NPTE on the first attempt. Of the 5 who failed the first attempt only 2 have not passed on subsequent tests. Examining the other end of the spectrum, 6 of 81 students with GE over 14 in all 3 subtests on the NDRT failed the NPTE on first attempt.

## 5. Discussion

If scores on the NDRT are true to grade level, an associate degree course would require a reading level of 13 to 14.9, reported in GE. The mean independent reading level of PTA students was 14.67, representing an appropriate level based on the degree attained. With 49% scoring below a GE of 14 in one or more areas of the NDRT, there is potential for reading skills to impact learning in the PTA program. While the readability levels of 3 of the 5 textbooks used in lecture courses scored higher than the mean of the independent reading levels of students, only a moderate negative correlation between reading level of textbooks and average grades in individual courses occurred. NDRT scores and individuals courses exhibit a weak correlation. In

addition, NDRT and NPTE scores had weak correlations for vocabulary and comprehension and moderate for total reading score.

The NDRT test reports scores for vocabulary, comprehension and a total reading score. Therefore, educators must use discernment in interpretation of scores. The total reading score shows a higher correlation than the individual subtests. With only a moderate, positive correlation between the NDRT total score and the NPTE, more assessments and information is needed to make a decision regarding prediction of success or failure. Examination of students with the lowest reading levels revealed 9 out of 161 had reading levels at or below a beginning senior in high school. Four of those students passed the NPTE on the first attempt and 3 on subsequent attempts. Examination of students with high reading levels (all scores above 14) revealed 6 failed the NPTE on the first attempt. Examination of all students failing the NPTE on the first attempt revealed 22 out of 29 had a low NDRT score (<14) in at least one area.

## 6. Conclusions

Results of the current study imply that reading skills impact learning and success in the PTA program; however, reading skills alone will not determine success for every student. Students with lower reading abilities can overcome reading difficulties and be successful in the program and on the NPTE. Students with high reading abilities may not take in enough content or have the decision making skills necessary to be successful on the NPTE. While the NDRT does have value to instructors, the use of results should be used in combination with other indicators of academic struggle.

Future investigations need to search for other ways to measure independent reading comprehension for healthcare students in a college program. Prior general knowledge could impact NDRT scores. Based on the literature review, miscues and sentence verification technique may be more reliable sources of testing since relevant materials can be used in testing. Terminology used in healthcare professions is unique and merits investigation of whether independent reading comprehension of general text correlates to independent reading comprehension of medical terminology.

Another concern with using independent reading comprehension and readability of textbooks to predict success or improve chances of success for students is making sure comparisons and correlations are appropriate. Does the NDRT actually measure the literacy and comprehension skills necessary for success on the NPTE?

## 7. Further Recommendations

Relating readability of textbooks to success in the program is difficult since various formulas yield different results. With 3 of 5 textbooks above the average reading level, a majority of students are still successful. There is a need to know

how our students are using textbooks as well as how teachers are using the textbooks. Are textbooks used as a primary source of information, as a reference, are chapters read in detail or are summaries reviewed? What is the primary source of information for courses? According to Lei, S., Rhinehart, P., Howard, H., and Cho, J. (2010), the future of textbooks is the integration of textbook material with other additional aides and online resources. Independent reading levels of students and readability of textbooks indicates that selection of textbooks should consider ancillary materials that can provide reading skill support for students. Does the teacher follow the text closely or have it available as supplemental information. Do students or teachers use the ancillary materials available from the textbook or online resources such as PowerPoint or YouTube videos?

Although formulas exist to assess various caveats of the general readability of textbooks, a single method providing the depth and breadth of necessary elements has not been established. For example the analysis of a narrative text versus an instructional text cannot be distinguished with the formulas that are currently available. A formula that accounts for more variables including prior knowledge and factors outside the reader's mind is required. Readability analyses should be targeted toward the appropriate audiences by utilizing input from both instructor and student feedback relative to a common goal. The development of the Coh-Metrix Multilevel Analyses of Text Characteristics by Graesser, A., McNamara, S., and Kulikowich, J. (2011) include the analyses of word concreteness, syntactic simplicity, referential cohesion, causal cohesion and narrativity which have the capacity to broaden the readability analyses that have been performed thus far.

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