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Comparison of Reading Levels of Pharmacy Students and Reading Level of Primary Literature

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Abstract

Objectives: The project purpose was to evaluate pharmacy students' reading levels using the Nelson-Denney Reading Test (NDRT) and compare these results with the reading level of primary literature to investigate incongruities between student's comprehension ability and the readability level of assigned reading in the curriculum.

Methods: The NDRT was administered to first- through third-year student pharmacists to determine grade equivalents (GE) for vocabulary and reading comprehension. Twenty articles previously identified as Patient-Oriented Evidence that Matters (POEMs) were analyzed to determine the Flesch-Kincaid Grade Level and Gunning-Fog Score. Student demographics, information regarding language spoken, and reading habits, were also assessed. Pearson product moment correlations, t-tests, ANOVA, and descriptive statistics were used to assess relationships between demographic data and NDRT scores.

Results: One hundred students participated. The mean NDRT total grade equivalent (\pm SD) was 16.95 ± 2.1 (median = 17.3). NDRT grade equivalents were statistically different for students with different racial or ethnic backgrounds ($t(98)=3.74$, $p=0.026$), English as a second language (ESL) students ($t(98)=5.19$, $p=0.021$), and students that read works of fiction for pleasure ($t(98)=4.31$, $p=0.002$). The average Gunning-Fog Score for all primary literature articles was 11.48, with the introduction section being the most complex. The average Flesch-Kincaid Grade Level was 17.04, with the results section scoring the lowest average grade level.

Implications: While the overall reading grade level of our pharmacy students suggests that they are capable of comprehending reading assigned in the pharmacy curriculum, minority students and students for whom English is a second language may struggle with comprehending complex text.

Keywords: Nelson-Denney Reading Test, Primary Literature, Pharmacy Students, Gunning Fog Score, Flesch-Kincaid Grade Level

INTRODUCTION

The general decline of reading ability has hastened the need for comprehension assessments, particularly in professional degree programs.¹ When coupled with the academic reading requirements of many college courses, this decline can impede the success of students. Challenging texts provide important preparation for high school students entering college and the workforce. A 2013 National Public Radio feature assessed what students are reading in and out of class. Through interviews with high school students and teachers, investigators found that assigned reading did not match the appropriate grade level and that text complexity of these readings has been declining in recent years. According

to the investigators, the assigned texts were actually intended for younger audiences (2-3 grade levels lower) rather than high school students. In addition, experts noted that reading for pleasure may lead to students selecting more complex works of literature, in their future studies, and, thus, should be encouraged.²

Increasing numbers of college students may not have high school preparation sufficient for success in college or in the job market.³ In 2006, the National Center for Education Statistics found that many 12th grade students in the United States read at a fifth grade level. Educators have postulated that the cause of discrepancy between instructional level and ability level is lack of reading comprehension.⁴ Text complexity, and its comprehension, was found to be the "the clearest differentiation in reading between students who are college-ready and those who are not" in a report by American College Testing (ACT) organization.⁵ College readiness is hard to define. The ACT test has long been the benchmark for college readiness in high school students, and in 2012, it was reported that 52% of high school graduates were ready for college-level reading.⁶ For underrepresented minority

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students, Latinos and African Americans, however, the proportions of students ready for college-level reading were even lower, 36% and 22%, respectively.⁶

Greene and Winters have stated that minimal competency prior to college entry includes a high school diploma and mastery of basic reading. Under this metric, roughly a third of United States students are college-ready upon high school graduation.⁷ Many community colleges throughout the nation offer transitional curricula for high school students who desire a college degree but need more preparation to be successful. It has been reported that 33-60% of first-year college students take such courses.⁸⁻⁹ Even with transitional courses, students may find themselves "...overwhelmed by the density of their college textbooks and baffled by the strangeness and complexity of primary sources and by their unfamiliarity with academic discourse."¹⁰

The demanding schedule of academic reading requirements found in many college courses can derail student success, when students are additionally struggling with the ability to read and comprehend what they are reading. In professional degree programs, reading dense textbooks and journal articles is required. This struggle is the impetus for assessing reading abilities prior to program entry, as well as, prior to professional licensure.¹¹ Many academic programs use assessments, such as the Nelson Denney Reading Test (NDRT), to gauge the ability of students to successfully complete their curriculum. Studies support the use of this tool during many points in the academic timeline of a professional student. It has been used as a student recruitment tool, as a baseline assessment of ability, as a mechanism for course placement, to determine ability to remediate course failure, and as a predictor of licensure exam success.¹¹⁻¹³ Studies have found that, unlike entrance or licensure exams, the NDRT can be given multiple times to determine progress in an individual's reading comprehension. Repeated measures also provide feedback on whether interventions to improve reading are significantly impacting student ability.

In 2007, Fuller and colleagues conducted a study of third year pharmacy students using the NDRT.¹⁴ In addition to assessing reading ability, the authors examined the relationship between PCAT and NDRT scores. The investigators found a strong correlation between the NDRT vocabulary section and the verbal assessment on the PCAT. The mean NDRT score was 16.5, which corresponds with a reading level of a student at the end of their fourth year of college.¹⁴ The study also assessed the readability of tertiary literature in the form of published treatment guidelines, and a pharmacotherapy textbook; reading levels were 18.1 and 19.2, respectively.¹⁴

The authors concluded that the discrepancy between mean reading level of students (16.5) and readability levels of assigned reading (18.1-19.2) indicated that students may struggle with the expectations of the pharmacy curriculum.¹⁴

The application of knowledge found in the primary literature to inform clinical decision making, is one of the educational outcomes assessed by the Center for the Advancement of Pharmacy Education.¹⁵ Most educators consider the amount of reading they assign students over the course of a semester; however, they may not consider the difficulty of the reading material, especially primary literature, student reading ability, or reading rate (words/minute). Accounting for these factors may assist faculty with setting reasonable expectations for student's ability to complete required reading and/or assignments. In an effort to further investigate the potential incongruities between student's reading abilities and the readability of primary literature, a pilot study was conducted at Belmont University College of Pharmacy. The primary objective of this pilot study was to determine the reading level of pharmacy students currently enrolled in first-, second-, or third-year of their pharmacy education. The secondary objectives were to examine differences in reading level associated with demographic characteristics and to assess the readability of primary literature articles that are classified as patient-oriented evidence that matters (POEMs).

METHODS

This study was conducted during the fall semester of 2014, and students from the first through third professional year classes at the Belmont University College of Pharmacy (BUCOP) were invited to participate. Students were given the option of taking the NDRT during a regular class period. In addition to the assessment, a survey instrument assessing sociodemographic information, mood during time of assessment, and prevalence of reading for enrichment or non-academic purposes was administered. Demographic information included age, gender, race/ethnicity, prior degree, and the use of English as a primary language spoken in the home.

This study was approved by the Belmont University Institutional Review Board. No financial incentives or course credit were offered in exchange for participation. Students were encouraged to participate so they could obtain their individual results and discuss them with the lead investigator, if desired. Informed consent was obtained immediately prior to administration of the assessment.

Student Assessments

The NDRT was administered according to the standardized instructions provided in its *Directions for Administration*.¹⁶

Created in 1929, the most recently updated version is comprised of three timed portions: vocabulary (80 definitions, 15 minutes), reading comprehension (7 passages, 38 questions, 20 minutes) and reading rate. More than 5,000 students randomly sampled from four-year institutions were stratified by location, size and type of institution for the standardization sample. Precautions to decrease or eliminate race and gender bias were taken. Grade equivalents were determined according to the *Nelson-Denny Reading Test: Manual for Scoring and Interpretation*.¹⁷ Predictive validity studies found that the NDRT was a reliable measure of reading aptitude, reading attitude and general academic achievement.¹⁸ The NDRT provides a raw score, scaled score, and grade equivalent for all measures. The raw score for vocabulary, reading comprehension and total scores are computed to report a grade equivalency score. Grade equivalents are based on the United States educational system and are equivalent to the number of years of education completed. Reliability coefficients of the NDRT instrument are 0.91, 0.74, 0.90 and 0.66 for the vocabulary, comprehension, total score and reading rate, respectively.¹⁸

The mood of the student at the time of the assessment may impact NDRT performance, therefore mood was assessed as a possible variable that might confound performance. The impact of mood on reading comprehension has been studied elsewhere.¹⁹ One study in particular found that when participants reported positive mood (happy) versus negative mood (sad), they were more engaged in text-based inferences on reading assignments.²⁰ The Brief Mood Introspection Scale (BMIS) is a mood adjective scale that assesses mood states including happiness, anger, anxiousness, tiredness, and calmness.²¹ The BMIS is a four point scale with the following response categories: definitely do not feel, do not feel, slightly feel, and definitely feel.²¹ Students were asked to report the magnitude of selected mood states from the BMIS (happy, tired, grouchy, drowsy, nervous, and calm).

Analysis of Readings

Primary Literature

In addition to determining the reading level of each student, the reading level of selected primary literature was assessed. Primary literature articles designated as Patient-Oriented Evidence that Matters (POEMs) for primary care physicians by Ebell et al. were selected for analysis.²² The POEMs classification was created to address the usefulness of information in the patient care process by assessing relevance, validity and the time or effort used to respond to clinical questions.²³ Based on these criteria, these articles were considered representative of the primary literature that students will be reading in didactic and experiential curricula and in practice. The selected articles²⁴⁻⁴³ were analyzed using

the Gunning Frequency of Gobbledygook (FOG) Reading Score and the Flesch-Kincaid Grade Level.⁴⁴⁻⁴⁵ Both scores were obtained for each article section (abstract, introduction, methods, results, and discussion). The Readability Score website (<https://readability-score.com>), which is available through subscription, was used to assess the FOG reading score of each section of the clinical trials. The website specifies that the grade level provided for the Gunning FOG is based on the United States education system with a grade level of 10-12 being equivalent to a high school graduate. Microsoft Word was used to assess the Flesch-Kincaid Grade Level. Articles were converted from portable document format to Word documents using Adobe Acrobat DC (Adobe Systems Incorporated, San Jose, CA). Only the text sections of the selected POEMs articles were assessed; tables and figures were excluded.

The Gunning FOG Index evaluates the sentence structure of textbooks and other reading passages, using a formula to determine the grade level of reading materials based upon the average sentence length and the percentage of words that have more than two syllables. These scores correspond to the number of formal years of education needed to comprehend the passage after one reading of the text.⁴⁴

The Flesch-Kincaid is the primary reading level formula used in Microsoft applications and is the Food and Drug Administration mandated formula for assessing the reading level of informed consent documents.⁴⁵⁻⁴⁶ There are two Flesch-Kincaid tests for readability: a grade level index and a measure of reading ease. The reading ease formula can be converted into a grade level with a linear relationship connecting the two between grade levels 8 and 16.⁴⁵ According to the Flesch-Kincaid, passages with a reading grade level greater than or equal to 16 are deemed very difficult to read, and scores over 22 should generally be interpreted as graduate level text.⁴⁴

Required Reading Assignments

Course syllabi were reviewed to determine the number of pages of required reading assigned each week for each course. The total number of pages for all courses was totaled to obtain the number of total weekly pages. If the syllabus listed a range of chapters (e.g. Chapters 1-3), the specific reference was consulted to determine the number of pages in the chapter. The number of words per page was estimated by multiplying the average number of words per line of text by the average number of lines of text per page. This number was then multiplied by the number of pages to estimate the number of words in required readings. Finally, the number of words per week was multiplied by the reading rate (words/minute) to determine the time required to complete required readings per week.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 21 (IBM Corp., Armonk, NY) was used to analyze the data.⁴⁷ Power analysis using G*Power software program (Universität Düsseldorf, Düsseldorf), found that for a one-tailed study, a sample size of 84 (with 2 groups in subgroup analyses) was needed to run one way ANOVA with a large effect size (0.40), $\alpha=0.05$ and powered to 95%.⁴⁸ Pearson product moment correlations, t-tests, ANOVA, and descriptive statistics were used to assess relationships between demographics, mood, and NDRT scores.

RESULTS

Of the 203 students in the first, second and third didactic year of the pharmacy program, 100 students participated in our study, producing an overall response rate of 49%. In the P1 cohort, 13% of the class participated (n=9 out of 69); 83% of the P2 cohort participated (n=54 out of 65); and, 50% of the P3 cohort participated (n=37).

The demographic information for study participants can be found in Table 1. The majority of the participants were English speaking, female, Caucasian students with a bachelor's degree. Despite nine respondents noting English was not their first language, all respondents felt that they spoke English either well or very well (25% and 75%, respectively).

The mean NDRT total grade equivalent was 16.95 (SD 2.1) for the entire cohort. The range was 9.7 - 18.9, with a median score of 17.3. There were no statistically significant differences between cohorts, however, it is interesting to note that the P1 students had a slightly higher mean score when compared to the P2 class (16.9 +/- 2.2 versus 16.6 +/- 2.3). Predictably, the P3 students had the highest mean score of 17.5 (+/-1.8).

Subgroup Analyses

Statistical differences were found among NDRT grade equivalents for the following subgroups: non-white ethnicity, ESL speakers, and fiction readers. Grade equivalence scores were higher for Caucasian students (17.3 +/- 1.6) than for non-white students (15.3 +/- 3.3; $t(98)=3.74$, $p=0.026$). Results for NDRT sections related to vocabulary ($F=3.133$, $p=0.018$) and comprehension ($F=3.676$, $p=0.008$) were also statistically different between Caucasian and non-white students. ESL students scored lower than students who speak English as a primary language (17.2 +/- 1.7 versus 13.8 +/- 3.6; $t(98)=5.19$, $p=0.021$). Students who speak another language in the home were also significantly more likely to have lower grade equivalency scores than those students that speak only English at home (14.5 +/- 3.2 versus 17.3 +/- 1.6; $t(98)=3.258$, $p=0.006$). Students who reported reading works of fiction for

personal enrichment were found to have higher mean grade equivalent scores than students who did not read fiction (17.5 +/- 1.6 versus 15.5 +/- 2.7; $t(98)=4.31$, $p=0.002$). T-tests and ANOVA revealed no significant differences between men and women with respect to grade equivalency scores ($F=2.84$, $p=0.95$).

Information related to the frequency of pleasure reading for personal enrichment can be found in Figure 1. In this question, reading for enrichment does not include assignments for work or school. The breakdown by type of reading material can be found in Figure 2. Works of fiction were the most commonly cited type of reading material in the study sample, followed by newspapers, non-fiction, and journal articles.

Table 2 reports the mean, median and range for the 20 POEMs articles selected for the study. The overall average Gunning FOG Reading Score for all included articles was 11.48, with a range of 7.6 to 14 for individual sections of the article. The introduction was found to have the highest average score. The mean Flesch-Kincaid Grade Level was 17.04, with a range of 10.7 to 47.4 for individual sections. The lowest average grade level was found in the results sections. However, analysis of the results section only included text; tables and figures were not assessed. Analysis of the discussion section included the conclusion of the articles analyzed.

Correlations between non-academic reading and NDRT scores were computed. The strongest correlation was found between reading for pleasure and reading rate ($r=0.309$; $p=0.002$), with a medium effect size ($r^2=0.09$). Additionally, reading for pleasure was positively correlated with higher raw scores in vocabulary ($r=0.222$, $p=0.026$), scaled scores for vocabulary ($r=0.224$, $p=0.025$), grade equivalency vocabulary ($r=0.231$, $p=0.21$) and grade equivalency total ($r=0.200$, $p=0.46$). Further analysis using ANOVA confirmed that reading for pleasure was significantly associated with student reading rates (RSRR $F=2.713$, $p=0.034$; SSRR $F=2.682$, $p=0.036$). While a relationship was assumed, reading scholarly articles for pleasure did not appear to significantly impact grade equivalency scores ($F=0.713$, $p=0.401$).

Evaluation of required reading assignments revealed that students were expected to read between 88-173 textbook pages per week. The estimated number of words per page for each textbook ranged from 150 - 850; based on the individual course assignments and number of words per page, it was further estimated that a total of 54500 - 90000 words per week were assigned. Average respondent raw reading rate was 240.2 ± 68.3 (range 106-505) words per minute; the scaled reading rate was 206.4 ± 20.6 (range 166-286). From

these reading rates, it was estimated that on average, 227 - 375 minutes (3.78-6.25 hours) per week would be expected to be spent on required reading assignments.

DISCUSSION

The 2013 Center for the Advancement of Pharmacy Education (CAPE) Educational Outcomes report states that practitioners will “evaluate the scientific literature, explain drug action, solve therapeutic problems, and advance population health and patient-centered care”.¹⁵ Furthermore, the outcomes state that the critical analysis of scientific literature is necessary to enhance clinical decision making.¹⁵ Critical analysis is dependent upon reading comprehension, which, in turn, is viewed as a precursor to success in professional health care programs of study.¹¹ NDRT scores have been used with some level of success to control for reading comprehension when measuring critical reasoning ability.¹⁸

Our study sample had a mean reading score of 16.95 grade equivalent (GE). When examined by class, there were no significant differences, however, as was expected, the P3 class scored slightly higher than the other two classes (mean = 17.5 ± 1.7). Fuller et al. assessed reading comprehension in pharmacy students and the mean grade equivalent score was 16.5.¹⁴ Fuller et al. solely examined third year students, while we included first through third year students. Fuller et al. included 7% underrepresented minority students, 2% Asian American students, and 11% ESL students. Our study included 6% underrepresented minority students, 11% Asian American students, and 9% ESL students. We had a greater percentage of students with a four-year degree than those in the Fuller study (66% vs. 48%).¹⁴ While our average reading GE was somewhat higher than that found by Fuller et al., this trend may be explained by the higher percentage of students with a four-year degree prior to entry into pharmacy school.

Our study found that racial and ethnic minorities and ESL students scored significantly lower than non-minority or non-ESL students, respectively. It has been established in other studies that ESL students misinterpret universal health-related vocabulary used in pharmacy, which may inhibit their success in courses, such as pharmacology and communications, as well as in experiential education. Reading assignments, journal clubs and understanding care plans may be more difficult for these students.⁴⁹⁻⁵¹

The finding that students who identified as reading fiction for pleasure scored higher on the NDRT is of interest. Researchers at Emory University used functional magnetic resonance imaging (fMRI) to detect brain activity after reading novels. Their findings suggest that reading novels over time strengthens the areas of the brain responsible for language processing, as well as enhances the connectivity of

the brain to remember what was read days before.⁵² Reading works of fiction therefore, may help students by exposing them to vocabulary, improving language processing and in creating bridges between the material. - all of which will help them successfully navigate text assigned in the pharmacy curriculum.

Fuller, et al. found that *Pharmacology: A Pathophysiological Approach*, and treatment guidelines had a Gunning FOG Reading Score of 18.1 and 19.2, respectively.¹⁴ A secondary objective of our study was to evaluate the reading level of primary literature that students may be assigned to read. This is of utmost importance, especially given that some research has suggested notable inconsistencies between students' abilities and the amount and difficulty of required textbook reading.¹⁴ In our cohort, NDRT reading comprehension levels were higher than the Gunning FOG Reading Score of the primary literature analyzed, but comparable to the average Flesch-Kincaid grade equivalent. While our data suggest that most of our students are capable of reading assigned primary literature, there are specific subsets of the student population that may find reading and comprehending these materials more time-consuming and difficult.

Limitations

Several potential limitations of the study may have impacted the validity of individual student results, as well as their generalizability. Each class was tested at a different time of day and in a different classroom environment. This variation may have impacted responses due to the mood and cognitive overload of the students. In the testing environment, distractions were minimized, but not completely eliminated. Students who are easily distracted may have experienced negative effects on reading rate and comprehension.

The timing of the exam administration could have also negatively impacted response rates. The low response rate in the P1 class was likely due to an exam being held shortly after the NDRT test administration. As such, students who struggle with reading comprehension may have opted not to take the assessment in order to have more time to prepare for the exam being given that day. Additionally, the NDRT exam exceeded class time for the P3 class, therefore many students elected not to participate. Future studies should take these two limitations into consideration when scheduling the administration of this voluntary assessment.

IMPLICATIONS

Currently, most professional degree programs assess the general academic abilities of potential students prior to program entry. Although the Pharmacy College Admissions Test (PCAT) has a reading comprehension section, the predictive value of PCAT, both subtests and/or composite, on

academic success has been debated.⁵³⁻⁵⁵ Therefore, assessment with the use of the NDRT may be beneficial in discovering the underlying characteristics that a successful pharmacy student possess. Studies support the use of the NDRT as a more precise predictor of medical school achievement than the Medical College Admissions Test (MCAT) reading subtest.¹ In addition, professional programs have used the NDRT as an intervention tool in assessing and monitoring comprehension skills in graduate level students.¹² Also, the NDRT has been administered in dental school summer enrichment pipeline programs as a baseline assessment of ability, as well as upon completion of the programs to measure student preparedness and progress.¹² Perhaps having multiple assessments of potential student's reading ability would improve student success rates. Using or developing inventories that assess aspects of reading, such as comprehension, enjoyment, time spent and type, can allow educators to understand the needs of their students and tailor reading materials, assignments and classroom activities.

Scientific literature evaluation is just one of many areas the North American Pharmacist Licensure Examination (NAPLEX) assesses to determine a pharmacy student's competency to practice as a pharmacist.⁵⁵ Chisholm Burns and colleagues found that minority students scored significantly lower than non-Hispanic White students on the pre-NAPLEX.⁵⁶ No data regarding student demographics correlating with NAPLEX pass rates was found to corroborate these findings; however, it stands to reason that not only minority students, but also ESL students would score lower on the NAPLEX than their White counterparts, if struggling with reading comprehension. Using the NDRT to identify all students, minority, ESL or other, that have deficits in reading comprehension might improve pass rates for the individual and for schools over all, if interventions to improve reading comprehension can be implemented in advance of sitting for the licensure exam. A study examining the relationship between NDRT scores and the National Physical Therapy Licensure Exam (NPTE) found a significant correlation between the composite scaled score on the NDRT and the scaled score on the NPTE. This relationship was especially strong in those students that passed the NPTE the first time.¹¹

Finally, our results may be used to provide pharmacy educators with an estimate of student time required for reading outside of class when coupled with the length of reading assignments. Estimating the amount of time a student spends reading or studying outside of class time may help educators prioritize outside of class learning activities, especially when students are assigned extensive reading assignments for multiple classes.

Replication of this study in other pharmacy programs will allow for greater generalizability of results, as well as the potential for predicting success in pharmacy programs. Comparing NDRT scores to PCAT scores, pre-pharmacy GPA, pharmacy program GPA and NAPLEX scores might also indicate areas for improvement in curriculum and test preparation for those considering pharmacy as a profession and those preparing to enter practice as a licensed professional. Those that do not score at appropriate levels could be screened for remediation to improve chances for successful completion of the pharmacy degree program and a passing score on the NAPLEX.

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Table 1. Characteristics of Study Participants (n=100)

Characteristic	%
Female	57%
Caucasian or White	82%
African American or Black	3%
Hispanic	3%
Asian	11%
English as primary language	91%
Bachelor's degree	66%
Associate's degree	5%
Some college, no degree	25%
Master's degree	4%

Table 2: Flesch-Kincaid Grade Level and Gunning-Fog Score of POEMs

Article Sections	Flesch-Kincaid Grade Level			Gunning-Fog Score		
	Mean	Median	Range	Mean	Median	Range
Abstract	15.6	15.2	14.2 – 18.2	12.0	12.5	9.1 – 14.0
Introduction	20.9	18.7	14.0 – 47.4	11.8	11.8	7.6 – 13.4
Methods	16.2	17.0	12.8 – 18.4	11.6	11.5	10.1 – 12.9
Results	14.9	14.8	12.8 – 17.5	10.2	10.2	7.9 – 13.5
Discussion	17.4	17.6	10.7 – 21.4	11.9	12.0	9.8 – 13.6
Overall	17.0			11.5		

Figure 1. Frequency of Pleasure Reading

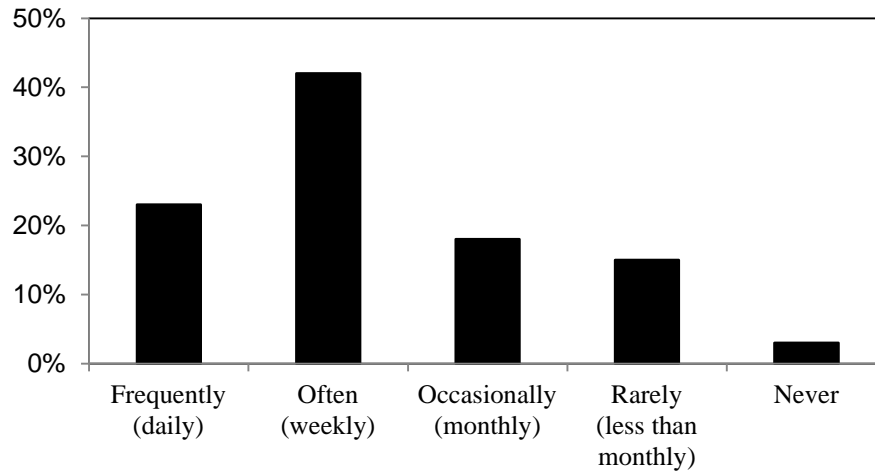


Figure 2. Frequency of Type of Reading Material

