RESEARCH

Evaluating the Relationship Between General Health Vocabulary and Student Achievement in Pharmacology

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Objective. To determine whether achievement in pharmacology is related to students' general health vocabulary knowledge.

Methods. Students registered for the pharmacology modules in the second (n=117), third (n=54), and fourth (n=41) years of the bachelor of pharmacy degree program completed a general health vocabulary assessment. Results of the vocabulary assessments in Pharmacology 3 and Pharmacology 4 were used to determine the effects of academic progression. Grades in the summative Pharmacology 2 examination served as indicators of achievement in pharmacology. Focus group sessions were held with a convenience sample of Pharmacology 2 (n=12), Pharmacology 3 (n=10), and Pharmacology 4 (n=5) students.

Results. A significant, positive correlation between Pharmacology 2 grades and vocabulary assessment scores was demonstrated. Student perceptions revealed during focus group interviews were that poor pharmacy-related vocabulary knowledge impacted their ability to learn pharmacology.

Conclusion. Achievement in pharmacology correlated positively with vocabulary knowledge ($p=0.031$) among a South African, multilingual student cohort in a setting where English is used in teaching and thus is imperative for learning.

Keywords: achievement, general health vocabulary, multilingual, pharmacology, pharmacy

INTRODUCTION

The extent of an individual's vocabulary knowledge is a known indicator of reading comprehension.[1,2] In the context of teaching English as a foreign language, Qian has shown that depth of vocabulary knowledge, as well as vocabulary size, can be used to predict academic reading performance.[3] In the teaching and learning of pharmacology, resources such as textbooks and pharmacological literature (journal articles) are essential resources for students. However, the readability of these texts and literature can be problematic. For example, the textbook *Pharmacology: A Pathophysiological Approach*[4] has a Gunning Fog index for readability of 18.1, while pharmacology-related journal articles have an average score of 19.2.[5] The Gunning Fog index gives an estimate of the number of years of formal education required to understand a piece of written work after one reading of the material. This method takes into account sentence length and the number of words longer than 3 syllables when calculating the complexity of the material. Material with a Gunning Fog score of greater than 16 is very difficult to read and has a reading level comparable to legal documents.[6] One study found that the reading ability of a group of third-year PharmD students in the United States was below the level required to read the relevant pharmacy literature.[5] An inadequate reading level may give rise to a situation that has been reported in other disciplines where students who cannot understand the concepts resort to rote learning without comprehension.[7]

As part of their research on the effect of English as a second language on the academic performance of pharmacy students, investigators in the United Kingdom, Australia, and the United States have administered various types of vocabulary tests. In the United Kingdom, students who spoke English as their first language performed better on a vocabulary test than did those who spoke English as their second language.[8] Another study in the United Kingdom found a correlation between scores on

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a preadmission English skills test and final examination grades at the end of a master of pharmacy degree program.[9] Poor English literacy skills in Australian pharmacy students were linked to failure to complete the degree in the prescribed time.[10]

The above studies focused on the general English vocabulary knowledge of pharmacy students in relation to academic achievement in the pharmacy program. In order to determine the role played by knowledge of vocabulary that is more closely linked to the discipline of pharmacology, Diaz-Gilbert investigated knowledge of common health and pharmacy-related vocabulary terms among US pharmacy students who spoke English as a second language and reported that these students held substantial misconceptions.[11] While these studies linked general English vocabulary to academic achievement in pharmacy, this paper investigates whether general health vocabulary knowledge is related to achievement in the discipline of pharmacology.

METHODS

The study was undertaken at the Nelson Mandela Metropolitan University (NMMU) in South Africa where the subjects for the research were students enrolled in the BPharm degree program. In South Africa, upon completion of the 4-year BPharm degree, graduates are required to complete a 1-year period of supervised practice and successfully sit for the preregistration evaluation, after which they are allowed to apply for professional registration as a pharmacist. Pharmacology was presented in 3 modules during the second (Pharmacology 2), third (Pharmacology 3), and fourth (Pharmacology 4) years of the program. The duration of each module was 1 academic year. During Pharmacology 2 and Pharmacology 3, the method of content delivery consisted of lectures in which basic principles and relevant therapeutics were presented. Vocabulary was not taught as such, but students were encouraged to read the assigned textbooks and consult relevant dictionaries when necessary. During Pharmacology 4, the focus was on application in the clinical environment of the pharmacological knowledge acquired in the Pharmacology 2 and Pharmacology 3 modules. The classes were a mixture of students who spoke English as their first language and students who spoke English as their second language. All course content was presented in English.

Three data sources were used in this study: (1) scores on a general health vocabulary assessment sheet; (2) Pharmacology 2 final examination grades; and (3) student comments from focus group interviews. The first 2 data sets provided quantitative data generated from students registered for the pharmacology modules in the BPharm degree. Purposive homogenous sampling was employed, ie, the sample was selected based on knowledge of the group to be sampled and it was a homogenous sample because the group had a common characteristic, ie, registration for the Pharmacology 2 module. The 3 samples were the students registered for Pharmacology 2 (n=117), and (to allow for assessment of the effects of academic progression) the students registered for Pharmacology 3 (n=54) and Pharmacology 4 (n=41). Students were verbally invited to participate in the study, and intent to participate was confirmed by completion of an informed consent form. A convenience sampling technique was employed in selecting the students for the focus group discussions. Students were invited to attend the sessions, with a separate session held for each of the 3 pharmacology modules. The general health vocabulary assessment sheet was a purpose-designed assessment tool. The vocabulary employed in the assessment sheet consisted of pharmacology and general health vocabulary extracted from tests, examinations, and practical schedules written over the previous 2 years by Pharmacology 2 students. The design of the vocabulary assessment sheet was similar to the questionnaire employed by Diaz-Gilbert in that it consisted of 2 parts with 50 words presented in isolation in Part A and 32 of the words from part A presented in context in a paragraph in part B. The students were required to provide a written definition of the word that was pertinent in the health environment. The assessment sheet was piloted with a group of postgraduate pharmacy students prior to implementation, and consensus was reached between the group and the researcher that it tested positively for validity and reliability.

Administration of the vocabulary assessment occurred during the first term of the academic year under test conditions with no time constraints, ie, students were allowed as much time as they required to complete each section of the questionnaire. Initially, only Part A was handed out; then, upon completion of part A, the student was given part B. At the time they completed the assessment sheet, the students had already completed coursework in physiology, anatomy, and pathophysiology. The grades for the final summative Pharmacology 2 examination, written at the end of the academic year, were used as an indicator of achievement in pharmacology.

Data from the vocabulary assessment sheets were captured in an Excel spreadsheet and analyzed. A total score out of 100 was calculated from the sum of the correct definitions provided by the students for part A and part B. Inferential statistics were applied to the quantitative findings (vocabulary tests and summative examination results). Tests employed included the unpaired Student *t* test, regression analysis, and analysis of variance with posthoc

testing using the Scheffe test. The Cohen *d* test provided an indication of the practical significance of differences.

The focus group sessions were conducted by the first author. An assistant moderator took notes during each focus group session and the sessions were recorded on a digital audio recorder. The discussions recorded during the focus group sessions were transcribed and then analyzed using Atlas.ti (Scientific Software Development, Germany), which facilitates analysis of qualitative data by coding idea clusters and generating dominant themes. To ensure validity and reliability, the recordings were transcribed by an independent second pharmacist after the researcher checked the data against the audio recordings for accuracy. Additionally, a sample of the coding was cross-checked by the second pharmacist. The focus group sessions formed part of a larger study; however, in this article, only the themes relating to the language of pharmacology, acquisition of terminology, and use of pharmacology textbooks are reported. In order to maintain confidentiality, an alphanumeric code was assigned to each participant.

As both quantitative and qualitative data were generated, this paper was framed within a pragmatist paradigm. The study employed a mixed methods approach with concurrent triangulation. Ethical approval for this study was granted by the NMMU Ethics Committee. All participants provided written informed consent prior to participating in the study.

RESULTS

Student participation rates of 96.7%, 77.2%, and 89.1% for Pharmacology 2, Pharmacology 3, and Pharmacology 4, respectively, were obtained. The Pharmacology 2 students provided correct definitions for 50.9% of the words (part A plus part B). The participants were aware that the context within which the vocabulary assessment sheet was set was the pharmacological/health environment; therefore, only definitions pertinent to this environment were accepted as correct. The Pharmacology 3 students provided correct answers to 61.3% of the words and the Pharmacology 4 students provided correct answers for 62.4% of the words. Vocabulary knowledge was significantly ($p<0.001$) higher among Pharmacology 3 (61.3%) than Pharmacology 2 (50.9%) students; however, this difference was not seen between Pharmacology 3 and Pharmacology 4 (62.4%) students.

The average score achieved by the Pharmacology 2 students was significantly lower than that achieved by the Pharmacology 3 and Pharmacology 4 students ($p<0.001$). The significant difference resided between the scores achieved by the Pharmacology 2 and Pharmacology 3 students ($p<0.001$) and between the Pharmacology 2 students and the Pharmacology 4 students ($p<0.001$). A Cohen *d* score of ≥ 0.8 indicates a finding of practical significance. In order to determine whether there was a significant relationship between vocabulary knowledge and achievement in pharmacology, the scores from the general health vocabulary assessment sheet by the Pharmacology 2 students were compared to the grades achieved by the students in the end-of-year summative examination for Pharmacology 2. A significant ($p=0.001$), positive, non-zero correlation ($r=0.299$) was obtained from regression analysis (Figure 1).

English was the first language of only 34.2% of the Pharmacology 2 students. There was no significant difference ($p=0.74$) in the scores achieved on the vocabulary assessment sheet by the Pharmacology 2 students whose first language was English (mean score $\pm$SD$=50.4\pm9.4$) and those students who spoke English as a second language (51.1 ± 11.1). However, the grades achieved for the Pharmacology 2 summative examination were significantly ($p=0.045$,) higher for students whose second language was English ($50.8\%\pm14.8\%$) than for the students whose first language was English ($45.1\%\pm15.2\%$). When the grades for the Pharmacology summative examination were correlated against the scores for the vocabulary assessment sheet for all students as 2 separate groups, a significant non-zero ($r=0.367$) correlation was only achieved for students whose second language was English.

Although a knowledge level of only 50% is not sufficient for effective practice of the profession, a grade of greater than or equal to 50% on a summative examination is generally considered to be a passing grade at university level. The Pharmacology 2 students were therefore divided into 2 groups according to whether or not they received a passing grade (50%). The students who received a grade of greater than or equal to 50% achieved significantly higher scores ($p=0.031$) on the vocabulary test than the students who achieved a score of less than 50% (Figure 2).

Focus group sessions were held with students from Pharmacology 2 (n=12), Pharmacology 3 (n=10), and Pharmacology 4 (n=5). Inclusion criteria were registration for the relevant pharmacology module and submission of written informed consent. Themes that emerged related to difficulties with understanding the vocabulary used during pharmacology, acquisition of terminology employed in pharmacology, and the difficulty level associated with reading pharmacology textbooks.

DISCUSSION

During the BPharm program at the NMMU, the first pharmacology module is presented during the second year of the 4-year program. In the first year of the BPharm

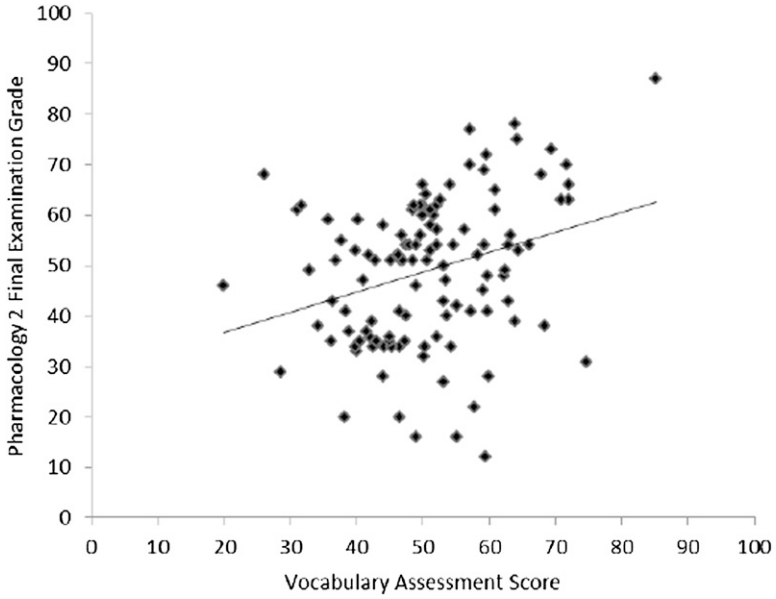

Figure 1. Correlation between the Pharmacology 2 final examination grades and Pharmacology 2 student scores for the vocabulary assessment (n5 117; r5 0.299).

program, students enroll for the foundation modules, such as anatomy, physiology, and pathophysiology. There are additional pharmacology modules presented in the third (Pharmacology 3) and fourth (Pharmacology 4) years of the BPharm program. Students complete systems pharmacology at the end of the third year of the BPharm program on completion of Pharmacology 3. Thereafter, during Pharmacology 4, the focus is on application, in the clinical environment, of the pharmacological knowledge acquired during Pharmacology 2 and 3. Thus, the period for acquisition of vocabulary would be during Pharmacology 2 and Pharmacology 3 when new information is being presented. Therefore, the changes with academic progression were in line with the academic approach to presentation of the pharmacology modules.

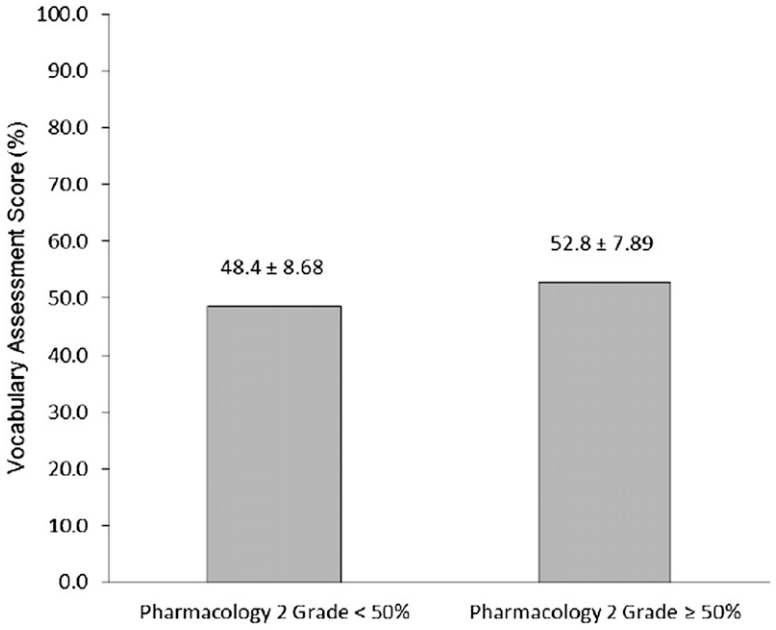

Figure 2. Mean scores and SD for the vocabulary assessment in students who achieved a final grade for the written Pharmacology 2 examination of either less than 50% (n=53) or equal to or greater than 50% (n=64). Significance is determined using the Student unpaired *t* test, $p=0.031$.

An increase in vocabulary knowledge as students progress through the pharmacy program has been presented by Long and colleagues,[8] who investigated scientific terminology comprehension in a group of MPharm students in the United Kingdom. Within the sample were students whose first language was English and other students whose first language was not English. The increase in score only occurred among the students whose first language was English and not among those who spoke English as a second language. The results of a study by Diaz-Gilbert revealed that average pharmacology vocabulary scores differed between groups of second, third, and fourth-year students.[11] Scores were higher among third-year (76%) students than among second-year students (53.8%), but lower among fourth-year students (56.3%). All of the participants in the Diaz-Gilbert study were students who spoke English as a second language and the number of participants per academic year was low. Nine participants were in their second year, 7 were in their third year, and 4 were in their fourth year. The higher scores in the third year (61.3%) in this study mirrors the findings of Diaz-Gilbert. From the third year to the fourth year (62.4%) the scores in this study plateaued, while in the study by Diaz-Gilbert, the scores decreased. The low sample sizes and participation of only students who spoke English as a second language may explain the difference in scores among fourth-year students in the Diaz-Gilbert study.

The significant correlation ($p=0.031$, $r=0.299$) between the summative grades for Pharmacology 2 and the scores achieved on the vocabulary assessment sheet is an indication that as the participants' general health vocabulary knowledge increased, the grades achieved in pharmacology increased. Yuksel and Mercanoglu[12] published a similar finding among a population of Turkish medical students where the correlation coefficient between vocabulary knowledge and achievement was $r = 0.38$. However when the Pharmacology 2 students were stratified into 2 cohorts according to whether English was their first or second language, the correlation was only significant for students whose second language was English. Further investigation of the scores achieved for the vocabulary assessment by the Pharmacology 2 students in relation to the grades achieved for the Pharmacology 2 summative examination indicated that students who were successful on the examination (grades greater than or equal to 50%) achieved significantly higher vocabulary scores ($p=0.031$) than the unsuccessful students (Pharmacology 2 examination grade of less than 50%) (Figure 2). Thus, although there is a clear relationship between achievement in pharmacology and general health vocabulary knowledge (Figure 2), it may be vocabulary knowledge rather than English language status that is the determining factor. Because among students who speak English as a second language, vocabulary knowledge appears to have a greater discriminatory effect (significant correlation between vocabulary knowledge and achievement in Pharmacology 2) than among students who speak English as their first language.

During the focus group discussions, a student commenting on learning pharmacology stated: "I don't enjoy learning that because I don't understand it. The language. . .it's over my head." This comment illustrates that at least initially the students viewed pharmacology as a foreign language. Some students instinctively seemed to know that, in order to cope with the acquisition of the language of pharmacology during the first pharmacology module (Pharmacology 2), they needed to acquire the relevant vocabulary. One way they accomplished this was by compiling vocabulary lists. There also seemed to be a general practice of looking up the meaning of words in order to better understand the material. Students realized that understanding the language of pharmacology was an essential tool for the fuller understanding of the discipline. The extent to which textbooks were used varied among the students. Some students seldom referred to textbooks, while others preferred using more than 1 textbook as different books explain concepts from different perspectives, making it easier to master the concepts. During the focus group session held with the Pharmacology 3 students, a lively discussion emerged on the relative level of reading difficulty associated with the prescribed and recommended textbooks.

The thread that runs through the themes identified from the focus group sessions is the difficulty encountered by students when trying to understand the precise, meaning-dense vocabulary embedded in the discipline of pharmacology. As such, the findings of this study suggest that in order to improve levels of student achievement in pharmacology, supplemental teaching or mentoring in the acquisition of a basic general health vocabulary is required. This need is demonstrated by the quantitative findings and is supported and enriched by the qualitative data.

The findings of this study are relevant in a South African context of a multilingual society with 11 official languages and where the student population at the university where the research was conducted is a multicultural, multilingual body taught in English. However, this scenario of a multilingual student body and a single medium of presentation (English) is common to pharmacy programs in developed countries such as the United States, the United Kingdom, and Australia, as well as in many developing countries such as Singapore and Malaysia. Therefore, these findings may provide further insight into the difficulties pertaining to vocabulary knowledge and achievement in pharmacology encountered by academic

staff and students, not only in South Africa but elsewhere in the world.

CONCLUSION

This study, undertaken in a population consisting of pharmacy students who spoke English as a first or second language, demonstrated a positive correlation between academic achievement in pharmacology and general health vocabulary knowledge. In the practice environment, pharmacists require excellent general health vocabulary for tasks such as performing medicine reconciliations, counseling patients, communicating with other health care providers, and reading the literature. This illustrates the importance of students gaining relevant vocabulary skills during the undergraduate program.

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