

To read or not to read, that is the question faced by undergraduate engineering students - using the cloze procedure to reveal their choice

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ABSTRACT: Many undergraduate engineering students face a task that is critical to the success of their academic studies, being that of reading. It has been noted that, in general, South African students are not meeting the reading and writing levels of achievement that their peers in other countries are reaching. The purpose of this article is to reveal the percentage of students who chose to read their assigned portion of prescribed course material by making use of cloze tests that were administered on-line using self-assessments in a learning management system. This cloze test required students to fill in a number of missing words, which they could only accomplish if they had read the prescribed material. A longitudinal study involving quantitative data is used. Results indicate that 51% of the students seemed to choose to read the assigned portion of material, with all students passing the module if they correctly filled in more than 65% of the missing words. This suggests that reading the assigned course material, and then completing a cloze test with more than 50% will lead to more students achieving academic success. It is recommended to use a variety of cloze tests in these on-line self-assessments.

INTRODUCTION

To be, or not to be, that is the question. These famous words, uttered by Hamlet in a soliloquy, written by William Shakespeare in the early 1600's, point to a dilemma that people face when undergoing a trial some or unbearable situation [1]. Should they continue to exist, yet to tolerate the whips and scorns of time, the offences of a tyrant, the contempt of the proud, the pain of rejected love, the insolence of interfering authorities and the advantage that some people take of others? Hamlet goes on to state that it may be better to end the suffering by suicide, using a *bore bodkin* or naked blade.

Some aspects of this soliloquy may be applied to a task that many undergraduate engineering students face, but do not really enjoy. That task involves reading, which they often have to do on a daily basis during their higher education career. This includes a wide variety of texts in order to build their vocabulary, background knowledge and genre knowledge [2]. However, it is a fact that many students do not like to read [3]. Some may thus come to view reading as a trial some or unbearable situation, one that is best cut-away by using a *naked blade*.

A study revealed that only 48% of engineering students read literary texts for leisure purposes during their spare time [4], while other research suggests that, in general, engineering students read and interpret texts a good deal less than students from other disciplines [5]. It has also been noted that, in general, South African students are not meeting the reading and writing levels of achievement that their peers in other countries are reaching, even in other less well-resourced countries of Africa [6]. Students, who decide not to read, or not to improve their reading skills, are really depriving themselves of a wonderful opportunity to learn more about the world, thereby also stunting their intellectual growth.

The research question thus arises *What choices are undergraduate electrical engineering students making when it comes to reading prescribed course material?* Are they choosing to read, or not to read? The purpose of this article is to reveal the percentage of students who chose to read their assigned portion of prescribed course material by making use of cloze tests that were administered on-line using self-assessments in a learning management system (LMS). The cloze procedure is firstly explained and adapted to this study. The research methodology, results and conclusions follow.

CLOZE PRINCIPLES AND THE APPLICATION TO ELECTRONIC COMMUNICATION

The cloze procedure was first introduced by Taylor in 1953, who developed it as a reading test for native speakers [7]. Cloze tests are tests in which every n-th word is deleted randomly [8], usually being a consistent number somewhere between 5 and 12 [9]. This means that every 5th word could be deleted in a sentence or paragraph (being the lower value), or every 12th word could be deleted (being the upper value). It has become widely accepted as a reading

comprehension test among students whose mother tongue (first or home language) is not English. For example, researchers in South Africa made use of the cloze procedure to assess reading comprehension of marketing students (majority non-English mother tongue) by removing every 9th word from four specific passages of text [10]. The results indicated that the majority of respondents exhibited a reading comprehension that is at the frustration reading level. Various criticisms have been levelled against the cloze procedure, but despite these criticisms, it is still regarded as being *very helpful* as a *general proficiency indicator* [11].

Cloze procedures are often used as a diagnostic style of reading assessment in which the purpose is to identify students' knowledge and understanding of their reading and to assess how well they know, which words fit into the syntax structure [12]. Cloze tests are usually a minimum of two paragraphs in length in order to account for discourse expectancies, using two approaches for scoring; namely, exact word and appropriate word approaches [13]. However, the nature of the context differs across studies, ranging from a single sentence to a text passage and/or a picture [14]. There are, however, at least five main types of cloze tests available. These include:

- fixed-rate deletion (traditional cloze);
- selective deletion (rational cloze);
- multiple-choice cloze (maze cloze);
- cloze elide; and
- C-test.

The *traditional cloze test* involves deleting every n-th word (usually every fourth or seventh word starting with the second or third sentence of a paragraph) in the text [15]. Take, for example, the following traditional cloze test, which is used in an on-line self-assessment in Electronic Communications 4 (EKM4), where the brackets would be empty (word within the brackets deleted), when shown to students along with the rest of the sentence:

Important antenna parameters which must be remembered include [directivity], beamwidth in Degrees, horizontal polarization, vertical field, front [to] back ratio in dB and antenna gain in [dBi].

Here, every 9th word has been deleted, where the last one, dBi, is unique and cannot be replaced with a synonym. However, the first deleted word, *directivity*, could maybe be replaced with another parameter of an antenna, such as *lobes* or *impedance*, which has nothing to do with the directivity of an antenna. In this case, it creates ambiguity that will result in an incorrect or unfair mark being awarded to the student, if he or she inserted the word *lobes* instead of *directivity*. It has been argued that the traditional cloze test is an extremely difficult and anxiety invoking test, with the required length of a cloze passage making it inconveniently long as a unit of test assembly [16]. A possible solution to this dilemma involves the use of other cloze tests.

In a *rational cloze test*, certain categories of words are deleted [17]. This is better suited to engineering education, than the traditional cloze test, where fundamental theoretical principles may need to be assessed. This would require the deletion of specific key words, rather than every n-th word, which could be a definite (word *the*) or indefinite (letter *a*) article. Consider the following example from an on-line self-assessment in EKM4, where the brackets would be empty (word within the brackets deleted), when shown to students along with the rest of the sentence:

When choosing a modulation [scheme], the ultimate goal is [to] transmit, with specific energy, [as] much data as possible [over] a limited bandwidth with [an] acceptable bit error rate.

The word *an* (called the indefinite article) would need to be assessed within an English language course. However, assessing English grammar is not the primary aim of engineering education. Therefore, using the rational cloze test would be more appropriate, where the key words *modulation*, *data*, *bandwidth* and *error* would be deleted, as shown below:

When choosing a [modulation] scheme, the ultimate goal is to transmit, with specific energy, as much [data] as possible over a limited [bandwidth] with an acceptable bit [error] rate.

This would not be every n-th word, but rather specific key words. It should be the aim, in engineering education, to determine if the student understands the relationships between the various parts of a sentence, and not the grammar usage of the student. This is often referred to as inter-sentential or intra-sentential relationships (i.e. relationships between sentences or within a sentence) that need to be incorporated into assessments for senior or final-year students. These students need to be exposed to more higher-order questions (analysis and application), than lower-order questions, in order to promote deep-learning and critical thinking [18].

The *multiple-choice cloze test* is the most common type of cloze test, in which participants are provided with three to five choices for each missing word. It is easier than the typical cloze test, and reduces test anxiety and ambiguity [16]. The traditional or rational cloze test may be employed, when starting to design the multiple-choice cloze test, after which a number of words are chosen from which the student will have to select the correct answer. The following example illustrates the multiple-choice cloze test, where the words within the brackets would be presented to students to choose from:

Multimode-graded optic fibre cables have a core [diameter, radius, width, length] of 62.5 μm , while multimode-step optic fibre cables have a value of [125, 100, 62.5, 8] μm .

Four options are made available to students for each missing word in the sentence. This approach enables the use of single sentences, rather than lengthy paragraphs, thereby reducing the amount of time that students require to complete the test. This approach is furthermore well suited to freshmen or first-year engineering students, who may be well acquainted with multiple-choice questions from their high school career. These students would be exposed to more lower-order questions, according to Bloom's taxonomy, as they strive to acquire a knowledge base that they will need to apply later on in their academic studies. Multiple choice tests are best adapted for testing well-defined or lower-order skills [19].

The *cloze elide test* requires students to cross out incorrect and superfluous words in the passage of the test, which is called *eliding* [20]. Instead of deleting n-th words or specific key words from the sentence, incorrect or misleading words are inserted into their places. Consider the following example of a cloze elide test, where the word within brackets needs to be crossed out (note that the brackets would not be shown to students):

Hexagons are usually considered the basic [prison] shape, especially for theoretical calculations to [assume] the reuse distance.

The words *prison* and *assume* are incorrect in this sentence, and would need to be crossed out by the students. This type of question really tests the lower and higher-order cognitive skills of engineering students, as the sentence is shown to students in its entirety, without any brackets with missing words. The word *prison* should have been replaced with *cell* and the word *assume* with *calculate*. Students would first need to analyse (higher-order) the sentence, and then determine (higher-order) one key parameter, being the *reuse distance*. Secondly, they need to recall (lower-order) that this distance is calculated, and not assumed, based on specific criteria. Thirdly, students need to identify (lower-order) where the reuse distance is applied, namely in radio frequency communications or in cellular systems. Finally, they would need to recall (lower-order) that cellular systems feature hexagons as their basic structure or shape, being divided into cells.

The *C-test* requires that the first letter of each missing word be provided as a clue for test takers, as well as to limit the possible number of accepted responses [21], which is an improvement on the traditional cloze test. This approach is well suited to engineering education; as fundamental theoretical principles need to be assessed from time to time, where a variety of words could be inserted by different students. Take, for example, the following sentence from an on-line self-assessment in EKM4, where parts of specific key words need to be inserted between the brackets:

The bit error rate is the nu[mber] of bit errors divided by the to[tal] number of transferred bits during a sp[ecific] time interval.

This example of a C-test highlights that the first word *number* is not unique. It may be replaced with the synonym *sum* or *amount*. Similarly, the last word *specific* may be replaced with the synonym *precise* or *certain*. If an automatic marking system is employed, such as is available in most LMS, then it is difficult to list all the possible synonyms which may be used. Providing the first letter/s of the word helps mitigate this concern. It has been noted that some consider the C-test to be a highly valid, reliable and integrative measure of general language proficiency, and is easy to score and construct [22].

A strength of the cloze procedure is ease of construction based directly on reading materials that individuals are expected to read, usually in academic settings [23]. This is how the cloze test was applied in this study, not to measure reading comprehension, but to determine if students completed the reading of the prescribed material assigned to them. Several single sentences were extracted from each section that is covered in the prescribed course material. Undergraduate students were then required to supply answers for every n-th word that was deleted (3rd, 5th and 9th were used). The act of reading must be understood as a process in which the interpretation of what is read depends not only on what is printed, but also on the hypotheses that the reader himself formulated on the basis of his prior knowledge and the establishment of intertextual connections which allow for meaningful reading [24]. It is this prior knowledge of what the student has read, as well as the intertextual connections, which enable the cloze test to be used as a means of establishing whether students have read the assigned course material prescribed for them. These cloze tests were used in an electronic communication module, which is offered in the first semester (February to May) of every year.

STUDY CONTEXT

Electronic Communications 4 (EKM4) is an optional offering or module in the Baccalaureus Technologiae (BTech: Engineering: Electrical) qualification in South Africa (SA) [25]. Students have to obtain a minimum of 120 credits to successfully complete this degree. The Central University of Technology (CUT) operates on a semester basis of roughly 14 weeks during which time BTech students attend one classroom session per week (five periods, each of 45 minutes in duration with three periods dedicated to practical work in a laboratory). The syllabus of EKM4 is primarily aimed at

telecommunication based students as it focuses mainly on digital communication, where the entire transmission and reception path is covered. The learning outcomes in this module incorporate illustrative verbs, such as define, describe, sketch, analyse, calculate, design, determine and evaluate. The last five verbs are used extensively in the assessments as it places particular emphasis on the higher levels of learning listed in Bloom's taxonomy, which contribute to deep learning and critical thinking [18]. This module exposes students to a number of new fundamental theoretical principles that they have not encountered before. This would require students to have read through a specific portion of prescribed course material before attempting the cloze tests. Students must obtain a minimum course mark of 40% to gain entry into the final examination. Any contribution towards this 40% is usually welcomed by students, even if it is only 4% as contributed by the completion of the cloze tests.

RESEARCH METHODOLOGY

A longitudinal study involving quantitative data is used. Longitudinal studies are defined as studies in which the outcome variable is repeatedly measured [26]. In this study, the outcome variable is whether students are choosing to read specific prescribed course material or not to read it. This is done for a period of five years (2014-2018) by obtaining quantitative data for each year from a different group of undergraduate electrical engineering students at CUT in the Free State province of SA. Each additional wave of data (or data from each successive year) from a longitudinal study increases the reliability and precision of measuring change and adds power to the results [27]. Descriptive statistics, rather than inferential statistics, are used as the results are interpreted with regard to specific engineering students enrolled at CUT. Descriptive statistics include the student profile, the number of correct words inserted into the missing spaces, as a percentage, and the final grades awarded to the students in the module EKM4.

The target population involves all undergraduate engineering students enrolled for EKM4 ($n = 70$), thereby requiring no sampling technique. All these students were required to complete bi-weekly on-line self-assessments via the institutions LMS, called eThuto, built on the Blackboard™ platform. These self-assessments were designed to promote student engagement of the course material [28] by encouraging students to read specific material and to reflect on their educational experiences in the classroom and laboratory [29]. Course material, relating to the syllabus, was discussed by an academic in a classroom environment. Students were then given a specific portion of prescribed course material to read during the days following the classroom discussion. During the following week, they were required to complete an on-line self-assessment on the LMS which included a cloze test. Specific grades were assigned to each self-assessment, depending on the number of questions posed. However, students had to first read specific portions of the material before they could attempt the test. Correctly inserting more than 50% of the correct words into the missing spaces would serve as an indication that the students chose to read the assigned material.

RESULTS AND DISCUSSIONS

Only 16% (11 out of 70) of the students indicated that their mother tongue was English. The majority are, therefore, not English first language speakers and would, therefore, be suited to the cloze test if administered as an English foreign language (EFL) reading comprehension test. The predominant home language is Sesotho (between five and six students per calendar year), which is indicative of the Free State province of SA [30], while males outnumber females on average by 4:1 (76% males and 24% females). Attempts at integrating more women in engineering over the past decades have proven to be only partially successful [31]. The majority of students were older than 25 years of age (see Figure 1). This trend was observed for each year in the five-year period, suggesting that these students have completed their National Diploma and are seeking to improve their qualification. A National Diploma usually requires a minimum of three years to complete after having obtained a National Higher Certificate at the average age of 18 years.

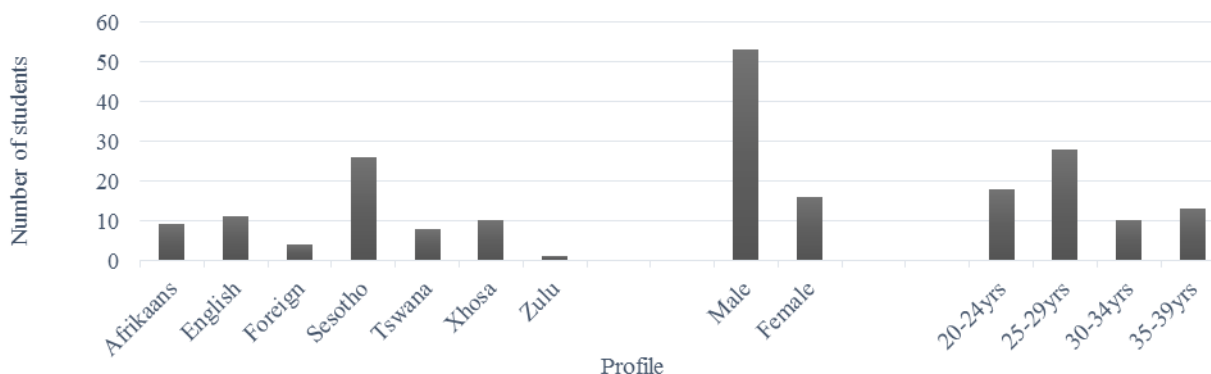


Figure 1: Student profile.

Figure 2 presents the total number of students ($n = 70$) who enrolled for EKM4 between 2014 and 2018. The data has been ranked according to the number of correct responses for the individual students (represented by the grey area). Student 7 achieved less than 10% correct responses, suggesting that he or she did not read the portions of prescribed course material. Student 46 achieved more than 60% correct responses, suggesting that he or she did read the sections of

prescribed course material. The black columns represent the student's final grades, awarded at the end of the semester. Of the 70 students, 15 inserted more than 70% of the correct words, while 16 students never achieved more than 20%. The average number of students who correctly inserted more than 50% of the correct words over the five-year period equalled 29 (51%). A statistically significant correlation was not established between the percentages of correct responses and the final grade awarded to students ($R^2 = 0.148$). However, it is noteworthy that all the students who achieved a final grade of more than 67% had obtained more than 60% correct responses. Furthermore, only 62% of the 34 students who did not read the assigned text (they achieved less than 50% correct responses in the cloze test) eventually passed the module. On the other hand, 81% of the 36 students who did chose to read the assigned text (achieving more than 50% correct responses in the cloze test) successfully passed the module. This suggests that reading the assigned course material, and then completing a cloze test with more than 50% correct response will lead to more students achieving academic success.

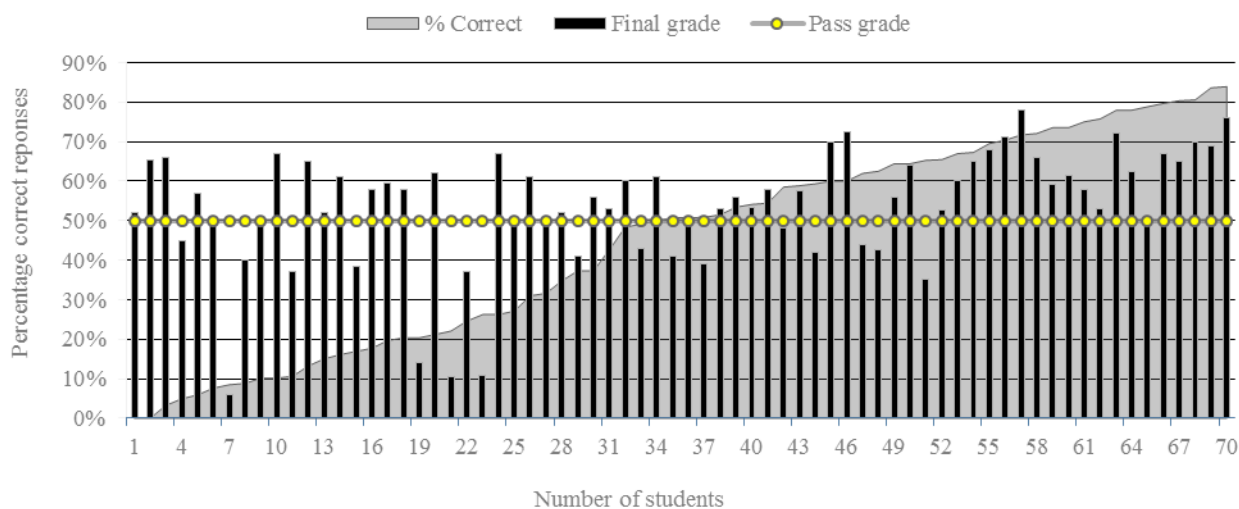


Figure 2: Cloze test results versus final grades.

CONCLUSIONS

The purpose of this article was to reveal the percentage of students who chose to read their assigned portion of prescribed course material by making use of cloze tests that were administered on-line using self-assessments in an LMS. A longitudinal study (2014-2018) involving quantitative data was used, where the grades (cloze test grades from on-line self-assessments and final examination grades) achieved by EKM4 students were analysed. Results indicate that 51% of the students seemed to choose to read the assigned portion of prescribed course material, with all students passing the module if they correctly filled in more than 65% of the missing words. A noteworthy result was that 81% of the students who chose to read the assigned text (they achieved more than 50% correct responses in the cloze test) eventually passed the module, as compared to the 62% of the students who achieved less than 50% correct responses. However, no significant statistical relationship was established between the number of correct responses to the cloze test and the final grades awarded to students.

Limits of this study relate to only one module being used and to the fact that 76% of the students were male. A more representative sample in which more females are present in a number of other modules may address this limitation. However, it is recommended that academics in engineering education make use of the rationale cloze (specific words are deleted) to test student comprehension of fundamental theoretical principles, rather than using the traditional cloze test (every n-th word is deleted). The C-test may also be used to assess the lower-order cognitive skills (knowledge of prescribed course material) by freshmen or first-year students in higher education, especially in large classes.

To read, or not to read, will continue to be a question that engineering students will have to answer for themselves. Their decision should not be taken lightly, as it will bring them either beneficial or disastrous consequences within their academic career.

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