A preliminary study of the technical use of Arabic in Saudi secondary physics classes

Nouf Mohammed Albadi
University of Newcastle, Australia, and the Ministry of Education, Kingdom of Saudi Arabia
John Mitchell O'Toole and Jean Harkins
University of Newcastle, Australia

English for specific purposes research reveals that learners at a variety of levels experience difficulty reading science text, sufficient to impede their acquisition of science understanding. However, little research exists regarding subject-specific language styles or reading difficulty in Arabic. Difficulties with specialised language may seriously impede the development of physics understanding by Saudi students. Remedial attempts may remain ineffective unless informed by a better understanding of specific readability issues.

This quantitative study involved 80 female Year 10 students studying science in two cities in Saudi Arabia (Jeddah and Abha). A specialised cloze test based on the mandatory physics textbook was developed to identify language features of the passage that participating students found difficult. Findings reveal that (a) these Saudi students experienced greater difficulty in reading their physics book (28% conceptually correct responses) than that suggested by earlier work with English speakers of similar age (62% conceptually correct responses); and (b) Saudi student difficulties with grammatical categories form a distinguishable pattern, but the pattern differs from that indicated by earlier work with English-speaking student.

Introduction

There have been a number of recent educational developments within the Kingdom of Saudi Arabia. The establishment of the King Abdullah University of Science and Technology in 2009 indicated an increasing national commitment to science and technology (King Abdullah University of Science and Technology, n.d) and the recently released Saudi *Vision 2030* incorporates the desire not only to increase investment in the digital economy, but to take an active leadership role and for Saudi citizens to more directly contribute to national development (*Vision 2030*, 2017). These things will require more graduates with skills in science subjects to move into the Saudi and Middle Eastern economies (Cavacini, 2016). These technological developments fit well within the context of Saudi aspirations, as Islam strongly urges people to study and explore the universe within which we find ourselves. Muslim scholars have historically paid great attention to many different aspects of life such as medicine, astronomy, geography, mathematics, and the humanities. Seeking knowledge is obligatory in Islam for every Muslim, man and woman (Falagas, Zarkadoulia & Samonis 2006). However, Arabic is the language of the people in the Arabian Peninsula and English is the language of international science and technology.

Content and language integrated learning (CLIL) suggests that the entire science course should be taught in English, as occurs in parts of Europe (Lorenzo, Casal & Moore, 2009;

Pérez-Cañado, 2012) and, more locally, in the United Arabic Emirates (Younes, 2016; Al-Bakri, 2013). However, recent work in Lebanon revealed a preference for communication in Arabic in local science classes (Salloum & BouJaoude, 2017). The Saudi context is slightly different as international expressions in English are being embedded within Arabic text.

Previous work with English suggests that communication in scientific contexts makes use of a specialist language style that can impede student understanding and subsequent success in science study (Phillips & Norris, 2009). This paper documents a preliminary investigation into the existence of such a barrier within Arabic.

'Literacy' can have a range of meanings in different contexts. In its widest sense, it denotes access to specialised knowledge.

> The phrase 'scientific literacy for all learners' expresses the major goal of science education – to attain society's aspirations and advance individual development within the context of science and technology (Bybee 1997, p.69).

This requires students to function in appropriate and purposeful ways within the variety of language forms that science learners confront: visual representation, mathematical symbolism, and experimental operations (Lemke, 1998). All of this happens within interacting pressures from encounters with instructional science and home languages (Yore & Treagust 2006). As Philips and Norris (2009) noted, the individual development to which Bybee (1997) refers depends on *access* to specialised knowledge. Expectations of such access may be misplaced.

So, in the present context, scientific literacy is taken to mean the reader's ability to extract scientific understanding from text that embodies the intersection of specialist language and content. It is well established that in English, readers have difficulty with specialist language, particularly scientific language. Is there a pattern in Arabic learner difficulties that is similar enough to that seen in English, to call for responses similar to those used in the field of English for specific purposes (ESP)?

Literature review

Science language

Arabic education is made complex by the diversity of vernaculars and their distance from Modern Standard Arabic. The use of specific styles of language in different school subjects may further complicate such a situation (Amin, 2009; Dagher & Boujaoude, 2011). Textbooks have long occupied a central place in school teaching in many contexts (Valverde, Bianchi & Wolfe, 2002) and learner access to the language within them is crucial to learning. The written language of the textbook in science subjects particularly is fundamental. English medium learners who are unable to read with understanding will have difficulty developing analytical understanding from their science textbooks and are consequently unlikely to develop the degree of scientific literacy suggested by Bybee

(1997) and other science educators (Reeves, 2005). Many international jurisdictions require school students to gather information and data from reference books, journals and websites; follow instructions from manuals and interpret descriptive diagrams, tables and graphs. This has provoked recent interest in the 'readability' of Arabic texts (Arifin, Halim, Sham & Shukry, 2013).

Such 'readability' forms part of communication in science, which is the process that allows transfer of ideas and information between people (Zytun, 2008). This occurs through a range of media: orally; or through written schedules, diagrams, research reports; or through graphs, maps, and pictures (Mazen, 2007, 2008). Contemporary Saudi educational practice privileges written language and this makes reading scientific text a very important communicative skill for students, if they are to achieve commonly accepted science education goals (Khalil, 2012). Development of such skills should begin in upper primary school levels and by the intermediate school students should be able comprehend what they read; extract main ideas; interpret and present data; and make summaries of reading passages (Atiefa & Souror, 2011). All of this is problematic if students cannot read the text and general readability is an attempt to quantify the ease with which students may read different texts.

The use of mandated texts and the considerable uniformity of teaching practice within the centralised Saudi education system suggests that moving beyond such general readability may be useful. In the past, secondary school textbooks were entirely in Arabic and students could easily remember unit names from the initial letter, for example, but in higher education the science curriculum was presented in the English language. However, the most recent secondary texts for the science disciplines are translated into Arabic from English, except for numbers, symbols and unit names, presumably to ease the transition between secondary and tertiary education. The retention of such English expressions within the Arabic text is one of the novel features of the new textbooks. This inclusion of English in the symbols and the unit names might be difficult for secondary school students, as they process the movement to "9.8 m/s^2" from the Arabic expression ٩،٨ م/ث٢

It has long been recognised that, within English, the written language of science is different from the more general language used in everyday life (Lindsay, 2011; Wellington & Osborne, 2001). It appears that successful English-medium science students need to show an understanding of specific language of their textbooks; need to be able to use appropriate scientific and technical language; and need to use diagrams and tables to convey meaning (Hanrahan, 2009). Given the importance of centrally mandated science textbooks in the Saudi context, it may be of interest to discover whether similar expectations exist in Arabic-medium science classes. A specific form of Arabic may well be developing for use in scientific contexts, and this form may cause problems for learners. More information on the shape of such a specialised form of Arabic may inform the development of more effective responses to an increasingly recognised problem.

Cloze test

The modern cloze test was developed by Taylor (1953) as a tool to measure the readability of particular text. Construction of cloze tests (Gellert & Elbro, 2012) usually involves the deletion of a random word in the second sentence of a passage, then the deletion of every fifth (or seventh, ninth, eleventh or thirteenth) word thereafter until the desired number of words (usually 50) have been deleted. A particular group of readers then tries to replace the deleted words. The words which readers suggest to fill the gaps left by the deletions that form a cloze test can be scored strictly (where only exact replacement of the word deleted will be coded as correct) or conceptually (where synonymous otherwise meaningful alternatives may be acceptable).

The group average of correct cloze responses is interpreted as an estimate of the access the specific group would have to the meaning of the particular text (Oller & Jonz, 1994). The individual deletions can also be categorised and average reader success in correctly replacing words of a particular category can be interpreted as reflecting more general difficulty with the language feature represented by that category (O'Toole, Cheng & O'Toole, 2015).

The accessibility of a particular text depends on some factors arising from the text and others arising from the reader. Readability formulas in Arabic (such as that suggested by Al-Tamimi, Jaradat, Aljarrah & Ghanem, 2013) represent an attempt to quantify the difficulty that a particular text may pose for a generalised 'reader', in contrast to 'cloze' tests which offer more opportunity to match particular texts against specific reader groups. This makes deletion-based cloze techniques potentially attractive as they avoid "artificial lines between language and content knowledge" (O'Sullivan, 2012, p. 83). The words deleted to form a cloze test may have grammatical or content functions. If learners cannot correctly fill the gaps while maintaining the meaning of the passage, then it can plausibly be inferred that they do not understand that passage. Content words form the most obvious problem within specialist text but failure to comprehend the grammatical framework within which they sit may make the passage equally incomprehensible. Problems in both areas at once are very likely to cause a learner to stop reading.

The cloze test has been employed to assess the level of learner readability within a variety of languages, such as English, Spanish, French and German. Most of the research on Arabic science textbooks attempts to measure the level of text readability and analysis of exact replacement coding of cloze tests suggests that students have palpable difficulty in reading their Arabic science texts (Al-Bardi, 2013; Al-Matrafi, 2010; Ktait, 2002). Research in Arabic language readability has focussed on automated and computerised measurement of readability (Forsyth, 2014).

Close analysis of student errors in replacing words into the gaps produced to form a cloze test can be used to identify specific language features causing problems for particular groups of readers. In earlier work based on English medium science text, over 2000 students completed a range of cloze based on English-language school science textbooks (O'Toole & O'Toole, 2004). This earlier study may allow preliminary comparison between

English and Arabic patterns of difficulty, which may, in turn, indicate whether the wider English for specific purposes literature provides any guidance for on-going work in Arabic. Consequently, the data for 654 female Year 10 students who specified English as their heritage language was extracted from this larger set of cloze results to produce a baseline for the present research; similar students studying physics in Arabic may have more, less or different degrees of difficulty with their science textbook. Cloze tasks from the earlier study indicated that based on apparently age-appropriate science text in English, a sample of more than six hundred adolescent students, yielded a mean result of 30.83/50 (standard deviation 11.56; 62% correct). This conceptually correct average cloze score suggests that a Year 10 female student sitting around the middle of this group would be unable to correctly replace over a third of the words deleted. Students who were less able readers of science text would be able to successfully replace progressively fewer of the words deleted, indicating progressively greater difficulty in accessing the meaning of their science textbook.

This smaller set of data was further analysed to produce information regarding the difficulty these monolingual English-speaking students were having with features of their text. This more fine-grained analysis produced a pattern of difficulty with the features of the language of these science books that provides both evidence of some of the causes of student difficulty with the English of their science books and suggestions for remedial action. Broad similarity to this existing English data in the results of the present investigation would suggest that effective responses to these difficulties in English might form a useful place to begin thinking about responses in Arabic-medium Saudi Physics classes.

Purpose of this study

Most existing research into the problems that can emerge where Arabic is the language of school instruction deal with the beginnings of literacy. There is research into the features of Arabic language (Hammadi & Aziz, 2012; Neme & Laporte, 2013; Nwesri, Tahaghoghi & Scholer, 2005); diversity across different dialects (Bouhlila, 2011; Ibrahim & Aharon-Peretz, 2005); the role of vowels (Ibrahim, 2013; Seraye, 2016); the effect of morphology (Taha-Thomure, 2008) and difficulties with spelling (Saiegh-Haddad, 2013). However, there is less research into the problems of older readers, for whom the written language of their science textbook is fundamental. This research aims to employ the cloze test procedure to identify the features of any such barrier to Saudi secondary school learner access to their physics textbook. Whereas exact replacement in the multiple choice version of cloze forms the basis of recent attempts to estimate overall readability in Arabic (Arifin et al., 2013; Freahat, 2014; Ghani, Noh, & Yusoff, 2014), the current study uses conceptual coding of student answers to widen the evaluation of text comprehension. This study also looks more deeply into the language features to seek more specific patterns of language difficulty, following on from Mock's (1974) point that a major limitation of cloze tests is their identification of readability levels without indicating the causes.

The present study is guided by the following specific research questions:

1. Does close linguistic analysis of Saudi student replacement of regular deletions from an authentic physics text reveal a pattern of language difficulty?
2. Does any emerging pattern match existing data on the problems faced by English-speaking students with the language of their science books?

Science education in Saudi schools

The Saudi Ministry of Education administers a centralised education system. Schools are gender segregated (Reda & Hamdan, 2015) and the twelve years of Saudi schooling are organised into three levels: six years in Elementary, three years in Intermediate and three years in Secondary level. General science is included in the Elementary and Intermediate levels and students study chemistry, biology and physics separately at the Secondary school level. Students in the first Secondary year (usually 15-16 years of age) study each discipline for two periods per week. The most recent reform of secondary schooling provided Year 11 and 12 students with three options after they finish Year 10 (Ministry of Education, 2015). They may choose between Literary, Scientific, or Administrative streams. All students in the science stream study biology, chemistry, physics and mathematics. Arabic is the medium of instruction (Ministry of Education, 2006).

Classes occur within the framework provided by centrally produced curricula. Teachers and students receive the mandatory textbooks without charge and teachers are obliged to cover all their mandated content (lessons, exercises and practical work) within specified periods.

Method

This quantitative study attempts to establish a baseline for further work on Saudi student difficulties with the Arabic of their physics books. This preliminary work rests on close analysis of student errors on a cloze test based on a physics textbook that was mandated locally (Rafee, Hadad, Sabag & Alorani, 2014).

Although cloze techniques are potentially attractive, they have also long been the source of controversy (Brown, 2013; Sadeghi-Haddad, 2013; Spolsky, 2000; Stansfield, 2008). In the present case, the analysis of participant conceptual replacement of deleted items to reveal patterns of reader difficulty seems valid. Reader inability to suggest an entry that would maintain some meaning in the text implies some difficulty with the word deleted; and repeated inability to make such suggestions for deleted words of a similar class implies difficulty with that class of words within the specialist style.

Sample

This preliminary investigation was carried out in three government schools for girls in Abha, a city in the south of Saudi Arabia. Ethically defensible research methodology should take into account the culture of the fieldwork location (Al-Rashidi & Phan, 2015;

Shaw, 1994). Education in Saudi Arabia is gender-segregated and the primary author is female, so this study was carried out in girls' schools. Eighty (80) Year 10 students, between 15 and 16 years old with Arabic as their mother tongue, completed the investigation instrument in Arabic.

Abha is a moderately-sized regional Saudi city with a developed educational system. The results obtained from schools there could be expected to be typical of such contexts within the Kingdom and the fact that the three schools are from the north, south and central parts of Abha should make them typical of the city. Year 10 was chosen because it is the first year of the more specialised secondary school years within Saudi Arabia. Students begin their study of the separate science disciplines at that time.

Instrument

A cloze test was based on the local physics text book (Rafee et al., 2014, pp. 77-79). This text was mandatory at the time of this study. Any learner difficulties consequent on its language could not be ameliorated by teacher choice of another resource. Teacher modifications for board work maintain the textbook language, as does the centralised examination system. The base passage is attached to this paper, both in the Arabic original (Appendix 1) and loose English translation (Appendix 3). The base text was produced by forming a coherent passage from text across the three pages specified in the reference above. The test instrument itself forms Appendix 2.

The passage on which the cloze test was based dealt with gravity and Newton's laws. The content had been covered in class by the participating students before they attempted the test. Student familiarity with this material from their mandatory physics textbook supports the validity of instrument developed from it. Every fifth word was replaced with a numbered gap and students were asked to enter the Arabic word that they thought most clearly maintained the meaning of the passage. The test as whole returned a reliability of 0.970 (Cronbach's alpha) and the subtest reliabilities were Noun (0.877), Pronoun (0.696), Verb (0.781), Adverb (0.653), Conjunction (0.547), preposition (0.513) and technicality (0.892). The instrument as a whole and these subtests all appear sufficiently valid and reliable to permit discussion.

Procedure

Previous contact had secured meetings between the first author and school authorities, at which she presented the Ministry permit and conducted a short meeting with teachers. This meeting described the procedure, and allowed arrangements for meetings with the students to be made, after return of consent forms from both schools and students. The first author then introduced herself to participating students at these subsequent meetings and gave them some notes on the research and its importance in discovering aspects of language reading difficulty in the physics textbook. She explained (in Arabic) how to answer the cloze test saying "please read the passage and try to fill the missing gaps word" and stressed that "This is not a test to be given marks, but please try to be as honest and reliable as you possibly can*"*. Saudi schools use 45 minute class periods and so the students were given approximately this time to complete the investigation instrument.

Coding

The student entries were coded as exactly correct, conceptually correct or clearly wrong. The conceptual category was broad: any entry that maintained meaning was coded as conceptually correct. Analogous examples from English would be "movement" for "motion" and "form" for "shape". Deletions for which no entry was made after the final attempt were coded as 'defeat' and as 'error' before it, to distinguish between non-attempt and genuine inability. This coding produced the raw data for this investigation; which was entered onto an *Excel* spreadsheet that was then uploaded into IBM *SPSS Statistics 19*.

The deletions were then analysed and patterns of student difficulty suggested by patterns of entry error. This analysis produced Table 1, with the following columns:

1. Words with affixes treated as a separate word, for example: (فإن) (so) the original word is إن (so that) and the first letter ف (*fa*) read from right to left is an affix. Affixes were separated because they potentially change substantial meaning and their separation follows precedents within the literature (Hmeidi et al., 2010). The example below was the first missing word in the passage and happens to be a word without any affixes.
2. Translation of the word into English.
3. Part of speech (noun, adjectives, verb, adverb, pronoun, conjunction, preposition).
4. Transliteration.
5. Technicality classification ('Technicality' = technical, used only within science, and semi-technical words (more common word used with a special meaning in science).
6. Alternate meanings.

Table 1: Classification example for the first deleted word

1	2	3	4	5	6
:عام:	year	noun	aam	semi-technical	years, general

Cloze items were categorised by the Arabic language feature that they represented.

SPSS syntax routines were written to

1. Define the conceptual total for each participating student;
2. Establish language feature sub-tests that would expose student difficulty with the cloze items grouped as representing various language features;
3. Generate mean error scores from the sub-tests for each language feature.

Data was extracted from the *SPSS* runs to provide the Arabic components of Figure 1 (following) and the more detailed table that forms Appendix 4. The international data used for pattern comparison purposes was drawn from extraction of data from the earlier study that uncovered the features of the language of science which caused problems for different groups of secondary students studying science in English.

Comparison of the two sets of data described below is indicative, rather than definitive. The student groups are approximately the same age and are at similar points in their differing education systems. The language features reported for English are chosen because they match those emerging from separate analysis of Arabic. Although the students did not complete the same cloze tests and were operating in completely different languages, indicative comparison of the shape of their difficulties allows suggestion of an answer to the second research question.

Results

The mean conceptual replacement score of the 80 participating physics students was 14.03/50 (standard deviation 10.044): Only 28% of deletions were filled with a conceptually correct entry. It is likely that these results underestimate the level of difficulty posed by the text in question. They rest on mean scores: half of the class had greater difficulty than indicated and the mean is itself skewed by the use of the conceptual coding necessitated by the more detailed analysis that follows (O'Toole & King, 2011). These results provide quantitative support for expressions of reading difficulty that emerged from informal conversations between researcher and participating students. These students were unable to suggest conceptually correct entries for almost three quarters of the gaps formed by regular deletion and so they might indeed have difficulty understanding the book from which the passage was extracted. Such support for the existence of a specialist language barrier in Arabic is interesting, but the nature and composition of that barrier is potentially of even greater interest.

Analysis of the language feature sub-tests gave some indication of the probable linguistic form of this barrier, again compared with earlier data for scientific English in secondary schools (see Figure 1 and Appendix 4). The earlier English data is presented purely for illustrative purposes. The students are also completing Year 10 but the cloze tests were completely different.

It appears that these Saudi students are generally having more trouble with the Arabic of this physics text than the earlier students did with the English of their science books. This suggests that the barrier for students learning physics in Arabic may be similar to, but possibly stronger than, that already documented for English. Figure 1 allows comparison of the form of barrier that may be provided by describable features of the Arabic of the school physics textbook. If the barrier revealed by close analysis of student errors compares with that earlier revealed for English science text, then the greater volume of research available on English for specific purposes may provide some guidance for deeper and more thorough research on Arabic for specific purposes. This would extend the emerging work on readability in Arabic that was described earlier in this paper.

The relative size of the shapes on Figure 1 suggests that these Saudi physics students are experiencing greater levels of overall difficulty than did their English-speaking counterparts. The barrier posed by the specific English that characterises science at both secondary and tertiary levels is fairly well established. Figure 1 and Appendix 4 indicate that there may well also be such a barrier in Arabic. Both Arabic and English readers have predictable difficulty with the technical words within their respective texts. The data from the present study indicates that this happened even though the Saudi classes had previously studied the pages on which the cloze test was based. Failure to correctly interpret the function of deleted grammatical words may be more surprising and the two shapes on Figure 1 suggest that differing levels of difficulty with grammatical features may be characteristic of the two barriers. However, there is enough similarity between the two sets of data for the earlier work in English to provide some guidance for continuing work in Arabic.

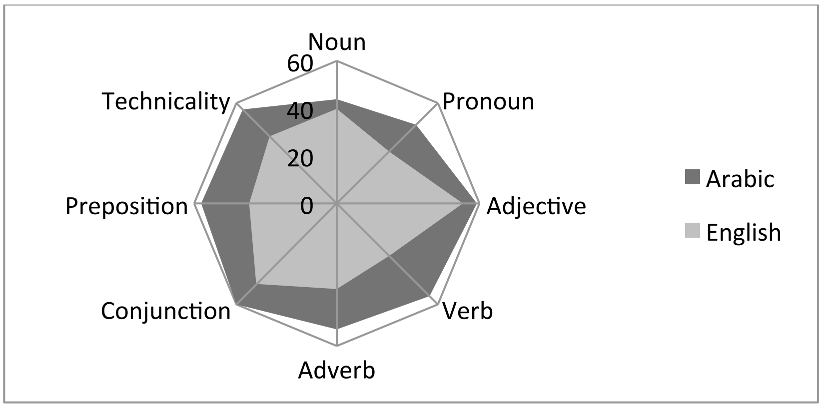

Figure 1: Levels of student difficulty with features of specialist language (mean percentage of deletions representing specified feature for which group was unable to suggest a conceptually correct entry)

Discussion

Teacher assumption of student understanding of features that do not seem particularly technical has been noticed in English-speaking technical contexts (Mudraya, 2006) and something similar may well be happening in these Saudi physics classrooms, where it probably compounds existing problems.

Current research into language difficulties in Arabic seems to focus on broader issues of readability as mentioned earlier. The students in this study seemed to be also having difficulty with the more 'grammatical' features of this school physics text in Arabic. Figure 1 indicates that the students got almost half of the deleted pronouns wrong and were unable to provide conceptually correct replacements for more than half of the adverbs, verbs, adjectives and conjunctions. These difficulties were identified through more precise analysis of cloze results and they go beyond broad concerns with readability. The problems with pronouns deserve further investigation as they suggest student difficulties with text cohesion.

Teacher classroom roles greatly impact student performance. The Saudi teaching style has been traditionally teacher-centred but the new reforms call for a shift from teacher- to student-centred approaches, especially in science. Teacher perceptions of the new science textbook that embodies this approach will be discussed in a future publication.

English is currently the dominant international language for science, and science has been identified as the field of knowledge most responsible for the rapid global spread of the language (Ammon, 2001). Most members of the natural sciences academic community read English and the majority of books and articles are published in that language (Swaan 2004).

However, controversy remains regarding the use of English, as opposed to students' mother tongue, in secondary science education. Some educators recognise English as the gateway to innovations and new technology (Amin, 2009) while others clearly prefer use of the mother tongue (Salloum & BouJaoude, 2017) and such use of Arabic is made more complicated by linguistic diversity among spoken forms and between any of them and the Modern Standard Arabic used in textbooks (Dagher & BouJaoude, 2009).

Conclusions and implications

This preliminary study indicates that Saudi secondary school students studying physics may have difficulty with the Arabic text of their schoolbooks similar to the difficulty that English-speaking students have with the language of their school science books.

Whilst the actual patterns of difficulty differed in this study, the phenomenon seems clear enough to suggest that existing work on English for specific purposes may suggest possible paths for research into problems in Saudi classrooms. Content and language integrated learning (CLIL) may also provide useful insights. This may also be of wider interest in the Arabic-speaking world.

The degree of difficulty with this mandatory textbook suggests that these Saudi students may face barriers in accessing the information contained in it. Student inadequacies are often suggested as the reason for such access difficulties, particularly in the case of female physics learners. However, these results suggest that at least some of the difficulty lies in text accessibility rather than learner competence. Attempts to increase student performance by focusing on motivation, relevance, class size or grouping, or other worthy educational innovations are likely to fail if they ignore the impact of communication difficulties such as those indicated in this paper.

These results support the relevance of approaches from English for specific purposes and CLIL to difficulties emerging in Saudi physics classes. For example, it may prove useful for physics teachers to be more explicit about the language expectations implicit in the textbook they are asking their students to read, and also more explicit about their own expectations regarding what they expect their students to write. The results of the present study indicate that such explicit language teaching should go beyond the more obvious issues of technical language and reach into the grammar that this study has suggested is characteristic of this mandatory Saudi physics text. Direct treatment of technical vocabulary remains necessary but this study suggests that it will not be sufficient.

However, there are a number of limitations to this preliminary study. The widely recognised divergence between standard Arabic and regional and colloquial variants may explain at least some of the difficulties exposed here. These students may have the same difficulty with anything that they try to read. Students from these three schools may not be representative of female Saudi physics students. The base passage for this test instrument was compiled from several pages of the then-mandated textbook. This may not be fully typical of the reading tasks expected of Saudi physics students. Current changes in Saudi science texts may increase or reduce the difficulties experienced by contemporary secondary physics students. All of these topics would provide fruitful directions for further research.

However, this preliminary investigation inspires sufficient confidence to suggest that further work on differences between the Arabic of general reading matter and that characteristic of secondary physics textbooks could be fruitful. The impact of the inclusion of technical terms in English on student understanding might be of particular interest. Widening the participant sample beyond a single city and involving a greater number of students would challenge the representativeness of these preliminary results. Use of the most recent textbook, intact pages of which include bilingual elements, diagrams and other discourse features of Saudi science text, would increase the representativeness of the text sample.

Notwithstanding such possibilities for further work, this study clearly indicates the existence of a pattern of reader difficulty that is likely to impede learner access to Saudi secondary physics in Arabic.

Acknowledgements

The authors would like to acknowledge the contribution of the following people, without whom this study would not have been possible.

The schools, teachers and students who participated in this study;
Mr Abdullah M. Almatrafi, English Language Lecturer, Jeddah College of Technology;
Dr Nasser S Alasmari, English Language Lecturer, Jeddah University;
Mrs Mona M. Almatrafi, Deputy Head of Asir Department of Education;
Mr Sherif Aboul Khair Al Rakhawy, English Language Lecturer, Qunfudah College of Technology;
Mrs Hana Alsharif, Physics Teacher in the General Directorate of Education in Assir Province;
Mr Abdulrahman Alsulaimani, Head of General Studies Department, Jeddah College of Technology;
Shaik Mohammed Khamis, Imam of Newcastle Islamic Society Association Mosque;
Dr. Musa Alzahrani, University of Um AlQura.

References

Al-Bakri, R. H. (2013). Teaching scientific vocabulary to EFL learners using English: Content and language integrated learning. *Arab World English Journal*, 4(1), 269-284. http://awej.org/index.php/volume-4-2013/32-awej-volume-4-number-1-2013/219-rehab-helmi-albakri

Al-Bardi, A. (2013). *The level of readability of year 8 science text book and its relationship with some variables.* Master's thesis (in Arabic), Um Alqura University. http://search.mandumah.com/Record/736984

Al-Hammad, K. (2015). A conceptual framework for re-shaping science education in Saudi Arabia. In N. Mansour & S. Al-Shamrani (Eds.), *Science education in the Arab Gulf States* (pp. 121-136). Springer. https://doi.org/10.1007/978-94-6300-049-9_6

Al-Matrafi, G. (2010). The relationship between the readability of science text-book, achievment system and type of education of the first class students in the elementary school of the Saudi Arabia. *Journal of Faculty of Education,* 21(83), 91-160. (in Arabic). http://search.mandumah.com/Record/58684

Al-Rashidi, O. & Phan, H. (2015). Education context and English teaching and learning in the Kingdom of Saudi Arabia: An overview. *English Language Teaching,* 8(5), 33-44. https://doi.org/10.5539/elt.v8n5p33

Al-Tamimi, A., Jaradat, M., Aljarrah, N. & Ghanem, S. (2013). AARI: Automatic Arabic readability index. *The International Arab Journal of Information Technology,* 11(4), 370-378. http://ccis2k.org/iajit/PDF/vol.11,no.4/5200.pdf

Amin, T. (2009). Language of instruction and science education in the Arab region: Towards a situated research agenda. In S. BouJaoude & Z. Dagher (Eds.), *The world of science education: Arab states* (pp. 61-82). Rotterdam: Sense Publishers.

Ammon, U. (2001). *The dominance of English as a language of science: Effects on other languages and language communities*. Berlin: Mouton de Gruyter.

Arifin, Z., Halim, Z. A., Sham, N.M. M. & Shukry, A. S. M. (2013). The readability of the Arabic prose text. *Middle-East Journal of Scientific Research,* 17(3), 338-343. https://www.idosi.org/mejsr/mejsr17(3)13/12.pdf

Atiefa, H. & Souror, A. (2011). *Teaching science in terms of quality education objectives and strategies.* Cairo: Publishing House for universities. (*in Arabic*).

Bouhlila, D. S. (2011). The quality of secondary education in the Middle East and North Africa: What can we learn from TIMSS' results? *Compare: A Journal of Comparative and International Education,* 41(3), 327-352. https://doi.org/10.1080/03057925.2010.539887

Brown, J. D. (2013). My twenty-five years of cloze testing research: So what? *International Journal of Language Studies,* 7(1), 1-32. http://www.ijls.net/pages/volume/vol7no1.html

Bybee, R. W. (1997). Towards an understanding of scientific literacy. In W. B. Gräber & C. Bolte (Eds.), *Scientific literacy: An international symposium* (pp. 37-68). Kiel: Institut für die Pädogogik Naturwissenschaften an der Universität Kiel.

Cavacini, A. (2016). Recent trends in Middle Eastern scientific production. *Scientometrics,* 109(1), 423-432. https://doi.org/10.1007/s11192-016-1932-3

Dagher, Z. R. & Boujaoude, S. (2011). Science education in Arab states: Bright future or status quo? *Studies in Science Education,* 47(1), 73-101. https://doi.org/10.1080/03057267.2011.549622

Falagas, M., Zarkadoulia, E. A. & Samonis, G. (2006). Arab science in the Golden Age (750-1258 C.E.) and today. *The FASEB Journal,* 20(10), 1581-1586. https://doi.org/10.1096/fj.06-0803ufm

Forsyth, J. (2014). Automatic readability prediction for Modern Standard Arabic. Paper presented at the Workshop on Free/Open-Source Arabic Corpora and Corpora Processing Tools Workshop Programme. https://books.google.com.au/books/about/Automatic_Readability_Prediction_for_Mod.html?id=lhfooQEACAAJ&redir_esc=y

Freahat, N. M. (2014). A comparison of reading levels of high school and freshmen university students in Jordan. *Theory and Practice in Language Studies,* 4(10), 2042-2050. http://www.academypublication.com/issues/past/tpls/vol04/10/09.pdf

Gellert, A. & Elbro, C. (2012). Cloze tests may be quick, but are they dirty? Development and preliminary validation of a cloze test of reading comprehension. *Journal of Psychoeducational Assessment,* 31(1), 16-28. https://doi.org/10.1177/0734282912451971

Ghani, K. A., Noh, A. S. & Yusoff, N. M. (2014). Linguistic features for development of Arabic text readability formula in Malaysia: A preliminary study. *Middle-East Journal of Scientific Research,* 19(3), 319-331. https://www.idosi.org/mejsr/mejsr19(3)14/2.pdf

Hammadi, O. I. & Aziz, M. J. A. (2012). Grammatical relation extraction in Arabic language. *Journal of Computer Science,* 8(6), 891-898. http://thescipub.com/PDF/jcssp.2012.891.898.pdf

Hanrahan, M. (2009). Bridging the literacy gap: Teaching the skills of reading and writing as they apply in school science. *Eurasia Journal of Mathematics, Science & Technology Education,* 5(3), 289-304. http://www.iserjournals.com/journals/eurasia/download/10.12973/eurasia.2009.00151a

Ibrahim, R. (2013). Reading in Arabic: New evidence for the role of vowel signs. *Creative Education,* 4(4), 248-253. https://file.scirp.org/pdf/CE_2013041511063668.pdf

Ibrahim, R. & Aharon-Peretz, J. (2005). Is literary Arabic a second language for native Arab speakers?: evidence from semantic priming study. *Journal of Psycholinguistic Research,* 34(1), 51-70. https://doi.org/10.1007/s10936-005-3631-8

Khalil, M., Abu Alfotouh. (2012). *Contemporary approaches for teaching science* (in Arabic). Future Education House for Publishing and Distributing.

King Abdullah University of Science and Technology (n.d). Vision and mission. Retrieved 25/05/2017 from https://www.kaust.edu.sa/en/about/vision

Ktait, G. Y. (2002). *Evaluation of the second secondary physics textbook and the level of its readability* (in Arabic). Master's thesis, Amman Arab University.

Lemke, J. L. (1998). Teaching all the languages of science: Words, symbols, images, and actions. Paper presented at the Conference on Science Education in Barcelona. https://www.researchgate.net/publication/270904608_Teaching_All_the_Languages_of_Science_Words_Symbols_Images_and_Actions

Lindsay, D. (2011). *Scientific writing = thinking in words*. Collingwood, Vic: CSIRO. http://www.publish.csiro.au/book/6529/

Lorenzo, F., Casal, S. & Moore, P. (2009). The effects of content and language integrated learning in European education: Key findings from the Andalusian bilingual sections evaluation project. *Applied Linguistics*, 31(3), 418-442. https://doi.org/10.1093/applin/amp041

Mazen, H. (2007, 2008). *Modern approaches for teaching and learning science* (in Arabic). Cairo: Dar Al Fajr for Publishing and Distributing.
Ministry of Education (2006). The Education system in Saudi Arabia. Retrieved from http://www.ed.edu.sa/gproject/index.html
Ministry of Education (2015). The quarterly system in secondary schools (in Arabic). https://www.makkahedu.gov.sa/index.php
Mock, C. C. (1974). Readability tests for Arabic. *The Bible Translator,* 25(1), 117-131. https://doi.org/10.1177/026009357402500103
Mudraya, O. (2006). Engineering English: A lexical frequency instructional model. *English for Specific Purposes,* 25(2), 235-256. https://doi.org/10.1016/j.esp.2005.05.002
Neme, A. A. & Laporte, E. (2013). Pattern-and-root inflectional morphology: The Arabic broken plural. *Language Sciences,* 40, 221-250. https://doi.org/10.1016/j.langsci.2013.06.002
Nwesri, A. F. A., Tahaghoghi, S. M. M. & Scholer, F. (2005). Stemming Arabic conjunctions and prepositions. *International Symposium on String Processing and Information Retrieval.* (Vol. 3772, pp. 206-217). Berlin Heidelberg: Springer. https://link.springer.com/chapter/10.1007/11575832_23
O'Sullivan, B. (2012). Assessment issues in languages for specific purposes. *The Modern Language Journal,* 96(s1), 71-88. https://doi.org/10.1111/j.1540-4781.2012.01298.x
O'Toole, J. M. & King, R. A. R. (2011). The deceptive mean: Conceptual scoring of cloze entries differentially advantages more able readers. *Language Testing,* 28(1), 127-144. https://doi.org/10.1177/0265532210375687
O'Toole, J. M., Cheng, J. & O'Toole, G. (2015). An enduring lens for a continuing problem: Close analysis of conceptually scored *cloze* items. *Language Testing in Asia,* 5(1), 1-14. https://doi.org/10.1186/s40468-015-0015-3
O'Toole, J. M. & O'Toole, G. (2004). Specialist language style and supposedly adept monolingual science students. *International Journal of Learning,* 9(9), 1201-1214. http://hdl.handle.net/1959.13/34792
Oller, J. W. & Jonz, J. (1994). *Cloze and coherence.* London: Bucknell University Press.
Osborne, J. (2002). Science without literacy: A ship without a sail? *Cambridge Journal of Education,* 32(2), 203-218. https://cset.stanford.edu/publications/journal-articles/science-without-literacy-ship-without-sail
Pérez-Cañado, M. L. (2012). CLIL research in Europe: Past, present, and future. *International Journal of Bilingual Education and Bilingualism*, 15(3), 315-341. https://doi.org/10.1080/13670050.2011.630064
Phillips, L. M. & Norris, S. P. (2009). Bridging the gap between the language of science and the language of school science through the use of adapted primary literature. *Research in Science Education,* 39(3), 313-319. https://doi.org/10.1007/s11165-008-9111-z
Rafee, A. M., Hadad, Z. Y., Sabag, E. F. & Alorani, A. A. (2014). *Physics: Year 1 Secondary first semester.* Riyadh: Obeikan/McGraw-Hill.
Reda, G. & Hamdan, A. (2015). Gender, language, and society: Saudi female university students perception of the category of professions. *Generos: Multidisciplinary Journal of Gender Studies,* 4(2), 666-689. http://dx.doi.org/10.17583/generos.2015.1334
Reeves, C. (2005). *The language of science.* Hoboken, NJ: Taylor & Francis.

Sadeghi, K. (2013). Doubts on the validity of correlation as a validation tool in second language testing research: The case of cloze testing. *Language Testing in Asia,* 3(15). https://doi.org/10.1186/2229-0443-3-15

Saiegh-Haddad, E. (2013). A tale of one letter: Morphological processing in early Arabic spelling. *Writing Systems Research,* 5(2), 169-188. http://dx.doi.org/10.1080/17586801.2013.857586

Salloum, S. & BouJaoude, S. (2017). Science teaching and learning in multilingual Lebanese middle school classrooms. *European Science Education Research Association* (pp.1-3). https://keynote.conference-services.net/resources/444/5233/pdf/ESERA2017_0785_paper.pdf

Seraye, A. M. (2016). Short vowels versus word familiarity in the reading comprehension of Arab readers: A revisited issue. *International Electronic Journal of Elementary Education,* 8(3), 481-506. http://files.eric.ed.gov/fulltext/EJ1096585.pdf

Shaw, K. (1994). *Writing up a dissertation*. Exeter, UK: University of Exeter, Educational Research Monograph Series.

Spolsky, B. (2000). Language testing in *The Modern Language Journal. The Modern Language Journal,* 84(4), 536-552. https://doi.org/10.1111/0026-7902.00086

Stansfield, C. W. (2008). Lecture. 'Where we have been and where we should go'. *Language Testing,* 25(3), 311-326. https://doi.org/10.1177/0265532208090155

Swaan, A. (2004). English in the social sciences. In *ALLEA Biennial Yearbook: Critical Topics in Science and Scholarship* (pp. 135-146). Amsterdam: All European Academics. http://www.allea.org/wp-content/uploads/2016/02/Swaan_English_Social.pdf

Taha-Thomure, H. (2008). The status of Arabic language teaching today. *Education, Business and Society: Contemporary Middle Eastern Issues,* 1(3), 186-192. https://doi.org/10.1108/17537980810909805

Taylor, W. L. (1953). "Cloze procedure": A new tool for measuring readability. *Journalism and Mass Communication Quarterly,* 30(4), 415-433. http://journals.sagepub.com/doi/pdf/10.1177/107769905303000401

Valverde, G., Bianchi, L. & Wolfe, R. (2002). *According to the book: Using TIMSS to investigate the translation of policy into practice through the world of textbooks*. Dordrecht: Kluwer.

Vision 2030 (2017). *Vision 2030*. Retrieved from http://vision2030.gov.sa/ar

Wellington, J. & Osborne, J. (2001). *Language and literacy in science education*. Buckingham UK and Philadelphia USA: Open University Press. https://www.mheducation.co.uk/openup/chapters/0335205984.pdf

Yore, L. D. & Treagust, D. F. (2006). Current realities and future possibilities: Language and science literacy - empowering research and informing instruction. *International Journal of Science Education,* 28(2-3), 291-314. http://dx.doi.org/10.1080/09500690500336973

Younes, M. I. (2016). *The impact of CLIL on Arabic, English and content learning of Arab high school students in the UAE*. Master's thesis. https://dspace.aus.edu/xmlui/handle/11073/8333

Zytun, A. (2008). *Methods of teaching science* (in Arabic). Amman, Jourdan: Dar Al shrouk for Publishing and Distributing.

Appendix 1: Original text in Arabic

عِلمُ الفيزياء هو العلم الذي يدرُس المادة و المجالات المؤثِرة عليها (كالجاذبية)، و استغلال الطاقاتُ المُرتبِطة بالمادةِ و حركتِها و القُدرة على تحويل الطاقة إلى أشكالِها المُختِلفة ومن المُميزات الأساسية لعلمِ الفيزياء إنهُ علم تجريبي، لا يعتمد على الجانبِ النظري فقط.

قبل حوالي أربعُمائة عام تقريباً، استنتجَ جاليليو أن جميع الأجسام التي تسقط سقوطا ًحراً يكون لها نفس التّسارُع و ذلِك بإهمال تأثير مقاومة الهواء، وأن هذا التّسارُع لا يتأثر بأي من نوع مادة الجِسم الساقط أو وزن هذا الجِسم أو الارتفاع الذي سقط منهُ أو كَوُن الجِسم قد أُسقِط أو قُذِف. ويرمُز لتّسارُع الأجسام الساقطة بالرمز (g)، وتتغير قيمة (g) تغّيُرات طفيفة في أماكن مختلفة على الأرض والقيمة المتوسطة لها $9.8\ m/s^2$

فالتّسارُع الناتج عن الجاذبية الأرضِية هو تسارُع جِسم يسقُط سقوطاً حرا ًنتيجة تأثير جاذبية الأرض عليه.

فعند إسقاط صخرة تزداد سُرعتها بِمعدل $9.8\ m/s^2$ كل ثانية، فيمُكن اعتبار التّسارُع موجبا ًأو سالبا ًعلى النظام الإحداثي الذي يتم اتخاذه.

فإذا كان النّظام يعتبر الاتجاه إلى الأعلى موجباً؛ فإن التّسارُع الناتج عن الجاذبية الأرضية عندئذٍ يساوي[g-]. أمّا إذا اعتبرنا الاتجاه إلى الأسفل هو الاتجاه الموجب؛ فإن التّسارُع الناتج عن الجاذبية يساوي[g+] .

عند قذف كُرة إلي أعلى بإعتبار إن النّظام يعتبر الاتجاه إلى أعلى موجباً، فإن الكُرة تُغادر اليد بسرعة موجبة، أما التّسارُع فيكون للأسفل أي أن التّسارُع يكون سالبا ًوهو يساوي[$-9.8\ m/s^2$]. ولأن (أن فقط) السُرعة والتّسارُع في إتجاهيين مُتعاكسين؛ فإن سُرعة الكُرة تتناقص.

وعندما يسّأل النّاس عن تسارُع جِسم عند أقصي ارتفاع له أثناء تحليقهُ فإنهم في العادةِ لا يأخُذون وقتا ًكافيا ًلتحليل الموقف فتكون إجابتهُم: بأن التّسارُع يساوي صفر. وهذا ليس بصحيح بالطبع. حيث أن عند أقصى ارتفاع؛ تكون سُرعة الكُرة تساوي صفر. ولكن ما هو الحال لو كانَ التّسارُع في هذه النقُطة يساوي صفر؟ فإن الكُرة لن تكسب أي سُرعة للأسفل؛ بل ستبقى مُعلقة بالهواء عند أقصى ارتفاع لها.

وبما أنّ الأجسام المقذوفة إلى الأعلى لا تبقى مُعلقة؛ فسوف نستنتج :أن تسارُع الجِسم عند نقطة أقصى ارتفاع لطيرانِهِ يجب أن لا يساوي صفراً، وأن اتجاهه يجب أن يكون لأسفل.

Appendix 2: Cloze test in Arabic

تم حذف بعض الكلمات من النص و استبدالها بالأرقام. اكتبي الكلمة المناسبة في ورقة الإجابة عند الرقم المناسب.

عِلمُ الفيزياء هو العلم الذي يدرُس المادة و المجالات المؤثِرة عليها (كالجاذبية)، و استغلال الطاقاتُ المُرتبِطة بالمادةِ و حركتِها و القُدرة على تحويل الطاقة إلى أشكالِها المُختِلفة ومن المُميزات الأساسية لعلمِ الفيزياء إنهُ علم تجريبي، لا يعتمد على الجانبِ النظري فقط.

قبل حوالي أربعُمائة(1) تقريباً، استنتجَ جاليليو أن (2) الأجسام التي تسقط سقوطا (3)ً يكون لها نفس التّسارُع (4) ذلِك بإهمال تأثير (5)الهواء، وأن هذا (6) لا يتأثر بأي (7)نوع مادة الجِسم الساقط(8) وزن هذا الجِسم أو (9) الذي سقط منهُ أو (10) الجِسم قد أُسقِط أو(11). ويرمُز لتّسارُع (12) الساقطة بالرمز (g)، (13)تتغير قيمة (g) تغّيُرات (14) في أماكن مختلفة على (15) والقيمة المتوسطة لها (16)

فالتّسارُع الناتج عن (17) الأرضِية هو تسارُع جِسم (18) سقوطاً حراً نتيجة تأثير (19)الأرض عليه.
فعند (20) صخرة تزداد سُرعتها بِ(21) $9.8\ m/s^2$ كل ثانية، فيمُكن (22) التّسارُع موجباً أو سالباً(23)
النظام الإحداثي الذي يتم (24)
فإذا كان النّظام (25) الاتجاه إلى الأعلى موجباً؛ (26)إن التّسارُع الناتج عن (27)الأرضية عندئذٍ يساوي[-g].
(28) إذا اعتبرنا الاتجاه إلى (29) هو الاتجاه الموجب؛ ف(30)التّسارُع الناتج عن الجاذبية (31)[+g] .
عند قذف كُرة (32) أعلى (على اعتبار إن(33) يعتبر الاتجاه إلى أعلى (34) فإن الكُرة تُغادر (35) بسرعة
موجبة، أما التّسارُع (36)يكون للأسفل أي (37) التّسارُع يكون سالبا و(38) يساوي[$-9.8\ m/s^2$]. ول
(39) السُرعة والتّسارُع في (40) مُتعاكسين؛ فإن سُرعة(41) تتناقص.
وعندما يسّأل (42) عن تسارُع جِسم عند (43) ارتفاع له أثناء تحليقهُ (44)إنهم في العادةِ لا(45)
وقتاً كافياً لتحليل (46) فتكون إجابتهُم: ب(47) التّسارُع يساوي صفر. و(48) ليس بصحيح ب(49). حيث
أن عند أقصى (50)؛ تكون سُرعة الكُرة تساوي صفر ولكن ما هو الحال لو كانَ التّسارُع في هذه النقُطة يساوي صفر؟
فإن الكُرة لن تكسب أي سُرعة للأسفل؛ بل ستبقى مُعلقة بالهواء عند أقصى ارتفاع لها.
وبما أنّ الأجسام المقذوفة إلى الأعلى لا تبقى مُعلقة؛ فسوف نستنتج : أن تسارُع الجِسم عند نقطة أقصى ارتفاع لطيرانِهِ يجب
أن لا يساوي صفراً، وأن اتجاهه يجب أن يكون لأسفل.

Appendix 3: Free English translation of base text

Physics is the science which investigates matter, the fields which influence it, such as gravity, how energy acts on matter to change its motion and shape and how energy can be transferred to its various shapes. One of the significant characteristics of physics is that it is empirical and not theoretical.

Galileo concluded, four hundred years ago, that each free-falling body has the same acceleration. It accelerates at the same rate regardless of the kind of matter the body is made of, the weight of that body, the height from which it was dropped, or whether it was dropped or thrown. Bodies fall towards the earth because of gravity. The acceleration due to gravity (g) is slightly modified by where a body is located on earth and the average value of $9.8\ m/s^2$ is often used in calculations.

When dropping a rock accelerating by $9.8\ m/s^2$, this acceleration can be considered positive or negative by the parametric system that is chosen. If we choose ‘upwards’ as our positive direction, a falling body has a negative acceleration, because it is moving downwards (-g), whereas if we chose ‘downwards’ as positive, the acceleration would be positive (+g). ‘Up’ is usually ‘positive’, so throwing a ball upwards gives it both positive velocity and acceleration. When the ball reaches its greatest height, it begins to fall and both velocity and acceleration become negative.

People sometimes ask about the acceleration of the ball as it begins to change direction at the top of its flight. They don’t usually take sufficient time to analyse the situation and their answer would be that the acceleration equals zero. This is not true because gravity applies an acceleration of 9.8m/s^2 throughout the ball's flight. When the ball is at the utmost altitude, it is still and its speed is zero. But gravity continues to accelerate the ball at 9.8 m/s^2 and it begins to fall, picking up speed as it does. Acceleration moves from positive to negative as the direction changes but it remains at 9.8 m/s^2.

Appendix 4: Levels of student difficulty(1) with features of specialist language

Group (2)	Noun %	Prn %	Adj %	Verb %	Adv %	Conj %	Prep %	Tech %	Sm1 %	Sm2 %	Sm3 %	Fml %	Err %
Arabic n=80	44 SD= 26	47 SD= 44	59 SD= 50	55 SD= 27	53 SD= 32	60 SD= 31	57 SD= 33	75 SD= 36	47 SD= 27	39 SD =23	65 SD= 48	41 SD= 50	52 SD= 26
DfRnk (3)	8	7	2	5	6	1	3	4 (Mean = 56%)					
English n=654 (4)	40 SD= 24	31 SD= 28	53 SD= 32	31 SD= 26	36 SD= 32	48 SD= 35	37 SD= 35	40 SD=31					36 SD= 22
DfRnk	3	6	1	6	6	2	5	3					

1. Difficulty: Mean percentage of clear student error in replacing deletions of the stated category.
2. Noun; Pronoun; Adjective; Verb; Adverb; Conjunction; Preposition;
   Technical word; Semi-technical word, *Type 1*: Semi-technical word with one meaning;
   Type 2: Semi-technical word with two meanings;
   Type 3: Semi-technical word with three possible meanings; Formal word.
3. *DfRnk*: Difficulty rank - 1 is most difficult.
4. English results were recalculated from the data beneath O'Toole and O'Toole (2004).

Nouf Mohammed Albadi, School of Education, University of Newcastle, Callaghan, NSW, Australia; and Ministry of Education, Kingdom of Saudi Arabia.
Email: noufmohammeds.albadi@uon.edu.au

John Mitchell O'Toole, School of Education, University of Newcastle, Callaghan, NSW, Australia.
Email: mitch.otoole@newcastle.edu.au
Web: http://www.newcastle.edu.au/profile/mitch-otoole

Jean Harkins, School of Humanities and Social Science, University of Newcastle, Callaghan, NSW, Australia.
Email: jean.harkins@newcastle.edu.au
Web: http://www.newcastle.edu.au/profile/jean-harkins

Please cite as: Albadi, N. M., O'Toole, J. M. & Harkins, J. (2017). A preliminary study of the technical use of Arabic in Saudi secondary physics classes. *Issues in Educational Research,* 27(4), 639-657. http://www.iier.org.au/iier27/albadi.pdf