A. S. Hornby Educational Trust

REPORT ON A.S. HORNBY DICTIONARY RESEARCH AWARD PROJECT

Title: A Bilingual Corpus-Based Physics Dictionary for L1 Arabic Undergraduates

Country: Sultanate of Oman

Dates: July 2022 – August 2024

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1 BACKGROUND AND OBJECTIVES

The context

Oman is an Arab Gulf country which has a relatively young higher education sector, with its first and only public university being established in 1986. All the private colleges and universities in Oman are affiliated to British, American, or Australian universities, a requirement of the Ministry of Higher Education to ensure the quality of programmes (Al Mahrooqi and Tuzlukova, 2014). However, the students and staff at Omani institutions have limited access to the e-resources used in these Western universities, and hence, these institutions are relatively resource-poor in terms of access to standard learning materials. For example, the members of this research team from Oman need to depend on their colleagues working at the only public university in Oman or in universities abroad in order to access resources. The medium of instruction in Omani public schools is Arabic while English is the medium adopted by most tertiary institutions in the country. However, most students are not equipped with the language skills required for their undergraduate programmes and therefore have to complete a one-year Foundation Programme before they can enrol on their disciplinary courses (Al-Jardani, 2017; Mahrooqi & Denman, 2017). The language problems of these students continue even after they graduate; the results of a nationwide study (Al

Mahrooqi and Tuzlukova, 2014) indicate that graduates continue to struggle to communicate effectively in English, affecting their personal and professional success.

Discipline-specific vocabulary support for Arab learners: a brief review of the literature

A review of the literature reveals that research on the type of language support required by L1 Arabic students in undergraduate programmes across disciplines is quite scarce, barring a few exceptions (e.g., see Mathew, Nesi & Vincent, 2018). In the case of Physics undergraduates, the focus of this project, the language resources currently being used are inadequate to support these students as they are de-contextualized, and therefore do not consider the L1, the language level, the genres, and the sub-disciplines of Physics. They are also inaccessible to students as they are not available free of cost (a subscription is required, for example, to access the *Oxford Dictionary of Physics*). It is also apparent that L1 Arabic students need to be supported not only in general English but also in acquiring the technical lexis and syntax of their disciplines, so that their communication skills can be improved. Thus, the onus falls on both the subject lecturers and language specialists to collaborate and try to identify the problems, and design and implement solutions to address them.

> The language resources currently being used are inadequate to support L1 Arabic Physics students as they are de-contextualized, and therefore do not consider the L1, the language level, the genres, and the sub-disciplines of Physics.

A corpus-based and discipline-specific dictionary for Arabic L1 learners, compiled in collaboration with subject and language specialists who are actually teaching these students, could begin to address some of the language needs of these students. Focusing on key vocabulary in order to reduce the overwhelming number of items students need to master is one way of offering effective support. Williams (2003: 8) points out that “generalized senses found in dictionaries do not provide examples that will easily enable these users to instantiate their meanings in their working context.” However, few attempts have been made to provide dictionary tools that are sensitive to L1, genre and discipline (Paquot, 2012). Corpus-based electronic dictionaries based on corpora of general English such as the *British National Corpus* and the *Longman Corpus Network* are available to learners which, without doubt, provide learners with a wealth of information on collocations and the various contexts of use of the word. However, as Paquot (2012) points out, learners write various genres and are required

to adopt styles appropriate to them. It is therefore important for students to be aware of the vocabulary used in specific genres in order to engage with them.

The use of corpora in English for Specific Purposes (ESP) pedagogy has been acknowledged to be a powerful tool as it is able to sensitize learners to the phraseology, and specialized structures of ESP language varieties (Boulton, Carter-Thomas, & Rowley-Jolivet, 2012). However, it is also the case that corpus-based methods of ESP language teaching which require learners to directly access corpora might be better suited to advanced learners of the language rather than EFL learners who may not be familiar with corpus-use techniques and may be overwhelmed with the amount of unfiltered corpus data. One approach to support this category of students would be for the subject and language specialists to collaborate and compile a specialized corpus-based dictionary. This would facilitate the identification of the most relevant concepts and vocabulary that students will most possibly encounter in the course of their study, a critical factor to be considered since students only have a short time to acquire the vocabulary and a long list of items may not necessarily serve the purpose (Todd, 2017; Otto, 2021). However, most existing ESP word lists are presented without any context and the application of these in the classroom is left entirely to individual teachers (Durovic, 2021; Ohashi et al., 2020).

Aims and rationale for the project

The aim of this project was to create a discipline-specific dictionary for L1 Arabic undergraduates who have to study basic Physics concepts in the initial semesters of their programme in Electronics Engineering at Middle East College (MEC), Oman. The undergraduate programmes in Electronics Engineering, Civil Engineering and Mechanical Engineering are structured to include some pure science subjects such as Physics and Mathematics in the initial semesters of the programme, not only in this institution, but in most higher education institutions in Oman. This is because knowledge of some basic concepts in Physics that underpin concepts in these various specialisms is essential for students to be initiated into their disciplines. However, it often happens that most of these students who have studied these subjects in their L1 at secondary school level encounter severe challenges in mastering the technical vocabulary required to meet the demands of these courses.

Feedback from subject teachers and the performance of students in their assessments indicated that students need support in deciphering the vast number of highly technical terms they are expected to understand and use in the Engineering Physics module. Subject teachers revealed that Physics is a core subject which students across many disciplines are required to be familiar with. However, students are not able to fully exploit the learning materials available because of the lack of access to vocabulary. This problem needs to be addressed

as there is no discipline-specific English-Arabic dictionary available for students with examples of use in pedagogic contexts.

As we saw above, most students who enter tertiary education in Oman have to complete a one-year Foundation Programme to acquire the language, mathematical and computing skills needed for their disciplinary courses. Many of these students struggle with the extensive English language vocabulary they are required to master even after completing the Foundation Programme. There are scant resources to help these students acquire the vocabulary they need to meet the requirements of their degrees. At Middle East College, many Electronics and Engineering students in their first undergraduate semester find it challenging to comprehend the basic concepts of Physics in their lecture materials because they are not familiar with the technical words and are also introduced to new Physics concepts in English.

Although students can look up the meanings of words easily, Franceschi (2023) points out the need for dictionaries in ESP: “In an era where the Internet offers an astonishing abundance of resources, dictionaries necessarily need to incorporate rapidly accessible information all on the same page that would otherwise have to be retrieved with multiple searches”. When students are overwhelmed with the amount and range of information available on the internet, a specialist dictionary would offer a tailor-made and convenient tool to meet the needs of the students as they are initiated into their discipline.

This aim of this project was to create a bilingual Physics dictionary app based on part of the lecture materials provided to students. Students would be able to access the lecture materials through the app and look up word details including: the Arabic translation, explanations, example sentences, illustrative diagrams, and formulae. Explanations of the terms would be included in both English and Arabic using accessible language so that learners would not encounter the kind of problems they face when using standard dictionaries. Although the app would initially be used primarily by the learners in the research site, the app would be available to other learners in similar contexts. The aim of this project was not to create a comprehensive word list of all the topics in the Physics subject area chosen, but to choose a limited set of words in a narrow topic area. This is because the primary objective of this project was to fine-tune the methodology and pilot the idea among learners to obtain feedback so that more extended projects of a similar nature, not only in Physics but also in other disciplines, could be planned and implemented.

Objectives

- To create a bilingual corpus-based Physics mobile-app dictionary for Semester 1 L1 Arabic undergraduates

- To fine-tune the methodology for creating this specialized dictionary by restricting the focus to the basic terms in one topic (*Atomic & Quantum Physics* for undergraduates in Electronics Programmes)

2 DESCRIPTION OF RESEARCH

Stage 1: *Selection of headwords and building/choosing consultation corpora*

At MEC, comprehensive in-house supplementary materials which contain most of the concepts and vocabulary required by students are provided. The *Engineering Physics Handbook* selected for this project is peer-reviewed and available in handbook form for students. It was prepared by a subject expert who has more than 20 years of experience in teaching Physics. It comprises nearly 45,000 words and the first chapter entitled *Atomic and Quantum Physics* was uploaded on the app with selected words becoming headwords for dictionary entries.

For the purposes of creating the discipline-specific dictionary, 45 key vocabulary items, consisting of single or multi-word items, were retrieved from the first chapter of the *Engineering Physics Handbook*. These items were first retrieved using Sketch Engine, a corpus concordancing tool, and then scrutinized by two subject experts in the project team who each have more than 10 years of experience in teaching the subject. They used their judgement to shortlist the items that would be useful for students to understand the concepts being taught in the initial semester as well as in the semesters ahead.

A customized corpus consisting of 2,045,182 words was created for the current project on the topic of Atomic and Quantum Physics using the Boot Cat technology available via Sketch Engine. Seed words consisting of the terms selected for the dictionary items and other words recommended by the Physics lecturers and also those suggested by Sketch Engine were used to expand the corpus using the Make Bigger feature (see Figure 1). This corpus of about 2 million words, however, did not offer adequate coverage of certain terms on our shortlist.

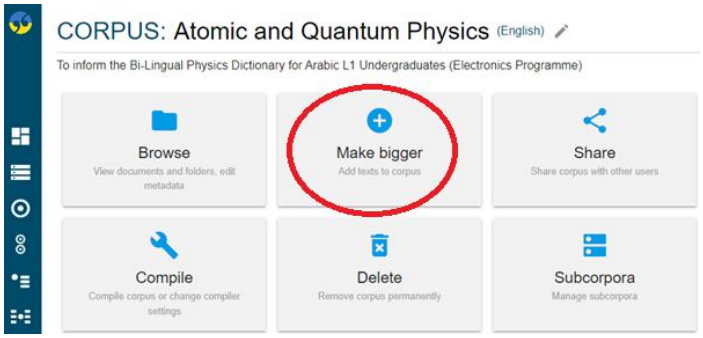


Figure 1

'Make Bigger' Feature in Sketch Engine

At this point of our corpus-building phase, we consulted a Sketch Engine expert, Ondřej Matuška, because we wanted to find the optimal method of expanding our corpus. Matuška suggested that, rather than expanding our corpus, we could use an additional billion-word corpus accessible via Sketch Engine which is much larger than one we could hope to build ourselves and which would possibly contain several references to our terms owing to its huge size. We did a number of searches to compare our customized corpus to the general purpose one; we found that several terms on our list were better represented in the general corpus and vice versa. For example, there were 64 instances of the term *Thomson Scattering* in the general corpus and only four in our customized corpus. Therefore, we chose the billion-word general purpose *enTenTen20* corpus as an additional source for writing the explanations and choosing the examples for each entry.

Stage 2*: Explanations, Examples and Illustrations*

This stage involved writing the explanation of the headword, adding illustrations and choosing examples showing the usage of the word in authentic contexts. At the initial stage of app development, we chose to present examples in the form of concordance lines (for two headwords: *scattering* and *momentum*) as well as more conventional example sentences because we wanted to know which of these formats students preferred. We chose 14 concordance lines for each headword presented in Key Word in Context (KWIC) format with the headword highlighted in red. The concordance lines were curated to exclude words and sentence structures which students might find challenging. Citations were carefully selected, making sure to avoid any ambiguities that may result from the same term being used in multiple senses across disciplines (Nesi & Haill, 2002). For example, the word *scattering* (see Figure 2) has a technical meaning in the handbook but carries multiple meanings and concordance lines needed to be chosen with care in order to reflect the precise meaning, collocations, and other co-text (see Figure 6 and further discussion of this feature in section 3 below).

Figure 2: *Concordance lines for 'scattering' retrieved from enTenTen20 corpus*

Electron ***scattering*** *occurs when electrons are deviated from their original trajectory.*

The Compton effect is the name given to the ***scattering*** *of a photon by an electron.*

Compton ***scattering*** *can be used as an analytical tool for examining the electronic structure of a solid.*

In addition to the concordance lines, several conventional example sentences were chosen for each word, using the *Word Sketch* feature of Sketch Engine to help us choose a variety of the highest-ranking collocations for the term. In the example sentences provided for the word

momentum, the bolded words next to the headword are the collocations which were the most frequent. When we chose the examples (see 1-4 below), we took care to include not only function words (*of the*) but also other parts of speech such as *carry* and phrases such as *and energy* as well. The 'good dictionary examples' feature of Sketch Engine helped us choose appropriate example sentences. The subject teachers were then consulted, and these examples were moderated because sometimes the examples chosen contained advanced information that learners do not need to know at this point of their studies. For example, one of the example sentences containing the term *angular momentum* was removed on the recommendation of the subject teacher because this is a phenomenon not taught at this stage of their Physics study.

*1. The right side of the equation is the momentum **of the** system right after collision.*

*2. Compton postulated that photons **carry** momentum.*

*3. The incoming photon transfers part of the momentum **and energy** to electrons in Compton scattering.*

*4. The direction of **linear** momentum of photon is always constant.*

Working with us to use the corpus, the subject teachers then came up with the explanations and notes for each of the headwords in English. After consulting the corpora, they decided that it would be useful to provide some extra notes for some of the headwords. They felt that this would pique the interest of the learner as well as equip them with some additional basic facts about the headword which might be useful. Therefore, the notes consisted sometimes of simple facts or applications of the theory being explained. For example, the note for Quantum Theory is about its applications: *Semiconductors, lasers, nuclear reactors, and quantum computers have been developed based on Quantum Theory*.

Together with the subject teachers, we completed several rounds of consultations of the two corpora to complete the explanations and notes of the 45 headwords selected. The subject teachers then decided which of the headwords would need to be illustrated with diagrams and animations, and briefed a faculty member from the Computing Department who agreed to do our illustrations and animations. They also had a multi-media specialist re-draw many of the diagrams (see Figure 4) in the original handbook for clarity and to avoid copyright issues.

***Stage 3**: Translation, Uploading Entries to the App, Feedback and Launch*

During this stage, the translations of the explanations and notes were completed. One of our team members who has a PhD in a Physics-related field and is also an Arabic speaker

translated all the explanations and notes into Arabic and then got them moderated by an appropriately qualified and experienced colleague.

After several discussions between our team members and the moderator, the translations of the explanations and notes were finalized. By this point, the multi-media specialist had also completed all his illustrations, so we were now ready with all 45 headwords and their entries.

Talks had been taking place in parallel with several software vendors with the help of colleagues from the Computing Department. We were looking for an app developer who had the expertise to develop the app as well as one that would allow us to stay on budget. After the app developer was hired and we had explained our requirements, it was decided that our app would first be published on the Play Store (the app store for Android device users) for two reasons: it would be much easier to change the content, and it would be cheaper than the App Store (for users of Apple devices). The team members were provided with a link to update the details of the entries. This was very convenient because we were able to make revisions to any part of the entry without depending on the developer for every change. After the entries for 20 words were completed, the app was made live on Play Store by the end of the first year of the project to enable us to collect initial feedback from students.

(https://play.google.com/store/apps/details?id=com.mec.bilingual_physics_dictionary).

Unfortunately, it turned out that most students had iPhones, so it was challenging to collect feedback because most of them could not install the app on their own phones. We turned to focus group interviews as the most feasible method for data collection in this scenario. On the whole, the feedback was positive, but it was clear that the students were not comfortable reading concordance lines (details of the feedback are provided in a subsequent section). So, it was determined that we would use only carefully curated examples rather than concordance lines.

In the second phase of the project, the app was launched on the App Store. Unfortunately, there were problems with the special figures in the text such as the symbol for lambda not displaying correctly on the app. The text had to be meticulously proofed by the subject experts to avoid such mistakes (see Figure 6 which has red crosses showing instead of symbols). After testing and further refining, the app was made available on the App Store towards the end of the second year of the project.

Description of the App and its features

After the app is installed, the user can view the “About Us” page which describes the project. When they click on the Content page (Figure 3), the user can navigate through the pages of the chapter and locate any topic of interest. Clicking on 1.1.2, for instance, takes them to

Bohr's model of the atom (Figure 4). The highlighted dictionary headwords on this page (e.g. *electron*, orbit) illustrate how the headwords are highlighted on each page of the text uploaded on the app.

Figure 3 *Content page as shown on an iOS device*

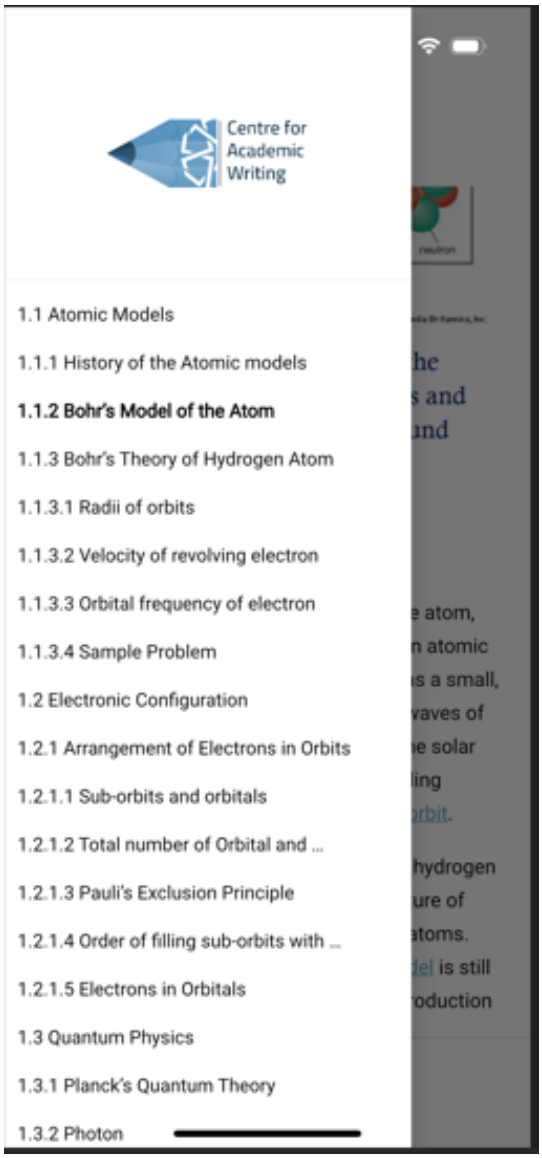
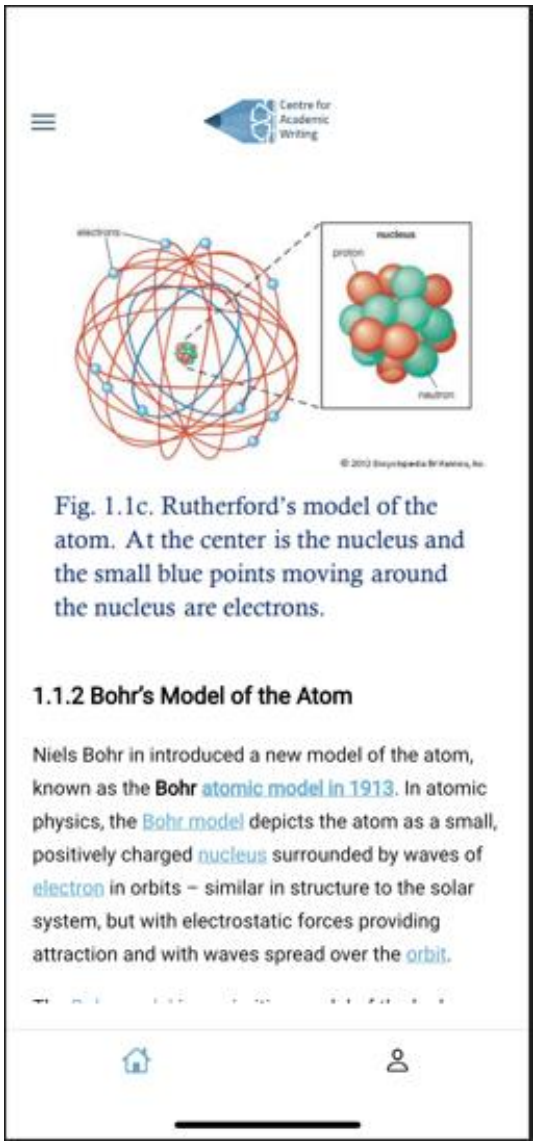


Figure 4 *screenshot of a page as it appears on an iOS device*



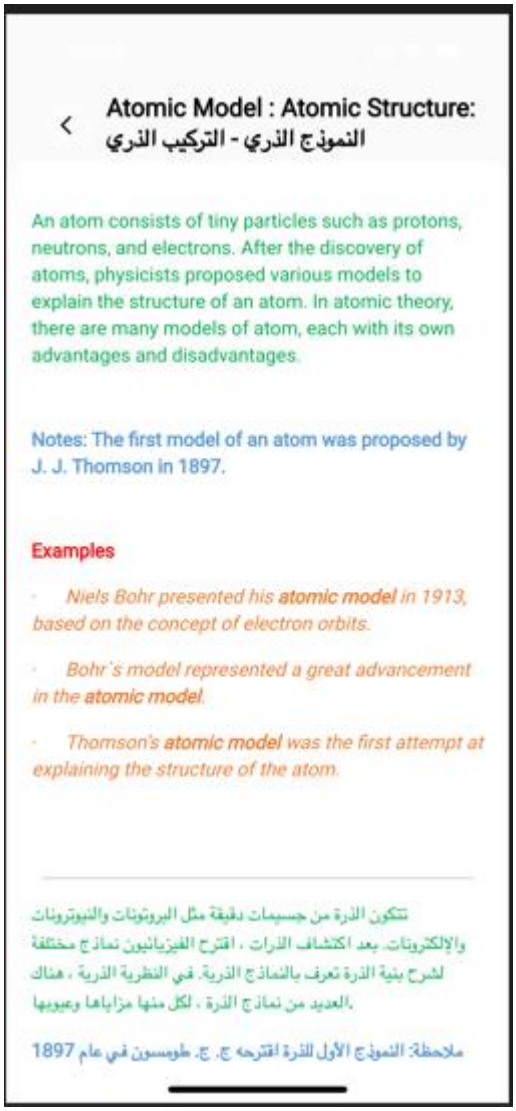


Figure 5

Screenshot of dictionary entry for the term 'Atomic Model' on an iOS device

3 RESULTS, EVALUATION AND DISSEMINATION

Feedback was collected from various stakeholders including students at MEC, students and faculty at other higher education institutions, a conference audience, and faculty at MEC. To collect feedback from students enrolled on the course on the usefulness of the dictionary app, a focus group interview, rather than a survey was conducted. Five students (three female and two male; F1, F2, F3, M1, M2) were asked to download the app and check the entries. Two of the students had completed this module two semesters back while the remaining three were students currently enrolled for the module.

Focus Group Discussion

The focus group discussion centred around three main themes: the usefulness of the app in helping them understand the topic, the convenience of using the app and its features, and

problems and suggestions for improvement. The students had been told in advance about the purpose of the interview and reassured that their responses or decision to participate would not affect their grades. They were asked to download the app so that they would be familiar with it before the discussion. They were told that their responses would be used as feedback to improve the features of the app.

The initial round of discussions about the app indicated that students were quite excited about it. All the participants indicated that it was a relief to see some of the terms translated into Arabic. F2 and M2 mentioned that they had studied these terms and concepts in school but were finding it hard to memorize the vocabulary and express the concepts in English. They said that the app would be useful but noted that only the first chapter of the handbook is covered by the app. F1 said that she felt at ease when offered the Arabic translation and particularly liked the animated diagrams.

> All the participants indicated that it was a relief to see some of the terms translated into Arabic. Some mentioned that they had studied these terms and concepts in school but were finding it hard to memorize the vocabulary and express the concepts in English.

At this stage of app development, the examples were given in the form of concordance lines as well as example sentences because we wanted to know which of these formats students preferred. Students could view 14 concordance lines with the headword highlighted in red (in KWIC format). Figure 7 shows the concordance lines at the top of the screen and the examples sentences in orange at the bottom. The concordance lines were curated to exclude many words and sentence structures which students might find challenging. However, F1 and F2 did not think the concordance lines were easy to read because of the incomplete sentences and the large amount of information they contained. They said that seeing so many sentences bunched up together made them anxious. The other participants agreed that the example sentences on their own would be much better to read. It seemed that the participants were more focused on the explanations, notes, and the diagrams rather than the example sentences. F3 added that it would be convenient to open the app any time she wanted, especially on the bus, since she has a long commute.

***Figure 6**: Screenshot of concordance lines for 'momentum' in version 1 of the app*

Analysis of the focus group interview discussions helped us gain an overview of the usefulness of the app and its features. Based on this feedback, we decided to replace the concordance lines with just example sentences. We also realized that Physics students are more focused on understanding the meaning of the concept rather than on learning how to use it appropriately in correct English. This was hardly surprising to us because many students (and teachers) at our institution think that minor language errors that do not detract from the meaning can be ignored safely.

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Pre- and Post-Test Results

A pre- and post-test was originally built into the evaluation stage of the app. However, since the app was only available at the end of April 2024 for iPhone users, most students enrolled on this module were not attending classes regularly by this point because they were revising for their exams. As a result, only 7 students participated in the pre-test and 9 in the post test. A quiz consisting of 10 multiple choice questions was administered through Moodle for the pre-test group and since this set of students did not have a session the same week, another group of students was administered the post-test.

The results of the analysis of their scores are provided below (Table 1). The pre-test scores are normally distributed, while the post-test scores are not. On average, the post-test group scored higher, but there is more variability in the post-test group. The descriptive statistics indicate that there is a difference of 1 in the mean marks between the two groups.

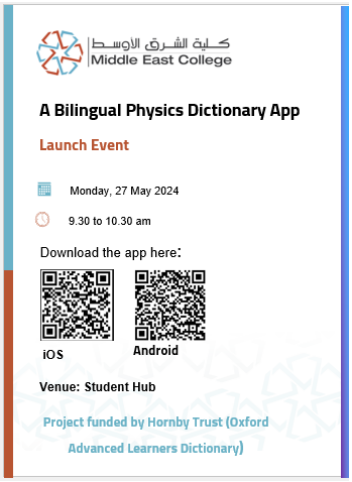
Since the sample size is not large enough, the Mann-Whitney U test was not conducted to determine any statistically significant differences in the scores between the two groups.

***Table 1**: Descriptive Statistics for analysis of pre- and post-test scores*

	Score	
	Pre-Test	Post-Test
Valid	7	9
Mean	10.71	11.89
Std. Deviation	3.402	4.226
Coefficient of variation	0.3175	0.3555
Shapiro-Wilk	0.9196	0.7547
P-value of Shapiro-Wilk	0.467	0.006
Minimum	6.000	4.000
Maximum	15.00	15.00

Seminar for students at other HEIs

10 groups of students accompanied by two faculty members representing various HEIs in Oman were scheduled to visit MEC in May 2024 for another event. The project team took this as an opportunity to introduce the app to students and faculty outside MEC. Faculty from the Electronics and Telecommunications Department, and those from the Management Studies Department who had already spoken about the applicability of the idea to the Logistics discipline were also invited to the seminar.



Participants were given time to download the app and get familiar with it. On the whole, the feedback was positive, although no very concrete suggestions came up.

The app has been made available on Play Store, for Android phone users, as well as for iPhone users and is now live and freely accessible by anyone who has the link.

4 OVERALL REFLECTIONS AND FUTURE PLANS

The limitations of the study

There are several limitations of the project. The app covers only 45 terms from the topic *Atomic and Quantum Physics* from a handbook prepared in-house by the course instructor at our institution in Oman. It is possible that students and instructors in other contexts might feel other terms from the same topic are more important. The content of the dictionary is also limited to students whose first language is Arabic. The subscriptions to the Play Store and App Store to display the apps via these platforms, currently covered by funding for this project, need to be renewed each year; so eventually the app will become inaccessible. A more sustainable solution needs to be found in contexts such as ours which are relatively resource poor. Also, the feedback that we were able to collect through the focus group discussions was limited, and more testing on the effectiveness of the app in familiarising students with the headwords would have been ideal.

Issues that have been more difficult than expected to overcome

This project necessitated collaboration between language specialists and subject experts. We had to explain to the Physics lecturers the importance of using corpora as reference when they created their definitions. They were highly skeptical at first when we insisted that the explanations should not be intuitive but rather drawn from various authentic sources. It was also time-consuming to have several rounds of discussions involving consultations of the

corpora for writing the explanations. The moderation of the examples and translations took more time than expected because the academics involved had to also fulfil the responsibilities of their full-time jobs.

New questions and avenues of research that have opened up

During the project, the app was shared with colleagues from various departments because the project team believed that such engagement would facilitate its reach to a larger audience and potentially inspire similar projects in other fields. After the app went live, it was shared with students and fellow academics who received it quite well. Faculty from other disciplines shared their interest in doing similar projects with us. One such discipline is Logistics Management, a programme which is popular in Oman and the region in general. Faculty members teaching this module mentioned that there are several technical words in this discipline that students struggle to master. They also pointed out that diagrams would be very useful accompanying the explanation of a headword as there are several pieces of equipment and components (e.g. *forklift, pallet, palletiser*) that students need to be familiar with.

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Future plans

Since faculty from another discipline have already shown considerable interest in applying the idea of a bilingual mobile app in their own discipline, our plan is to apply for funding to develop a large-scale project. A comprehensive glossary of terms in the Logistics discipline will be drawn up, not only based on suggestions from faculty but also from professional bodies in Oman, ensuring that employees also benefit from the app. This list will then become headwords of a specialized and comprehensive bilingual dictionary in Logistics.

5 CONCLUDING COMMENTS

This corpus-based Physics dictionary for L1 Arabic students will be useful for those just being initiated into the discourse of their discipline, especially those students for whom the language of instruction and assessment in this subject has previously been their mother tongue. Students of Engineering need to be familiar with an overwhelming amount of technical

vocabulary in their own discipline as well as in others, such as Physics and Mathematics. A bilingual discipline-specific dictionary, such as the one developed through this project, will support students to look up words very quickly through the mobile app. For time-poor students, this resource should be very convenient and useful.

Since the app will be made available free of cost, L1 Arabic students in Oman as well as in the MENA region and international students in other countries can benefit from the app. Further discipline-specific corpus-based dictionary apps can be created for other subjects depending on the student response to this one.

ACKNOWLEDGMENTS

Two subject lecturers were involved in the project, Dr Senthil Kumar and Dr Alya Al Farsi, both from the Department of Mathematics and Applied Sciences, MEC, Oman. They provided invaluable subject-specific input which included writing and translating the entries, and helping with piloting the app among students.

We would like to thank Dr Radhika S.N., from the Centre for Academic Writing at MEC, who helped in liaising with the subject lecturers to shortlist the final list of vocabulary items, doing the first phase of language editing for the definitions, and cleaning of the corpus.

Dr Ramalingam, Head of the Faculty for Information Technology at Majan College, Oman, guided the team regarding the technical requirements of the app, and liaising with the software team designing the app.

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