

# DEVELOPMENT AND EVALUATION OF INTERACTIVE PHARMACOLOGY TEACHING TOOLS IN ARABIC VS ENGLISH

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## Abstract

### Introduction

Innovative teaching methods embracing of technology are essential to help academics manage increasing pressures and facilitate student learning in the face of other competing interests. Pharmacology educators have adopted computer assisted learning (CAL) as flexible, interactive and visual approaches to optimise student learning, with the emphasis placed on student-focused learning and creation of independent life-long learners. However, for students with English as a Second Language (L2) comprehending drug mechanisms described in their second language is challenging. Transition from native language to English as the language of instruction has previously been shown to restrict students' ability to express their understanding, to discuss related scientific concepts and to interpret and analyse scientific questions. Therefore the aim of this preliminary study was to develop interactive pharmacology CAL tools in two languages (Arabic and English) in order to determine if the language of instruction influences student learning by comparing both student performance in terms of test scores and satisfaction.

### Methods

A computer-based flash animation describing diuretic mechanism of action was developed and narrated into two different languages (Arabic and English). The study group comprised students with Arabic as a native language and enrolled into the Health Faculty at Griffith University. Ethical approval was granted by the Griffith University Human Ethics Committee. Thirty six student volunteers were randomly allocated into two groups, English group (N = 18) and Arabic group (N = 18). Online summative assessment was used to evaluate student performance by using a multiple choice question (MCQ) quiz consisting of 12 questions. Student satisfaction with the tool was also measured using a 5-point Likert scale. Both groups received the same questions and were allocated the same time frame to complete the quiz. Time taken to answer each question and the quiz as a whole was also compared between the Arabic and English groups. Data were analysed statistically by t-test using SPSS software.

### Results

Performance as measured by mean test scores was not significantly different ( $p=0.79$ ) between the groups (Arabic group,  $M= 35.64 \pm 18.25$ ,  $n=18$ ; English group,  $M= 33.79 \pm 18.4$ ,  $n = 18$ ). However, the mean time taken (seconds) to complete the quiz for the group receiving the Arabic narration ( $M= 381.56 \pm 154.41$ ;  $n = 18$ ) was significantly quicker ( $p<0.05$ ) than that of the group receiving the English tool ( $M= 466.33 \pm 169.8$ ;  $n = 18$ ).

With respect to student satisfaction with the tool in terms of clarity there were no significant differences observed between the two groups (14 positive comments and 4 negative in each group). Furthermore, the same was trend was observed regarding the usefulness of the tool in making learning and understanding easier (13 positive and five negative comments in Arabic group compared with 16 positive and 2 negative comments in English one).

### Conclusion

The results of the present study suggest that material delivered in native languages may improve student's ability to recall information, despite not significantly influencing student performance. Surprisingly there was no clear preference for either tool. However, further studies with larger student cohorts are required.

# 1 INTRODUCTION

Innovative teaching methods, embracing of technology and responsive to individual student needs, are essential to help academics manage increasing pressures (including an increasingly diverse student cohort) and facilitate student learning in the face of competing interests [1].

The last period of the 20th century has seen a rapid expansion of the pharmacology knowledge-base, an increased understanding of the mechanisms of drug action, and an increase in therapeutic classes and drugs available for the treatment of disease [2]. It is essential to add this new knowledge into existing pharmacology curricula because of its relevance to contemporary clinical practice; however, no additional time is usually allocated for its inclusion [3]. It is likely that these aforementioned factors, in part, hinder student learning, prevent true comprehension and understanding, and restrict integration of the knowledge into a students' existing knowledge-base [3]. From experience, the effect of these factors is no more evident in those students with English as a Second language (L2). The Health Faculty at Griffith University has a large international cohort with the majority of these students being non-English speaking (Arabic native). These students, from experience, generally struggle to grasp complex pharmacological concepts with traditional formats of content delivery (*viz.* didactic lectures, workshops, tutorials). This is further evidenced by assessment scores and informal student feedback. Northway and Paul (1994) showed that students with English as a Second language (L2) require extra effort to comprehend mechanisms of drug action when taught in English as the language of instruction [4]. In addition, researchers have shown that the transition from native language to English as the language of instruction restricts a students' ability to express understanding, discuss related scientific concepts, and interpret and analyse related scientific questions [5]. It is suggested that the use of a student's first language in a well organised and resourced program could have great educational benefits, including improved performance [6].

Pharmacology educators have adopted computer assisted learning (CAL) and other E-learning resources as flexible, interactive and visual approaches to optimise student learning, thereby helping to place emphasis on student-focused learning [7, 8]. It is proposed that this technological shift could help pharmacology educators overcome these challenges and meet the growing needs and expectations for higher-quality education [3], whilst encouraging student-focused learning and developing independent life-long learners [9]. Many claims are made regarding the potential benefits of E-learning and CAL tools. Researchers argue that CAL has the potential to increase students' knowledge and understanding of a particular subject, and allow them to direct their own learning [10]. It is proposed that CAL provides flexible learning opportunities to students, allowing them to learn when, how (learning style, assessment type, collaborative or independent learning), what (content) and where (place) they want [11]. Many CAL tools have been implemented and evaluated in dental, health science and nursing curricula and continuing professional education [2, 12, 13].

The aim of this preliminary study was to develop interactive pharmacology CAL tools in two languages (Arabic and English) in order to determine if language of instruction influences student learning by comparing both student performance in terms of test scores and satisfaction.

## 2 METHOD

This investigation was conducted into five phases:

### 2.1 Phase one (literature review)

A literature review was performed to locate studies that compared the benefit of CAL tools to conventional teaching methods, assessed student performance, or assessed the effect of language of instruction on student learning. Only those articles or resources in the field of health science education were further considered. Sourced resources were critically evaluated to define the pedagogy of CAL and aid in the rational development of tools in this study. Four different computer databases were searched, including: MEDLINE (via Ovid); PubMed; Informit Search; and A+ Education. Keywords used consisted of the following: computer assisted learning; CAL; E-learning; blended learning; computer-based instruction; web-based instruction; online education; performance assessment; formative assessment; summative assessment; MCQ; English as a second language; bilingual education; and native language.

## **2.2 Phase two (Development of CAL)**

The pharmacology of diuretics was chosen as the content area for this study due to the complexity and subtle differences in the actions of various drugs. The main objective of the CAL was to educate students on the pharmacodynamic mechanisms of diuretic action. The animation was constructed in PowerPoint™ and the relevant narration included (Arabic and English). All images used in the animation were obtained from Servier Medical Art and both animations contained brief subtitles to summarize the important points in each slide. The resultant file was then converted into a flash animation format using iSpring Pro™. Drawing students' attention to the major points and adding voice-over describing what is happening was previously found to have dual advantage of conveying information via more than one of the senses [14].

## **2.3 Phase three (Assessment)**

Online multiple choice questions (MCQs) summative assessment was chosen to evaluate students' performance. The literature strongly supports the use of MCQ's to assess factual knowledge (e.g., knowledge of terminology and knowledge of specific details and elements) according to Bloom's revised taxonomy [15, 16]. However, carefully constructed MCQs are also able to assess conceptual knowledge (e.g., knowledge of classifications and categories, knowledge of theories, models and structures, and knowledge of principles and generalisations) according to Bloom's revised taxonomy providing information about a student's higher level of comprehension and understanding [16, 17]. Consequently, MCQ tests can be authentic performance-based measures to assess the depth and breadth of knowledge [17].

In order to assess student performance, a quiz, containing 12 well constructed MCQs ranging in complexity, was developed using Question Writer 3.5™. All questions were designed to test primarily factual knowledge with some assessing elements of conceptual knowledge [18]. The developed quiz was embedded into the flash animation for delivery. The CAL was then burned to CD and randomly distributed to students on the day of investigation and then recollected at the end of the session. The time taken to answer each question and total time taken to complete the quiz were considered important variables for comparison between the Arabic and English groups. Both groups received the same questions in English and were allocated the same maximum timeframe to complete the quiz, however, no minimum time restrictions was set.

Student satisfaction with the tool was also measured using a 5-point Likert scale (strongly agree, agree, no comment, disagree and strongly disagree), in this way, both the effectiveness of the instruction language and the student's satisfaction (and hence motivation to learn) was assessed.

## **2.4 Phase four (Recruitment)**

This study was conducted at the Griffith University, Gold Coast campus. Ethical approval was granted by the Griffith University Human Ethics Committee. Students with Arabic as native language enrolled into Health Faculty programs at Griffith University were verbally invited to participate in the study. Participants included students from the Pharmacy and Nursing schools who had previously completed a foundation (fundamental) pharmacology course. Students were randomly allocated either to the English group (N = 18) or the Arabic group (N = 18). Results and feedback obtained were anonymous.

## **2.5 Phase five (Statistical Analysis)**

Data analysis was performed using SPSS software (version 17.0). Quantitative data was presented as the mean ± standard deviation (SD) where relevant. Paired t-test was used to compare the quiz results of the two groups. Descriptive statistics and paired t-test were used to compare performances and responses between the two CAL study groups. A  $p < 0.05$  was considered statistically significant.

## **3 RESULTS**

The final CAL tool developed was a flash animation illustrating and describing mechanisms of diuretic action narrated into two different languages (Arabic and English) with an embedded summative quiz which automatically recorded student responses and delivered results to a designated email address. The resultant flash animation importantly allowed students to easily control the pace and progress of the presentation. An example screen capture of the developed animation is presented in figure 1.

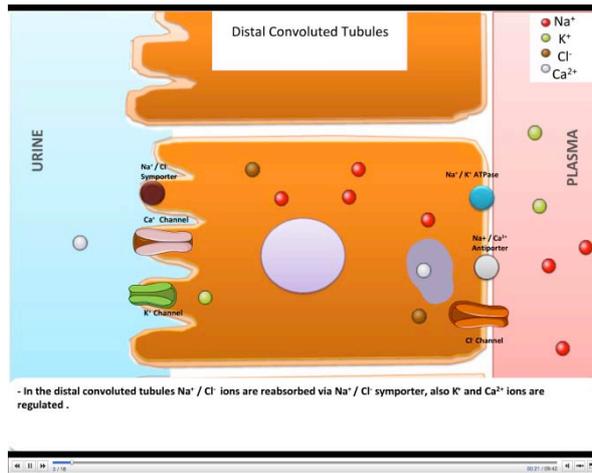


Figure 1. Example screen capture of developed diuretic CAL

A total of 36 students participated in this study (N=18 in each group). All students viewed the tool and completed the embedded quiz within the allocated time period, without experiencing any technical difficulties. Both groups completed a 12 MCQ quiz to assess performance. Figure 2A shows student performance (% correct answers) for individual answers. Performance was mostly the same for the majority of questions, with exception of those questions which were deemed to be more complex (i.e., testing conceptual knowledge). The students in the Arabic CAL group performed considerably better in these questions (Q5, Q6, Q8 and Q9). Figure 2B provides a summary of total student performance for the quiz. Marks distributions were comparable between the groups, with no significant statistical differences observed. Performance, however, tended to be higher in the Arabic CAL group. The highest percentage of 77.8% was achieved by a student in the Arabic CAL group. In comparison, the highest percentage obtained by a student in the English CAL group was 72.2%. Similarly, the lowest score was obtained by a participant from the English CAL group (5.5%). In comparison, the lowest score obtained in the Arabic CAL group was 16.6%.

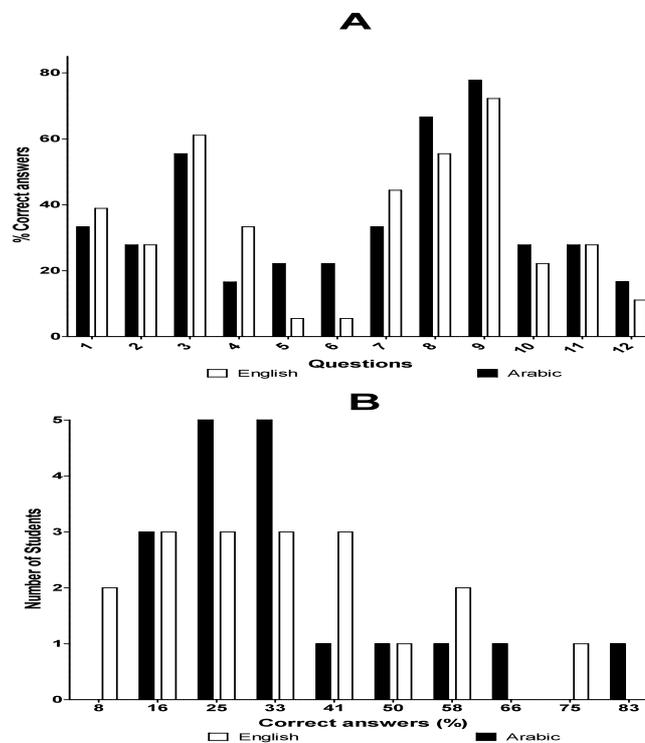


Figure 2. (A) Students' performance in the quiz. 12 MCQs were used to estimate participants' performance after watching the CAL. Both groups (N=18 in each group) received the same questions and allocated the same timeframe. Bars represent the percentage of the correct answers of the two groups. (B) Mark distribution of the study.

The results for the statistical comparisons between CAL group performance and time taken to complete the quiz is presented in table 1. Performance as measured by mean test scores was not significantly different ( $p > 0.05$ ) between the groups (*Arabic group*,  $M = 35.64 \pm 18.25$ ,  $N = 18$ ; *English group*,  $M = 33.79 \pm 18.4$ ,  $N = 18$ ). In contrast, the mean time taken (seconds) to complete the quiz for the group receiving the CAL with Arabic narration ( $M = 381.56 \pm 154.41$ ;  $N = 18$ ) was significantly faster ( $p < 0.05$ ) than that of the group receiving the English CAL tool ( $M = 466.33 \pm 169.8$ ;  $N = 18$ ).

**Table 1.** Comparison between students' performance and time taken to complete the quiz in each group using t-test

Performance <sup>#</sup>	Mean (SD)	95% CI	t value	p (2-tailed)
<b>English Group</b>				
(N =18)	33.79 (18.40)			
<b>Arabic Group</b>		-16.93 to 13.22	-0.26	0.799
(N =18)	35.64 (18.25)			
<b>Time<sup>##</sup></b>				
<b>English Group</b>				
(N =18)	466.33 (168.79)			
<b>Arabic Group</b>		15.17 to 154.3	2.57	0.02*
(N =18)	381.56 (154.41)			

# Mean represents % of correct answers, ## Mean represents time in seconds, \*  $p < 0.05$  significant

Table 2 outlines the student's satisfaction with either CAL tool and table 3 describes the statistical comparisons between the CAL groups. No clear differences were reported between the two groups (14 positive comments, 1 neutral, and 3 negative in each group) when assessing student satisfaction.

**Table 2.** Participants' response regarding satisfaction and usefulness of the CAL

Students' satisfaction	Positive (N)	Neutral (N)	Negative (N)
<b>English Group</b>			
(N =18)	14	1	3
<b>Arabic Group</b>			
(N =18)	14	1	3
<b>Usefulness of the tool</b>			
<b>English Group</b>			
(N =18)	13	2	3
<b>Arabic Group</b>			
(N =18)	16	1	1

The Likert scale used was from 1= strongly disagree to 5 = strongly agree. Numbers reported here were obtained by combining responses of 1 and 2 (strongly disagree and disagree are reported in as negative) and responses 4 and 5 (agree and strongly agree are reported in as positive)

More students in the Arabic group responded positively when asked if the CAL tool was considered to be a useful learning aid (13 positive, 2 neutral and 3 negative responses in Arabic group compared with 16 positive, 1 neutral and 1 negative response in English CAL group). Responses for participants' satisfaction of the CAL as measured by mean test scores was not significantly different ( $p>0.05$ ) between the groups (*Arabic group*,  $M= 3.8 \pm 0.98$ ,  $N=18$ ; *English group*,  $M= 3.9 \pm 1.05$ ,  $N = 18$ ). The same ( $p>0.05$ ) was noticed for students' comments on the usefulness of the CAL (*Arabic group*,  $M= 4 \pm 1.13$ ;  $N = 18$ ; *English group*,  $M= 4.3 \pm 0.82$ ,  $N = 18$ ).

**Table 3.** Comparison between participants' responses regarding satisfaction and usefulness of the CAL

Satisfaction	Mean Response (SD)	95% CI	t value	p (2-tailed)
<b>English Group</b> (N =18)	3.9 (1.05)			
<b>Arabic Group</b> (N =18)	3.8 (0.98)	-0.45 to 0.67	0.41	0.68
<b>Usefulness</b>				
<b>English Group</b> (N =18)	4.3 (0.82)			
<b>Arabic Group</b> (N =18)	4 (1.13)	-0.33 to 0.88	0.96	0.35

## 4 DISCUSSION

The main aim of the present study was to develop interactive pharmacology CAL tools narrated in Arabic and English and evaluate the contribution of instructional language to student learning. All participants were native Arabic speaking, with basic foundation pharmacology as a background.

Whilst the majority of participants in both groups were generally satisfied with the quality of CAL, and found it useful for explaining the mechanism of action of the diuretic drugs there was no significant benefits on student performance. However the Arabic CAL did improve time taken to complete the quiz compared with the group receiving the English CAL. This suggests that using a native language in instruction may enhance comprehension of the material and therefore quicker recalling of the information. This finding is supported by a previous study showing that students' content knowledge in their native language increases the amount of comprehensible input [19]. Further supporting evidence can be provided by a Connor (1984) who examined the differences in recalling information from a written passage between first and second language readers. This author discovered that participants who read the passage in their first language recalled more information than those who read it in their second language [20]. Furthermore, students' ability to learn depends on the amount of input they receive in the language, which is not dependent only on exposure to the language but appropriate teaching techniques [19]. These techniques were followed in that the CAL was student-focused with the objectives matched the expected outcome. The main objective of the CAL was to educate the participants about diuretics different mechanism of actions and then test their understanding with the MCQs quiz.

Student satisfaction in this study can be explained by the fact the design of the CAL was informed by sound pedagogy. Students' attention was focused on the major points and to the narration explaining

the visual depiction of diuretic mechanism of action [14]. Dual encoding including both visual and audio stimuli has previously been established by many education scholars to have added advantage of conveying information via more than one of the senses [14, 21, 22]. Mayer and Anderson (1992) developed an animation explaining the operation of a bicycle tire pump, along with concurrent oral narration of the steps involved in the process concluded that contiguity of words and pictures during instruction encourage students to build connections between verbal and visual information, which enhances learning and user experience [21].

However despite student satisfaction and enhanced comprehension of drug mechanism, as evidenced by quicker response times to questions students in the Arabic group did not perform any better than those in the English measured using MCQs. All of the questions utilised in this study were designed using the principles of Blooms revised taxonomy to test both factual knowledge and conceptual knowledge [18]. The results demonstrated no clear difference in performance between the groups. These results are supported with findings from previous studies. Although the benefits of bilingual education (BE) are widely accepted among educators and supported by a large body of empirical research and evaluation studies [5, 6, 23] other researchers suggest that BE teaching has no significant effect in improving either students' learning or performance. Those researchers discovered that BE students performed worse than students in monolingual group in some areas. In addition they claimed a lack of evidence for either long-term advantages or disadvantages associated with BE programs versus monolingual English ones in improving students' performance [19, 23, 24]. Alternatively, individuals in favor of BE assert that instruction in the two languages allows for cognitive skill development in the minority language; which eventually transfer to the English-speaking domain of the student [23]. The theoretical foundation of successful bilingual instruction is also widely accepted by the educational community [19]. It is based on the assumption that there is an interdependent relationship between language development and cognitive academic skills. Research into English as a Second language (L2) acquisition processes in academic settings indicates that learning takes place when language and concepts are linked in meaningful ways to produce growth in knowledge and competency in using the language to communicate knowledge and ideas [19]. These linguistic and cognitive skills develop over time when the learner receives adequate amounts of comprehensible input [19]. Furthermore, some supporting research suggests that students who participate in BE programs have relatively higher exam scores than limited-English-proficient (LEP) students immersed in monolingual-English classes [23]. However this was not clear in our investigation as there was no significant difference between both groups in performance. A possible explanation for a lack of benefit may be related to the small number of participants in the study. Another explanation could be the inability to examine the homogeneity of the students by not administering a pre-intervention test to evaluate participants' prior learning experience. Participants included in the present study were demographically diverse and enrolled into different course with the health school (Pharmacy and Nursing). Therefore there is a strong possibility that their basic foundation pharmacology was not equivalent.

In addition, the distribution of the grades showed that the majority of participants in both groups did not achieve the pass mark of 50%. An explanation could be that even the participants have basic knowledge of pharmacology from previous university studies; this knowledge could have potentially been overestimated. Furthermore MCQ questions in this study were designed to challenging student comprehension of the content with every effort made to exclude guessing by recognition of terms and therefore the process of elimination. As discussed by Harper (2003) well designed MCQs can be used to assess a variety of outcomes including all of the competencies in Bloom's taxonomy [16].

Finally, although student preference for either tool was not statistically significant the trend suggested greater satisfaction with the Arabic CAL. Informal interviews were conducted with the students to discuss their preferences and to our surprise the majority of them explained that English was the instructional language used in all course at their previous university studies were in English. Therefore the English group found no difference in listening to the English narration while the Arabic group found the narration unusual but helpful in recalling the information easily evidenced by the significantly quicker time taken to complete the quiz compared to the English group. However recent evidence suggests that online tools delivered in English may enhance the English communication skills in non-English speaking students [25]. Although not investigated in the present study this needs to be considered in future studies of this nature.

## 5 CONCLUSION

The results of the present pilot study suggest that material delivered in native languages may improve student's ability to recall information, despite not significantly influencing student performance. Surprisingly there was no clear preference for either tool. However, this was a pilot study and further studies with larger student cohorts are required. Furthermore comparisons between lecture CAL and groups receiving no intervention need be included and a pre-intervention performed to ensure homogeneity of the comparison groups.

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