

Mathematics Performance and its Relation to English Language Proficiency Level of Bilingual Arab University Students

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Abstract

Many universities in the Arab world are gradually becoming English medium universities in place of their traditional Arabic mediums. Therefore, students are now learning mathematics in English - a second language which the students are currently acquiring. Understandably, both the teachers and students usually experience some problems in teaching and learning mathematics due to these changes from their native language to English. This article investigates the relationship between language proficiency and mathematics performance among bilingual Arab university students. The finding in this study indicates that the students' proficiency levels in English are a factor affecting their performance in mathematics. However, we found a mixed response among student perceptions on whether the change of language of instruction from Arabic to English has any impact on their mathematics understanding and performance. The study confirmed the findings of many similar studies, and paves way for further investigation.

Keywords: Bilingualism, Bilingual Arabs, Instruction, Language, Mathematics

1. General Introduction

Arabic is the official language in the Gulf countries, and the main medium of instruction in most schools in the region. However, the last two decades have witnessed an apparent increase in the use of English as a medium of instruction, especially at the university level in the region. This might not be unconnected with the current globalization and the rapid economic growth in the region due to global oil and gas dependence.

In order to meet this economic challenge in these countries, many universities and higher institutions are being established. Foreign faculty, especially those with higher degrees from the West are employed to teach in these universities. A good number of these foreign faculty members are non-Arabs, and most of those who are Arabs did their higher education in the West, where

English is a medium of instruction. In addition, promising young college graduates from these countries are usually sent for higher studies in North America and Europe. Furthermore, most of the recommended textbooks in these universities, especially in the field of science, engineering and medically oriented courses are written in English. All these are parts of what is necessitating the increase in the use of the English language as a new language of instruction at the university level in the region.

King Fahd University of Petroleum and Minerals (KFUPM), where this study was conducted, is the first university in Saudi Arabia to use English language as a language of instruction. KFUPM was established five decades ago as a Petroleum College by the Saudi Arabian Petroleum Company with the aim of providing middle class manpower to the company. The university has grad-

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ually metamorphosed into a full-fledged autonomous university and has adopted a culture of using English as the official language of instruction. The university is now considered as one of the best universities in the Middle East in terms of high academic standards. It has also been ranked several times among the top five hundred universities in the world, and a source of professional employees for many multinational companies in the region.

In comparison to graduates from other universities in the region, KFUPM graduates have high chances of gaining useful employment with reputable companies that provide substantial remuneration packages. The main reason for this advantage is the fact that apart from the high education standards which KFUPM provides its students, the graduates are also able to communicate fluently in English. The duo of socio-economic and epistemological access³⁴ has given KFUPM an edge over other universities not only in Saudi Arabia, but also in the whole of the Middle East. Because of this, KFUPM is now serving as a role model to many new universities in the region.

However, despite the fact that English is increasingly being accepted as a language of instruction in many universities in these countries, there is little or no information on how predominantly Arab students from Arabic medium school backgrounds are learning mathematics in English⁶. In particular, not much is known about how this class of students is coping with the language switch. In addition, the impact of the language switch on the teaching and learning of mathematics in this context is equally unclear. It was only recently that the language issue as it relates to mathematics was raised for this class of students, and potential area of conflict highlighted⁴².

Therefore, using extensive data, this research investigates the effects of English language proficiency on student performances in mathematics. It is the first of its kind to be undertaken in the region. The findings have the potential to contribute significantly to ongoing national and international debate in this area of mathematics education. It is also anticipated that this research will provide opportunities for building more reliable theories in the area of mathematics education and particularly in this context, will generate more research interest in the area.

1.1 The Context of this Study

This study was conducted at KFUPM in Saudi Arabia which is a typical example of an English Language medium university in the Gulf region. However almost all

of the annual student intakes of KFUPM are from Arabic medium high schools.

It is worth noting that the language of instruction at the primary and secondary school level in Saudi Arabia is also in Arabic. Not only mathematics, but all other subjects are taught in Arabic. The English language is usually introduced much later - in secondary schools, and is taught as a stand-alone subject. It is so isolated that there seems to be little or no internal or external motivation to study it at that level. The students have received practically all of their twelve-years of instruction in Arabic. The mathematics registers are fully developed in Arabic and are utilized at the teaching, learning and research levels.

Additionally, the Arabic language is the official language for government operations in Saudi Arabia; it is the first language of the students, and therefore, the language students interact with at home, on the street, in markets or during religious gatherings. It is under these circumstances of a glaring deficiency in English language use and practice that these students gain admission to KFUPM - an English medium university - and are required to learn mathematics using English.

In order to smoothen out the transition, students who are admitted into English medium universities have to undergo a one year intensive English program. During this intensive English language program, the students also have to take two pre-calculus algebra courses. These courses help the students to review some of the high school algebra topics that are needed in calculus and also introduce students to learning mathematics through the medium of English. Hence, the students have the opportunity of learning English and at the same time use the language to learn mathematics. As expected, during the preparatory year, even though the students have been carefully selected, a good number of them face problems in mathematics despite the fact that the materials have been fully covered in high school. One factor that compounds the difficulty is apparently due to the students' lack of mastery of the new language of instruction. It has been aptly observed that expecting students to learn a new and difficult subject through the medium of a second language is unreasonable, as the process entails a double task for the students: the acquisition of two conceptually difficult and different skills at the same time¹⁹ (Brodie, 1989). They are also challenged because the dominant language of this class of students is Arabic, and English is only the language of the classroom. Therefore, the language learning might not be rapid, and there is a high possibility that

these students may experience subtractive bilingualism which may have some negative impact on their mathematics learning (Riordain, 2010). Furthermore, a one year intensive English program is found to be inadequate to learn a new language and effectively use it for academic activities¹⁴.

Students come to the Preparatory Year Program with diverse English backgrounds and abilities, so recently the Preparatory Year English Program has introduced placement exams to all new students. Prior to that, students were usually given promotion exams, those who passed (usually 5%-10%) were exempted from prep year English program, while others were treated uniformly as a group. However, now with this new development, students are categorized into six groups based on their English language proficiency levels: the first group is made up of those that are proficient according to the university standards and hence, are exempted from any prep year English program. The second category is for those who are partially proficient, but not enough to meet the university's requirement. This class of students is divided into two, and is placed in the second level of prep year English language (A and B). The remaining students will have to do the full Preparatory Year English Program, and are categorized into three groups (A, B or C) based on their proficiency levels. We shall elaborate more on this in the methodology section of this paper.

Now that the students are categorized in a more refined manner based on their English proficiency levels, this study is able to investigate whether, and to what extent, these levels of proficiency in the language of instruction contribute to their achievements in mathematics.

1.2 Language Proficiency and Mathematics Achievement

The most fundamental and most asked question in the area of language as it relates to mathematics is, does bilingualism or multilingualism have any effect on the students' mathematic achievement? This question is most frequently asked by teachers, policy makers and researchers⁷. Several studies have been conducted with the aim of answering the question. Some of these studies cut across various race, ethnicity and social classes^{33,37}, different countries and culture^{8,10,12,22,25} (Riordain and O'Donoghue) and students' educational levels^{5,21,28,29}. Furthermore, the studies were conducted using different perspectives and approaches such as comparing the following: monolin-

gual versus bilingual students who study under the same medium of instruction^{10,11}; students who study in the medium of a foreign language (English) versus those who study in their local language^{20,36}; and students who study in a language switch mode – in a medium using both foreign and local languages^{15,23,26}. Other studies investigate the role of the proficiency level of students in their first language as compared to the language of instruction^{16,17} (Clarkson, 1991); and the students' performance in word problems stated in their first language as compared to word problems stated in the students' second language^{2,8,12,30}.

Educational researchers' findings in all these studies, though inconclusive, tend to agree that language proficiency is one of the important factors influencing bilingual students' performance in mathematics^{33,37}. And bilingualism can be an advantage or disadvantage to the student depending on the proficiency level of the students in the two or more languages¹⁴. However, the deficit model for bilinguals has since been rejected and is now considered to be outdated by many scholars^{3,7,12}.

In this section we review some of these studies in their diversity of approach and context. For instance, in the USA, not many researchers have shown interest in following this trend of the effect of language proficiency on mathematics achievement³⁷. However, the findings of a number of studies that looked into the issue since then^{1,13,21} (Padilla, 2011; Calderon, 2001) indicate that the students' language proficiency has an impact on their mathematical performance.

In the UK, Philips and Birrell²⁹ compared the performance of students in the English medium who are native English speakers with Asians whose English is a second language. The performance of the Asian students in mathematics was far below their native English-speaking peers and also below the national mean. Further analysis of the examination items indicated that language factors were responsible for the low performance of the students.

Another study was conducted in the Wales where the students have different linguistic backgrounds. Some attended Welsh medium schools while others were taught in English¹⁸. It was reported that students in Welsh-medium schools performed better in mathematics than those in English-medium schools. Language factors were reported to contribute to these differences¹⁸. In a similar study, Roardria (2010) conducted an intensive study in Ireland on students whose local language is Gaelic. The study found out that students in the transition from a

Gaelic medium primary level education to an English-medium second level mathematics education experienced a disadvantage of 8.7 percent in performance on mathematical word problems. A significant relationship was also found between the students' performance on mathematical word problems through the medium of English and their Gaelic language proficiency. Furthermore, it was found that students with a high level of proficiency in both languages, and those who were predominantly proficient in Gaelic performed mathematically better than their monolingual peers.

In French immersion programs in Canada, Bournot-Trites and Reeder¹⁰ found that the group with high intensity French instruction outperformed the monolingual groups in mathematics and science. It was noted that by the time the students got into grade 6 they outperformed their monolingual counterparts in all skill areas (Swain, 2005). Therefore, overall, Canadian students have experienced positive benefits from participating in French immersion programs. Some other studies have found that the immersion students performed at a comparable level with English program students³⁸ (Swain, 2005).

In New Zealand, Barton et al. conducted a series of studies under a sociolinguistics framework with the aim of investigating students who were learning mathematics using English as a second language. The research which outlined the interplay between the language proficiency level and the students' performance at the university level found that, due to language difficulty, this class of students experienced a disadvantage of about 10 and 15 percent in mathematics. These researchers also found that students learning mathematics through English medium as a second language encountered greater difficulties with text than anticipated, and as such they wrongly relied more on symbolic modes of working⁵. Surprisingly, it was found that these second language mathematics learners were unaware of their disadvantage (Barton, Chan, King, Neville-Barton and Sneddon, 2005).

1.3 Language, Mathematics and Bilingual Arabs

As far as the language of learning and teaching is concerned, Arab students can be divided into two groups: 1) Those who are living or studying in predominantly Arab countries such as Saudi Arabia, Jordan, Yemen and Egypt and 2) Those who are living or studying in non-Arab countries such as the USA, Canada, Australia and the UK.

The first group is largely monolingual and the educational system is an Arabic medium. Hence, the home language is the language of instruction, and is the same language students use in their daily activities in their communities. Taken into consideration that mathematics has a long history with the Arabic language, and that mathematics registers are well developed in Arabic, there seems to be less of a language issue as it relates to mathematics to investigate in this context. However, English is now being introduced in the curriculum of many of these countries as an additional language, and many universities in the region are gradually changing to an English medium of instruction. Hence, there are some students in the first group learning mathematics in their second language - English.

The second group consists largely of immigrants. This class of Arab students usually has to immerse him or herself into the language of the community in which they find themselves, as well as learning mathematics in the second language.

Consequently, there are two groups of Arab students who are learning mathematics in their second language. That is, Arab students in some universities in the Arab world, as well as Arab students in non-Arab countries. Although globally, there is a renewed interest in language issues as they relate to mathematics education, information is scarce on both groups of Arab students. For instance, Arabs are among the people who have a large immigrant population in many Western countries, yet only a few studies have been conducted about the Arab students with respect to language and mathematics. Likewise, not much is known about how bilingual Arab university students in the Arab countries, who are learning mathematics in English, are coping with the language switch.

This section reviews some of the studies for both the subtractive and additive bilingual Arabs as they relate to mathematics teaching and learning. The additive Arab group is that which is currently found in some (English instruction) universities in the Arab world, and is the main focus of this study. One of the major problems students are facing in this context is largely due to a lack of proficiency in the new language of instruction – English. However, the philosophy of the language switch from Arabic to English is not well articulated, and, to the best of our knowledge, there are no studies that have been conducted with the aim of developing good teaching strategies to alleviate this problem.

Among the early studies that have pointed to the role of English proficiency in a student's performance in mathematics in this context was conducted by Yushau³⁹. In this study, English language proficiency was found to be among the major factors that predicts student performance in mathematics. This study was conducted with pre-calculus students, and followed up with studies which confirmed that the result is the same for Calculus⁴⁰, and for exemption criterion²⁷. Earlier, a teaching intervention was initiated with the aim of minimizing the students' language problems⁴¹. After more than a decade of teaching this class of students, the first author highlighted the language situation of this class of students⁴². In the paper, he gave some anecdotal evidence that indicates some potential areas of difficulty for this class of students. The present paper attempts to investigate the language issue empirically with much more extensive data, and isolating other factors, to see if there are any relationships between student achievements in mathematics and the level of their proficiency in English. The study is the first of its kind, and it is hoped that the result will bring forth more information in this context of the bilingual Arab, and leading to further studies in this area of research.

Research that involves immigrant Arabs is sparse and most appear to have been conducted by Arab PhD students who were looking for data for their thesis rather than a genuine concerted effort to address the problem. That is why in most cases, there is no follow up to such studies. A few of the existing studies on this class of Arab students is reviewed in this section.

Dakroub¹⁶ investigated the relationship between Arabic literacy and academic achievements in English reading, language and mathematics of Arab-American middle school students in a suburban Southeast Michigan. Results from the analyses confirmed that a significant positive relationship exists between the achievement of Arab-American middle school students in English reading, language and mathematics and their level of literacy in the Arabic language. Students who were classified as having high levels of literacy in the Arabic outscored subjects with low levels of Arabic literacy on measures of academic achievements in English reading, language and mathematics. These findings are inconsistent with Cummin's¹⁴ hypothesis, but are in line with other findings on studies conducted in other languages such as Spanish, French and Vietnamese.

In the same line of research, ³² was interested in how bilingual Arabs in the USA responded to mathematics word problems in either Arabic or English. She was interested in knowing whether the students' proficiency levels in the two languages have any effect on their performance in solving word problems in Arabic or English. It was found that Arab-American students performed significantly better in the English version of the word problems. Furthermore, Arab-American students with higher levels of Arabic proficiency performed better in the Arabic version of the word problems.

On the other hand, Zamlut⁴³, examined if there are any significant relationships between Arabic language proficiency and English language proficiency. A significant relationship between Arabic language proficiency and English language proficiency was found. However, no significant relationship was found between Arabic language proficiency and achievement in academic sciences.

AL-Fadley⁴ investigated the influence of formal education in the Arabic language, and the effect of English language proficiency and academic achievement in mathematics of Arabic-speaking students. The study found that there was no significant relationship between schooling in Arabic and English language proficiency. It was also concluded that there are no significant relationships between schooling in Arabic and academic achievement in mathematics.

2. Methodology

It was stated earlier that the current trend in higher education in the Gulf countries is towards English as a language of instruction in place of Arabic. This is despite the fact that the students have a weak background in English as a result of twelve years of Arabic medium instruction in primary and secondary school. Because Arabic is different from English in many aspects, there may be a high possibility that these differences will affect the teaching and learning of mathematics. However, the relative strength in which these differences influence mathematics learning and teaching is not known. This paper investigates the relationship between the students' mathematics achievement and their proficiency levels in English as the new language of instruction. This section of the paper highlights details of the methodology of the study. Additionally, the study examines the students' per-

ceptions of the lack of proficiency in English as it relates to their mathematics understanding and performance.

2.1 Participants

All students admitted to KFUPM for the 2010 and 2011 academic sessions comprise the data for this study totaling more than three thousand students. The participants were native Arabic speaking male students with an average age of 18 years, mostly fresh from high school. Because KFUPM is a highly competitive and selective institution within the Kingdom of Saudi Arabia, the majority of students admitted to KFUPM rank above the 90th percentile in their national secondary school final examinations. In addition to their high school rank, the students must have passed with high scores in the two admission exams on aptitude and achievement. Therefore, the newly admitted students are largely considered as the “cream” of Saudi secondary school graduates. Almost all of these students have Arabic as their first language as well as the language of instruction in their primary and secondary schooling. Most of them have very little English background but at the time of admission, the language of instruction is changed to English and the rigor of the program is far greater than what they have been accustomed to in secondary schools.

2.2 Data

The data for this study was collected longitudinally from the Fall of 2010 semester to the Fall of 2011 semester, comprising 2 academic sessions. Student scores on a placement examination at the entry level, letter grades for ENG 001 (the first English course for the newly admitted students at KFUPM) and MATH 001 (the first mathematics course for the newly admitted students at KFUPM) for all the students were recorded and used as part of the data of this study.

2.3 What is Meant by Language Proficiency in this Study?

KFUPM is an English medium university with almost its entire student intake from Arabic medium schools. Therefore, the university sets an English language proficiency level that each student is required to achieve before he can start any of the university programs. These are:

- a) A score of more than 500 in the KFUPM-ITP TOEFL at placement,

- b) an IBT TOEFL score of 63,
- c) an IELTS score of 5,
- d) or completion of the Prep Year English Program (which requires passing in two courses ENGL 001 and 002).

Although most of the students are from Arabic backgrounds, their English proficiency levels vary substantially. Therefore, to distinguish between these different language proficiency levels, all new students are given the chance to take a placement examination known as the KFUPM-ITP TOEFL in the orientation week. This test is conducted for course placement and promotion purposes. Previously, the result was fail or pass. That is to say that any student who got a certain minimum score would be promoted, or approved to take University English courses, while those who did not achieve the minimum score would have to go through a one-year preparatory year English program. However, it was noticed that the variation between the remaining students who did not pass was substantial. As a result, a new criterion was developed in order to classify the students further. In the new approach, students are categorized into three groups based on their performance in the placement exam. The first group is the ones who get more than 500 points on the TOEFL or one of the other equivalent criteria mentioned above. This class of students is exempted from preparatory year English, and they are to start the University program directly. The second category consists of those who got 400 – 499. These students have some background in English but not enough to start a degree program at KFUPM. These students will skip the first course and will go to the second course of preparatory year English and are to study for one whole semester. The group (doing only the second course) is further divided into A and B. The third category is made up of the ones who score below 400 points and this group needs to do the preparatory year English program completely. This third category is further divided into three groups; A, B and C. For these students who undertake the complete preparatory year program, the courses consist of three major components: Communications, Skills, and Independent Learning, and cover all aspects of language skills: Speaking, Reading and Writing. Details of these components can be found at the site http://www1.kfupm.edu.sa/pyp/general_overview.html.

With this background, English language proficiency level is measured in this study at two levels: at the entry level, using the placement exam score, and at the end of

the first semester, using the students' prep. year English program grades.

2.4 What is Meant by Mathematics Achievement in this Study?

At the preparatory year level, while the students are learning English, they also take two pre-calculus algebra courses. As discussed, we are interested in seeing if there is any relationship between the students' proficiency in English and their mathematics performance. These mathematics courses are taught in English. In addition to homework and class quizzes, students take two major exams and the final. The majority of the students' grade is based on these two coordinated major exams and final. The three scores account for 76% of a student's course grade. The remaining (24%) are for the quizzes, homework and a class test. The three major exams are multiple-choice in format and they are common exams for all students. The exams are developed using standardized criteria, with blooms taxonomy levels for cognitive processing and with reliability as in Table 1 below. From the Reliability column (which provides the Cronbach coefficient alpha), we can see that the test scores are fairly reliable (at least 0.70) for exams that are of these test lengths.

However, it should be noted that apart from the two major exams and final, all other aspects of the assessment (Quizzes, Class Test and Homework) are of a written type. In this study, the final course grades of the students in

these exams serve as their mathematics achievement.

2.5 Procedure of the Analysis

To investigate the relationship between student proficiency level and mathematics achievement, the chi-square contingency test procedure was utilized. We used the number of students in each category below to compare for this study.

- TOEFL (placement) Results of all the entry level prep year students in the Terms 101 and 111 were obtained.
- Similarly, the results of Math 001 of all the students in the Terms 101 and 111 were obtained.
- Grades of all students in English for term 101 and 111 were also obtained.
- Various chi-square contingency statistical techniques were used to analyze the data to see if there was any relationship between (1) and (2), then between (2) and (3). The results are discussed in the next session.
- In addition to this quantitative analysis, we measured prep year students' qualitative perceptions of their understanding and performance in mathematics in the English medium via a survey. The results of the survey are also reported in the next section. The survey was translated into Arabic, and was given to the students in both Arabic and English.

Table 1. Statistical characteristics of Exams in MATH001

Term	Exam	n items	Mean	SD	Reliability
101	Major 1	20	12.947	3.984	0.788
101	Major 2	20	14.388	3.639	0.776
101	Final	36	20.68	7.788	0.89
111	Major 1	20	13.214	3.782	0.749
111	Major 2	20	13.214	3.782	0.749
111	Final	36	21.473	7.724	0.89

3. Results and Discussion

In this section, we discuss the results of the study as well as the survey conducted to ascertain the students' perceptions of the effect of learning mathematics in their second language on their understanding and performance in mathematics. Tables 2 through 5 provide summaries of the longitudinal results while Tables 6 and 7 provide results for the survey. Table 2 below provides the number and percentage of students who were admitted to King Fahd University of Petroleum and Minerals in the 2010-2011 and 2011-2012 academic sessions. The table also indicates those students who were (fully) promoted to ENGL101, those who were (partially) promoted to ENGL002, and those who were just beginning the preparatory year English program, and hence were taking the preparatory year course, ENGL001.

From this table, it is clear that most students (around 80%) enroll in the first preparatory year English course (ENGL001), without being promoted to the next English course. This goes to show that a large majority of the students have inadequate English skills to start any program in an English medium university like KFUPM. Therefore, they must undergo at least a one year course in preparatory English at KFUPM. The table also shows that there are about 13% of the students who have partial English language proficiency but are not qualified to start studying in the English-medium university until after under-going at least a semester of the intensive English program. The students who have enough English skills for the university are just about 7.5%. This class of students, theoretically, requires no extra English preparation

to start any program in an English medium university like KFUPM.

The percentages of students with these varying English skills do not appear to be different from one academic session to the next. In fact, a test of the difference in percentages across semesters confirms this similarity by showing an insignificant chi-square statistic of 0.245 with 2 degrees of freedom and a p-value of 0.885. That is why we have combined the data for the two academic sessions for the subsequent analyses.

As identified in the Method section, in this part of the study we are interested in seeing if there is any relationship between the students' proficiency in English and their Mathematics performance. In order to do this, we classified students based on their final grade for MATH001 (which is the students mathematics achievement in this study) into three groups: (T) those who obtained a grade of at least B+ are classified as "top" performing students, (L) students performing at most D+ are classified as "low" performing students, and (M) those in between are classified as "medium" performing students. The rationale for this classification can be found partially in the university's policy of placing only students who successfully obtain grades of at least C in the preparatory year math courses into the university programs. Therefore, those who got less than that are classified as low performing. And those students with B+ and above are classified as honors students, and hence we call them top performers.

Table 3 below provides the number and percentage of students in the three categories of MATH001 performance versus their English proficiency level. At this level, the students were classified simply into two: promoted

Table 2. Number and percentage of predominantly Arab students in different academic terms who enroll in different English classes

English Promotion	Number of students in			Percentage of students		
	Term 101	Term 111	All	Term 101	Term 111	All
No	1223	1226	2449	39.81	39.91	79.72
to ENGL002	198	194	392	6.45	6.32	12.76
to ENGL101	112	119	231	3.65	3.87	7.52
All	1533	1539	3072	49.9	50.1	100

Table 3. Number and percentage of students in Math Performance groups versus their English promotion status

Math	Number promoted vs not			percentage promoted vs not		
group	no	prom	All	no	prom	All
Low	754	188	942	24.54	6.12	30.66
Medium	1123	270	1393	36.56	8.79	45.35
Top	572	165	737	18.62	5.37	23.99
All	2449	623	3072	79.72	20.28	100

(completely or partially, denoted as “prom” in the table) and those who were not promoted, denoted as “no” in the table).

The percentage promoted to both ENGL002 and ENGL101 combined is about 20%, and the bulk of the other students (more than 80%) were not promoted. However, the result of the chi-square statistic of this comparison is 2.780 with 2 degrees of freedom and a p-value of 0.249, which seems to show no statistically significant difference across the dichotomous English promotion status at the $\alpha = 0.10$ significance level. On the surface, this may say that the students’ English skills appear unrelated to their mathematics performance. This is perhaps due to the fact that the promotion levels were confounded. That is, students with partial and full exemptions were grouped together, and thus indistinguishable. As such, the result

of the statistical test is not conclusive. Therefore, we conducted a finer analysis by grouping students who were fully and partially promoted separately. This separation provides a different, finer, and more relevant result which is in line with the university’s vision of minimum English proficiency requirement.

Table 4 provides the result of this finer analysis. This table provides similar data to Table 3 except that the English promoted group is classified further to those who were partially promoted and those who were promoted completely.

The first column is for the three groups of students based on their mathematics performance. The second column is for the three groups of students who were not promoted in English. They are classified as weak in English language. The third column is for those who

Table 4. Number and percentage of students in Math Performance groups versus their English promotion status

Math	Number promoted vs not			Percentage promoted vs not			
group	no	ENG 002	ENG 101	no	ENG 002	ENG 101	All
Low	754	132	56	24.54	4.3	1.82	30.66
Med	1123	174	96	36.56	5.66	3.13	45.35
Top	572	86	79	18.62	2.8	2.57	23.99
All	2449	392	231	79.72	12.76	7.52	100

were partially promoted to ENGL002. These students are considered to have some background in English, but not enough to start any degree program. The fourth column is for those students who were promoted fully in English, and hence have enough proficiency in English to enter the university program. Columns 5 to 8 are the percentages of the groups.

With this added information, the chi-square statistic of 16.360 with 4 degrees of freedom (p -value = 0.003) shows a significant relationship between the three different English proficiency levels of the students and their mathematics achievement. This is the case even at an $\alpha = 0.01$ significance level.

If we examine the percentages of those who were promoted and those not promoted, we see that although the promoted students are only around 8% of the total student population, they consist of 34% of the total top performing students. On the other hand, only 23% of promoted students are in the low performing class as compared to 31% in the not promoted class.

Furthermore, a comparison between a promoted class and those that were partially promoted yielded 34% as

compared to 22% among the top performing respectively, and 24% as compared to 34% among the low performing respectively.

As stated earlier, KFUPM is a highly selective university. Students admitted into KFUPM are among the top 10% of Saudi Arabian high school graduates. Also, the university is basically an engineering and science university; therefore, students applying usually have good mathematics backgrounds as clearly reflected in their high school academic records. Based on this, one can say that the academic variation among students in terms of their mathematics ability level is marginal. Therefore, this seems to show that a larger percentage of students would belong to the top performing mathematics group had they had English proficiency levels up to the university requirement. This finding seems to imply that this class of students suffers some disadvantage in their performance due to lack of English proficiency. The quantification of this disadvantage is around 10%. This finding confirms what was reported by Barton and Neville-Barton⁵ for first year university students. Furthermore, the finding coincides with what was reported by Neville-Barton and

Table 5. Number and percentage of students by Actual Math grades versus their English promotion status

Math	Number promoted vs. not			Percentage promoted vs. not			
group	no	ENG 002	ENG 101	no	ENG 002	ENG 101	All
A+	136	31	38	4.43	1.01	1.24	6.67
A	188	24	23	6.12	0.78	0.75	7.65
B+	248	31	18	8.07	1.01	0.59	9.67
B	329	43	25	10.71	1.4	0.81	12.92
C+	427	65	38	13.9	2.12	1.24	17.25
C	367	66	33	11.95	2.15	1.07	15.17
D+	295	48	17	9.6	1.56	0.55	11.72
D	143	27	10	4.65	0.88	0.33	5.86
F	316	57	29	10.29	1.86	0.94	13.09
All	2449	392	231	79.72	12.76	7.52	100

Barton²⁴ for secondary school students, in which a 10% to 15% disadvantage was reported in five different studies. Also, Riordain and O'Donoghue (2008) reported a disadvantage of 8.7% in solving word problems for due to lack of language proficiency.

For a finer distinction of the mathematics performance groups, we examined student English skills based on their actual mathematics grades. Table 5 below provides similar information to Table 4 but instead, examines students by their actual MATH001 grades versus their English promotion levels.

With this added information, the chi-square statistic of 54.033 with 16 degrees of freedom (p -value = 0.000) shows a significant relationship between the English promotion groups and the students achievement in mathematics. This is true even at an $\alpha = 0.01$ significance level. This shows that the finer the division the clearer the effect of English language proficiency on the students mathematics achievement.

In the second part of the study, we investigated the students' perceptions of the effect of English language proficiency or lack of it on their understanding and performance in mathematics. To this effect, we conducted a survey with this class of students. There were two factors in the scale: Understanding and Performance. The "understanding" scale attempts to measure the perception of students of the effect of language of instruction (Arabic or English) on their understanding of mathematics. On the other hand, the "performance" scale aims at measuring the students' perceptions of the effect of language of instruction (Arabic or English) on their performance in mathematics.

The survey is a 5 point Likert scale ranging from "strongly agree" to "strongly disagree", where "Strongly agree" is coded as 1 and "Strongly Disagree" as 5. A total of 608 students responded to the survey. Table 6 below provides some statistics and reliability of the survey scores.

Table 6. Descriptive statistics and reliability of the survey scores

Scale	N	M	SD	Rxx
understand	10	29.9951	6.8173	0.7269
Performance	6	19.2533	4.7004	0.6122

The "understanding" scale, with 10 questions, registers an alpha reliability coefficient of about 0.73 and a scale average of around 30. This says the students are generally neutral with regards to the effect of English on their understanding of mathematics. On the other hand, the "performance" scale, which consists of 6 questions, has an alpha reliability of 0.6122 which is adequate for a short scale. The average of this scale is 19.25 or 3.21 per question. This indicates the perception that students are on average between neutral to disagree on the effect of language change on their mathematics performance. In addition, the correlation between the two scales registers at 0.041 with a p -value of 0.293, which says that the students do not perceive their mathematics understanding and mathematics performance in the English medium to be related.

This finding seems to indicate that the students in general do not seem to be aware of the disadvantage they have due to their lack of English language proficiency. Earlier research at both secondary school and undergraduate levels has shown that this is the case in general for this class of students^{5,24}. According to Barton and Neville-Barton⁵, this might have to do with the students' beliefs that mathematics learning is language free. Therefore, to address this problem, there is a need for raising the awareness level of all the stake holders on this issue so that a way can be paved to overcome the language disadvantage of this class of student.

For more detail, we present in Table 7 below, some statistics of the survey items. We also indicate in the table whether the item was reversed scored (for the purpose of consistency) on the Likert scale from the original question.

The first 10 questions belong to the "understanding" scale. For these items, most of the student responses are on average between 2.7 and 3.3 which is around the neutral category. However, looking into the items individually gives more revealing results. The item with the highest mean response was u3 (3.3), which mildly indicates that the students are not in agreement that they face difficulty in learning mathematics in English and learn better in Arabic (item u1, u10). This is not surprising, as the students have been learning mathematics in Arabic for the last twelve years. However, what is surprising to us is how mildly students responded to this clear question. We initially thought the response would be at the 'strongly agree' level. But other items seem to shed more light on the issue. They seems to indicate that in addition

Table 7. Descriptive statistics of the survey questions

Wording	Serial	Reversed	Mean	SD
I understand mathematics better in Arabic than in English	u1		3.0874	1.3824
I often understand mathematics easily	u2		3.0702	1.3774
I often find mathematics difficult when taught in English	u3		3.318	1.1647
I often find mathematics easy when taught in Arabic	u4		2.8903	1.1479
I think mathematics is easy but when it is written in English on the blackboard or textbook, I found it difficult to follow.	u5		2.7196	1.2203
I like reading my mathematics books in Arabic, but in English I find it difficult to even open the pages of the book.	u6		3.0689	1.3292
I started to have problem in understanding mathematics only when the language of instruction was changed to English.	u7		3.1031	1.2996
I found it difficult to understand mathematics lectures in either Arabic or in English.	u8	y	3.0214	1.1851
Mathematics lectures are clear to me in either Arabic or English	u9		2.874	1.2828
I understand mathematics better in English than in Arabic	u10	y	2.7651	1.2129
I will do better if my mathematics exams are all in Arabic	as1	y	3.2715	1.3134
My performance will be better if my mathematics instruction is in Arabic	as2	y	3.1659	1.4132
My performance is better since my mathematics instruction changed to English	as3		3.2515	1.3387
It does not matter if my exam is in Arabic or English, I do perform well in my mathematics exams	as4	y	3.5177	1.3837
I always do my homework on time and by myself.	as5		3.2105	1.246
I would have been encouraged to do my homework on time and by myself it was in Arabic.	as6		2.846	1.3195

to the language problems, the students have some other problems that have to do with the general understanding of mathematical concepts (u2, u4, u5, u6, u7, u8 and u9). This is understandable, as some students have some carryover of some misconceptions from high school and is still haunting them.

The last six questions belong to the “performance” scale. For these items, the students’ responses are also on average between 2.8 to 3.5 which is somewhere between neutrality and disagreement. In other words, the students are saying that they do not seem to agree that their proficiency level of English has much to do with their performance in mathematics. There seems to be a

mixed feeling on which is better – having their exams in Arabic or in English, item as 4, which carries the highest response, seems to say that it does not matter.

4. Conclusion

This study investigates the effect of student proficiency levels of bilingual Arab students in English on their performance in mathematics at KFUPM. In addition, the study examines the students’ perceptions on the effect of lack of proficiency in English on their mathematics understanding and performance.

Comparing the students dichotomously as either proficient or not proficient in English did not show any statistically significant difference between students as per their performance in mathematics is concerned. However, a finer and more practically relevant analysis revealed that mathematics performance is significantly related to the English proficiency level of the students. In particular, the profile of percentages of students who are top performers in mathematics are greater for students who are proficient in English than those who are weak. Similarly, the percentage of low performing students is higher among students who are not proficient in English as compared to those who are proficient. Therefore the disadvantage this class of students suffers due to lack of proficiency in English is around 10%, which is within the range reported in the literature.

A second part of the study attempted to find out students perception of the effect of lack of proficiency in English on their mathematics understanding and performance. The results revealed that the students are not aware of the disadvantage of their language deficiency, and so do not seem to think that this deficiency has any effect on their mathematics understanding and performance. Also, the results show that in addition to the language problems, the students seem to indicate that they have other problems that are mathematical in nature which are hindering their understanding and performance in mathematics.

Now that the effect of language proficiency is found to be a factor in student performance in mathematics among bilingual Arab university students, the next line of research should look into the challenges students, especially those who are less proficient in English, face while learning mathematics in English as a second language. Furthermore, the resources which students, especially the top performing ones, bring with them into the system, that help them to survive the language switch, also need to be investigated. These and some other issues related to student learning and teacher teaching in this context need to be investigated further.

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