Mathematics Learning Experiences: A Comparison between English and Arabic Languages

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Abstract

Universities around the world are beginning to use English as the language of instruction for a majority of their courses, which can lead to some difficulties if the students in those universities are English Language Learners (ELLs). The purpose of this study is to investigate the differences in achievement in mathematics between English and Arabic. Namely, the study aims to investigate if Arab students perform differently on mathematics exams depending the language used in the exam. The study utilized a mixed methods research design to measure mathematics achievement of the students in both Arabic and English and to understand students' experiences in the process of learning mathematics in the English language. The findings show that students demonstrated considerable gains on the Arabic version of the exam over the English exam. Other findings and implications of the study, as well as the recommendations for future studies are further discussed.

Type of Paper: Original Research Article

1. Introduction

According to Cuevas (1984), it is essential to take the language used to teach mathematical ideas into consideration, especially when that language is not the learners' first language or if the learner has not achieved a certain level of proficiency in that language. Since many universities in non-English speaking countries are now implementing curricula that are entirely delivered in the English language, the need to investigate the levels of English anxiety among students in these universities is becoming more important. While many universities offer preparatory programs as remedial for students' lack of mastery of the English language, many students still suffer high anxiety levels during their English courses as well as their major specific courses taught in English, including mathematics and physics courses.

1.1 Linguistic abilities and Mathematics Achievement

Many researchers have investigated the relationship between English language abilities and mathematics achievement and the majority of those studies found a positive relationship between English language abilities and mathematical abilities among students across different levels of learning (Becker &Vanderwood, 2009; Grimm, 2008; Pimperton& Nation, 2010). Achievement gaps between ELLs and native English speaking students have been widely observed in the literature (Lopez, 2010). For example, according to the NAEP results in 2005, only 54% of ELL students scored at or above the required achievement level in mathematics, while 83% of their native-English-speaking peers scored at or above the required level in mathematics (Perie, Grigg, & Dion, 2005). Moreover, Sovik et.al (1999) studied the relation between reading comprehension and problem solving strategies used in word problems among 9-year-old children, who were sampled using cluster sampling and assigned to four groups using stratified sampling. The findings of this study showed no significant evidence that students who were good at both reading comprehension and mathematics would emphasize deductive problem solving strategies more than students in other groups, who were not good at both reading and mathematics; another finding of the study was that IQ was a stronger predictor of arithmetic word problem solving than reading comprehension.

Moreover, Purpura et.al (2011) investigated whether early literacy skills uniquely predict early numeracy skill development among 3-5-year old children. The findings of this study suggest a unique relation between early numeracy skills and print knowledge and vocabulary. Similarly, another longitudinal study that investigated relations between reading and mathematics achievement was conducted on a much larger sample size of 46,373 participants (Grimm, 2008). The findings of this study showed that early reading comprehension was associated with changes in the application and conceptual understanding of mathematics as opposed to performing mathematical operations; this finding suggests a link between the cognitive processing abilities required for reading and those required for mathematical understanding. Also, Becker and Vanderwood (2009) investigated this connection between literacy and mathematics skills, and, also, found that there is a relation between mathematics skills and reading skills. To further emphasize the connection between linguistic abilities and mathematics achievement, Pimperton and Nation (2010) designed their study to investigate this connection among poor comprehenders, who are only poor at comprehension but do well on all other parts of literacy and reading. To be able to isolate students who are only poor at comprehension, the researchers used matched sampling to assign students to groups. The findings of this study state that poor comprehenders did not differ significantly from controls on the numerical operations tasks, but performed at a significantly lower level than controls on the mathematical reason test.

1.2 Anxiety and Achievement

The relationship between language anxiety and achievement has been widely investigated by researchers. However, the majority of researchers focused their attention on the relationship between foreign language anxiety and achievement in language courses (Awan et. al, 2010; Bailey, et al. 2000; Cheng, 2001; Horwitz, Horwitz, & Cope, 1986; MacIntyre& Gardner, 1991; Onwuegbuzie, et al. 1999). For example, Awan et.al (2010) conducted a study that included 149 participants, who were all ELL undergraduate university students. They measured students' anxiety levels and compared them to their achievement in college using GPA in English courses as the primary indicator of achievement; they concluded that there is a negative relationship between English anxiety and student achievement in English courses. Also, they found that "speaking English in front of others" was rated as the highest cause for anxiety. Similarly, Woodrow (2006) conducted a study that included 275 students enrolled in English for Academic Purpose (EAP) programs in order to investigate the relationship between English anxiety and students' achievement in EAP courses. The findings indicated that English anxiety was the highest predictor of achievement, especially oral achievement. Also, Gai and Yang (2010) studied the effect of English language anxiety on students' linguistic abilities and found that anxiety negatively affects students' linguistic achievement, especially their achievement in English speaking. The purpose of this study is to investigate the mathematics learning experiences of students attending a four-year university in the Kingdom of Saudi Arabia and how their linguistic difficulties might affect their achievement in mathematics courses. More specifically, the research questions of this study are:

1. Is there a difference between English Language Learners' achievement on mathematics exams written in English and Arabic?
2. What are the reasons for the difficulties (if any) that English Language Learners face in their mathematics classrooms when taught in English?

2. Research Methodology

2.1 Research Design

The study utilized a mixed methods design in order to completely address the research questions and in order to provide a more comprehensive understanding of any relationships between language and mathematics achievement in classrooms. Collins, Onwuegbuzie, & Sutton (2006), suggested that using a mixed-methods approach can provide instrument validity and significance enhancement to the findings of the study.

2.2 Sample

The participants for the study were all male students (N=109) enrolled at a private university in the Kingdom of Saudi Arabia, where all instruction is delivered in English throughout the entire university. The vast majority of students were Saudi Arabian and speak Arabic as their first language and many of them were either going through the English preparatory program or have recently completed the preparatory program and began taking courses in their respective colleges. Table 1 shows the distribution of the participants based on age and gender.

Table1. Distribution of participants based on Age group and Gender.

Gender\Age group	17-18	19-20
Male	41	14
Female	42	12

2.3Instrument

Quantitative Data: Mathematics Achievement: To gather data for the mathematics achievement variable, the researchers designed two parallel mathematics test; one test was written in English and the second test was written in Arabic. Both tests measured students' understanding of material they learned in their pre-algebra course at the university. Qualitative Data: qualitative data were collected through structured interview questions developed by the researcher. The researcher randomly selected 12 students from a pool of 45 students who indicated their agreement to participate in an interview with the researcher during the quantitative data collection phase.

2.4 Data Collection

The researcher randomly selected four mathematics classrooms, where the content was being delivered in English. Then, students in each class were asked to participate in the study. Out of the 118 students enrolled in those classes 109 volunteered and completed both the Arabic test and the English test; the Arabic test was administered first, then two weeks later the English version of the same test was administered to the same students. After quantitative data were collected, the researcher selected 12 students for interviews regarding their experiences in their mathematics classroom and the reasons for any difficulties they faced or are facing in their mathematics learning experiences in those classes.

4. Results

The results indicated that students' performed better on the Arabic version of the test (M= 81.15) than the English version of the same test (M=72.44), which indicates a 9% improvement to the advantage of the Arabic test. However, T-test results showed no significance differences between students' achievement on the Arabic test and the English test t(108) = 2.42, p=1.2.

Table2. T-Test results between Arabic and English Exams

GROUP	N	Mean	Std. Deviation	t	df	Sig.(2-tailed)
Arabic Exam	109	81.15	9.82	2.42	108	1.2
English Exam	109	72.44	7.03			

The researchers conducted a T-test between students' scores on both tests using only word problems and excluding simple mathematical problems, such as solving linear equations. The results showed considerable differences between students' scores on the Arabic version of the test (M= 37) and their scores on the English version of the test (M=20). Which indicates that the students were able to perform significantly better on exams written in Arabic than on exams written in English. To understand the reasons for any difficulties students face in their mathematical learning experiences in the English language, the researcher conducted 12 semi-structured interviews with randomly selected students and asked those students questions about their experiences in their mathematics classrooms. The interviews were transcribed and thematic analysis was utilized to analyze the collected qualitative data.

Thematic analysis yielded two main themes within the students' responses; each theme contained several patterns of difficulties that students face in their study of mathematics in a second language. The first theme is "*Understanding Instruction*". In this theme, patterns of responses relating to students having difficulty understanding the instructor during the lectures, as well as difficulties in communicating their own questions to the instructor were all included. For example, a student mentioned that he "cannot understand what the teacher is saying because he is American", another student said "I cannot ask questions because when I ask he doesn't answer me, but talks about something different". The second theme is "Linguistic Differences". In this theme, the main patterns included "*difficulties with reading*" the exam material and/or writing the answers in English and "*anxiety*"; nine students (75%) emphasized the fact that "the direction" of the writing poses an issue because in Arabic, writing in general is from right to left whereas in English writing is from left to right and students who are just beginning to experience mathematics taught in English seem to find that difference very confusing.

6. Discussion and Conclusion

The purpose of this study was to explore the experiences of English Language Learners in learning mathematics in a foreign language. More specifically, the study aimed at investigating differences in achievement among students who take mathematics tests in English and in Arabic and to check whether the language that the exam is written with bears any effect on the students' performance. Finally, the study aimed to explore students' understandings of the reason behind the difficulties they face when studying mathematics in a foreign language. The findings suggest that, while there are no statistically significant differences between students' achievement on the English and Arabic Exams, the students demonstrated considerable gain in achievement in the Arabic test compared to the English test. Which indicates that students were able to comprehend material presented in the exam more easily in Arabic than they did in English, which was reflected on their achievement? This finding supports the findings of previous studies that found similar results regarding students' achievement in their native language when compared to their achievement in a foreign language (Neville-Barton, & Barton, 2005).

Another finding of the study is that English Language Learners face difficulties not only in their language classes but also in their mathematics classes being taught in the English language. One of those difficulties include lack of understanding of the instruction being delivered in English, another difficulty is a high anxiety level associated with taking mathematics exams written in English. This result is not surprising since many researchers argued that English language anxiety could hinder the achievement of English Language Learners in different subject areas if they are taught in English (Mahmood & Iqbal, 2010; Kersaint, Thompson, & Petkova, 2014).

In Conclusion, the implications of these findings include that curriculum developers at the university level need to design courses that allow English Language Learners the opportunity to transition at the cognitive level from learning subject areas in their mother tongue into the foreign language of instruction at the university. Offering students English classes for special purpose (i.e Mathematics) could be a way to offer such opportunities; Smith and Stein (2011) suggested orchestrating classrooms that foster the development of both linguistic and mathematics abilities of students as a possible solution. Moreover, mathematics instructors and faculty members must take the necessary steps to reduce anxiety levels amongst their students as they learn mathematics in a foreign language.

Finally, further research that investigates the effect of English language anxiety of mathematics achievement, as well as research that explores possibilities of reducing foreign language anxiety is needed in order to support English Language Learners in their quest for education in English speaking educational institutions.

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