Role of reading comprehension and maths computation in word problems solving: A comparison of Arabic EAL and English-native adults learning maths in England

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To investigate the role of reading comprehension and maths computation abilities in successful word problem solving, 40 adult participants (Arabic and English native speakers who have previously studied maths in England) have been recruited. They have been tested on three subtests (WRAT V for text comprehension & maths computation, and PISA for word problems) to measure their skills in reading comprehension, maths computation and word problems. The results suggested that reading comprehension and maths computation were significant predictors for Arabic-native speakers' performance in the word problems subtest, but maths computation was the only significant predictor for English-native speakers. These results raise questions about the suitability of word-problems-curricula for assessing the maths abilities of different populations.

Keywords: EAL adults; adult numeracy; word problems; Arabic speakers.

Introduction

The difficulty of word problems comes from not being based only on maths ability but from the need for a certain degree of language ability. Kintsch and Greeno (1985) suggested that word problem solving is a form of text comprehension. This hypothesis was supported by later research as Cummins et al. (1988) suggested that children's errors are often due to a lack of comprehension of word problems. Vilenius-Tuohimaa, et al. (2008) suggested that word problems performance is strongly related to reading comprehension performance. Fuchs et al. (2018) concluded that language performance predicted word problem performance more than the maths element of pure calculations. Roe and Taube's (2006) analysis of PISA data in Sweden and Norway concluded that there existed a positive correlation (0.57) between maths and language proficiency. When the word problems became more challenging, the role of text comprehension skills became the most important (Pongsakdi et al., 2020).

This language influence can be found in EAL learners when the language used to convey word problems changes from their native language to English. Adetula (1990) found a better performance of Nigerian students when the word problems were presented in their native language rather than English. These findings have been replicated consistently in many countries like the Philippines (Bernardo**,** 1999), South Africa (Sepeng & Madzorera, 2014**),** and Spain (Cabezuelo & Pavón, 2019).

EAL adults studying maths in England

EAL children's performance and attainment in the English schools (Strand, et al., 2015; Strand & Hessel, 2018) show that their attainment became broadly similar to their English native peers as they progress in their study (Briggs, 2019). However, this may

not be the picture for EAL adults who face many challenges in the educational settings (Ní Ríordáin, et al., 2015).

Arabic EAL learners in England

In the 2011 census, Arabic speakers were about 159,000 speakers in England and Wales with ethnicity estimates (230,600) 0.4% Arabs (Gov.uk, 2020).

The Arabic language has several features distinct from the English language; it is written from right to left, uses a different number system including different symbols and a completely different orthography from English.

Predictably, Arabic EAL learners face several difficulties when learning maths in the English language like the use of the western Arabic numbers instead of the eastern Arabic numbers (٤،٣،٢،١), different symbols like using the dot *"."* instead of the comma *","* in decimals (Yushau, 2009), the confusion in writing direction of the equations, e.g., *220 = 120 - 1.8x,* and reversing the slope points in the graphs, e.g., *writing (x, y) oppositely* (Causapin & Groombridge, 2014). Also, the use of Latin and Greek maths terms may put extra burden on understanding the mathematical contexts.

Research Questions

Two questions were asked in the present study:

1. Will Arabic EAL participants perform significantly less accurately than their native speakers' peers in reading comprehension, maths computation, and word problems solving?
2. Will reading comprehension and maths computation skills predict Arabic EAL and English native participants word problems solving performance?

Methods

Participants

The current research focused on Arabic adult speakers who have studied maths in England in their adolescence or adulthood and how their word problem performance differs from English native adult speakers who studied maths in English since childhood. Arabic speakers, who have moved to England at a later stage of their life after receiving their compulsory education in Arabic in their home country then studied maths again in English in England, were asked to participate in our study. Participation was voluntary. The participants' levels of maths education are varied (see table 1).

Table 1. Participants' levels of maths education.

Qualification	Arabic native speakers	English native speakers	Total
Functional Skills (entry levels)	1	0	1
Functional Skills L1 & L2	5	5	10
GCSE	9	10	19
A-Level	2	4	6
Undergraduate	1	0	1
Postgraduate	1	1	2
Total	19 (1 missing)	20	39 (1 missing)

Twenty Arabic native speakers have completed the questionnaire in full. The average completion time is 113.58 mins, *SD*= 79.65. The sample included eight males and 12 females, aged between 23-56 years (*M*= 38.05, *SD*= 7.43). They have lived in

England for a range of periods; 1.8-20 years (*M*= 8.92). The youngest participant moved to England at the age of 17.

Twenty English native speakers, who received their maths education in English since childhood, completed the questionnaire as a control group. The average completion time is 75.68 mins, *SD*= 43.12. The sample included four males and 15 females (one missing ans.), aged between 19-61 (*M*= 36.72*, SD*= 12.39).

Measures

An online questionnaire using the Qualtrics platform has been created. Consisting of a battery of three tests; two WRAT 5 (*Wide Range Achievement Test*) subtests of text comprehension and maths computation (the tests adapted for online presentation), the third subtest consisted of 14 word problems: 13 word problems from the PISA 2003 framework (OECD, 2004) and 1 problem from Ní Ríordáin & O'Donoghue (2009).

Results

Table 2. Descriptive statistics of tests scores

Group	Measures	N	Min.	Max	Mean	SD
Arabic	Reading comprehension	20	20.00	94.00	64.20	19.53
	Maths computation	20	55.00	95.00	80.25	11.29
	Word problems	20	0.00	100.00	46.71	35.82
	Overall score	20	35.60	96.30	63.70	19.96
English	Reading Comprehension	20	82.00	100.00	92.90	5.00
	Maths computation	20	35.00	97.50	76.00	18.02
	Word problems	20	8.57	100.00	71.71	24.01
	Overall score	20	44.52	98.50	80.19	13.41

Note. The maximum possible score for each test is 100

H1. Arabic EAL participants significantly perform less accurately than their native speakers' peers in reading comprehension, maths computation and word problems solving questions.

The performance differences in different subtests have been analysed to test this hypothesis. Two groups; Arabic EAL learners and English native speakers. Three dependent variables were: WRAT-text comprehension score; WRAT-maths computation score; and PISA-word problems.

Reading comprehension test performance

A Mann-Whitney U test was run. Results show that reading comprehension test scores for English speakers (mean rank = 29.4) were statistically significantly higher than Arabic speakers (mean rank = 11.6), $U = 378$, $z = 4.82$, $p < .001$.

Maths computation test performance

A Mann-Whitney U test was run. Results show that maths computation test scores for Arabic speakers (mean rank = 21.25) and English speakers (mean rank = 19.75) were not statistically significantly different, $U = 185$, $z = -.41$, $p = .698$.

Word problems test performance

A Mann-Whitney U test was run. Results show that word problems test scores for English speakers (mean rank = 24.6) were statistically significantly higher than Arabic speakers (mean rank = 16.4), $U = 282$, $z = 2.22$, $p = .026$.

H2. Reading comprehension and maths computation skills predict Arabic EAL and English native participants word problem solving performance

Arabic EAL group regression

A multiple regression analysis has been conducted on the subgroup of Arabic EAL speakers with reading comprehension and maths computation scores as the independent variables and word problems score as the dependent variable. The multiple regression model statistically significantly predicted the word problems performance of Arabic EAL learners, F (2,17) = 18.88, $p < .001$, *adj.* $R^2 = .65$. Both reading comprehension and maths computation scores were significant predictors (see table 3).

Table 3. The Arabic EAL group regression model

WP Score	*B*	*95% CI for B*		*SE B*	β	R^2	ΔR^2
		LL	*UL*				
Model						.69***	.65***
Constant	-119.03**	-192.28	-45.78	34.72			
RC score	1.06**	.47	1.65	.15	.58**		
MC score	1.21*	.19	2.24	.48	.38*		

Note. Model = "Enter" method in SPSS Statistics; *B* = unstandardized regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient; ß = standardized coefficient; R^2 = coefficient of determination; ΔR^2 = adjusted R^2. *p< .05. **p< .01. ***p< .001.

English native speakers' regression

A multiple regression analysis was conducted on the subgroup of English-native speakers with reading comprehension and maths computation scores as the independent variables and word problems score as the dependent variable. The model statistically significantly predicted word problems performance of the English native participants, F (2,17) = 8.98, $p = .002$, *adj.* $R^2 = .46$. While maths computation scores contributed significantly to the model ($B = .90$, $p = .001$), reading comprehension did not ($B = .79$, $p = .350$) (see table 4).

Table 4. The English-native group regression model

WP Score	*B*	*95% CI for B*		*SE B*	β	R^2	ΔR^2
		LL	*UL*				
Model						.51**	.46**
Constant	-69.84	-229.81	90.12	75.82			
RC score	.79	-.94	2.52	.82	.16		
MC score	.90**	.42	1.38	.23	.68**		

Note. Model = "Enter" method in SPSS Statistics; *B* = unstandardized regression coefficient; CI = Confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = Standard error of the coefficient; ß = Standardized coefficient; R^2 = coefficient of determination; ΔR^2 = adjusted R^2. **p< .01.

Discussion

Although there were differences in performance between the two groups, these differences were not observed across all subtests. The English native group performed better than the Arabic EAL group in reading comprehension and word problems, but

Arabic speakers performed slightly better than English native speakers in maths computation, although this difference was small and not statistically significant.

But what about the role of reading comprehension and maths computation skills; can they predict word problems performance? Our data suggest the answer to be yes, but only for the Arabic EAL group as for the English native group only maths computation predicted their word problems solving performance.

These results are consistent with the notion that reading comprehension may only become a more significant factor with/ than maths ability in cases of reduced/ not fully developed reading comprehension ability like the situation here with EAL learners. Then our data suggest that, once participants achieved proficiency in reading comprehension, it may not be an obstacle/a factor in solving word problems. This may explain why the English-native group were able to answer the word problems accurately in line with their performance in maths computation, although they may have weaker maths skills than their EAL peers who performed much worse in word problems.

Accordingly, word-problems-based curricula in England like Functional Skills can be challenging for EAL learners, although it will be suitable for native speakers' participants. This represents a dilemma in the current government policy that designed this curriculum specifically for adult learners as it may disadvantage EAL learners consistently.

So, what should be taught and assessed in word-problems-based curricula; language or maths? Can altering the presentation of word problems in a way that reduces the importance of language (for example, by presenting the problems visually rather than verbally) improve the performance of non-native speakers?

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