Development and standardization of a phonological processing test in Arabic

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Abstract

The present study reports on the development and standardization of a test of phonological processing in Arabic, a language that has been less researched in terms of reading processes potentially due to the limited number of standardized tools. The test includes measures of phonological awareness, phonological memory and rapid naming, and a measure of non-word reading to link with (phonological) decoding skills in reading. Primary and middle school versions of the test showed good levels of reliability and variability in children's performance within and across grades, suggesting that the test can reliably differentiate children with differing levels of phonological skills across the target population. Findings are discussed in relation to Arabic language and literacy, theories of phonological processing and issues related to the teaching of the Arabic orthography.

Keywords: Testing; Phonological processing; Arabic literacy

Introduction

Research has provided a large amount of evidence that phonological skills are related to reading ability in English and other European languages in primary school (e.g., Catts, Fey, Tomblin & Xuyang, 2002; Harris, Terlektsi & Kyle, 2017; Poulsen, Nielsen, Juul & Elbro, 2017) and secondary school (Eklund, Torppa, Sulkunen, Niemi & Ahonen, 2018). Similar results have been recorded in non-European languages and across a range of orthographies, including Arabic, the focus of this paper (see, for example, Abu-Rabia, Share, & Mansour, 2003; Al-Mannai & Everatt, 2005; Boukadida, 2008; Elbeheri & Everatt, 2007; Taibah & Haynes, 2011). Phonological processing skills in this context follow those hypothesized by Wagner and Torgesen (1987), which the current work will refer to as phonological awareness, phonological memory and rapid naming. This model of phonological processing influenced the development of the Comprehensive Test of Phonological Processing (Wagner, Torgesen, Rashotte & Pearson, 2013), which the current research used as a basis for the development of the Arabic measures it proposes in this paper.

These concepts of phonological processing have been referred to in the reading research literature for many decades. For current purposes, they fit with the definitions used by Scarborough and Brady (2002). Phonological awareness, according to Scarborough and Brady (2002), can be defined as "[t]he broad class of skills that involve attending to, thinking about, and intentionally manipulating the phonological aspects of spoken language, especially the internal phonological structure of words." (p. 312). Phonological awareness includes awareness and manipulation of speech segments at the sentence, word, syllable and phoneme level. In the current work, the latter two (syllable and phoneme) were the focus of the measures.

Scarborough and Brady (2002) define phonological memory as "the temporary storage of information in terms of phonological representations" (p. 319), and rapid naming as"[r]etrieving the phonological representation and producing the spoken word that is the label for a particular referent that we encounter or think about."(p. 320). Therefore, these latter two concepts relate more to the storage and retrieval of phonological information. Rapid naming relates to the efficient access to a phonological form, which is why speeded (rapid) access is measured. Phonological memory measures will have more of a focus on temporary storage processes and may be better assessed by tasks requiring the storage of new/novel phonological material that would not already exist within the phonological memory system. The use of non-words in phonological memory measures means that it is unlikely that any participant will have frequently encountered the phonological stimulus, hence avoiding differences in frequency of encounter leading to differences in processing.

Skills of phonological processing, in addition to decoding, have been posited as the main areas of deficit in the two dominant theories of dyslexia, namely the phonological deficit hypothesis (e.g., Stanovich & Siegel 1994; Snowling, 2000) and the double deficit hypothesis (Wolf 1999). According to the phonological deficit hypothesis, the main deficit in dyslexia is due to the inability to develop efficient phonological processing that can support the learning of the correspondence between phonological units and graphemes, and hence enable the decoding of letter strings. The double deficit hypothesis argues that rapid access to phonological information (rapid naming) can also cause dyslexia in the absence of a phonological awareness deficit. It also proposes that if the two deficits are present, the symptoms of dyslexia are usually more severe.

Decoding of letter strings has been typically assessed via measures of pseudo-word or non-word reading. Non-words will require the participant to decode the letter string via translations of individual letters or groups of letters into language sounds (i.e., a phonological form) to produce a plausible pronunciation. Deficits in non-word reading have been found to be characteristic of individuals with dyslexia across a range of different languages/orthographies (see Rack, Snowling & Olson, 1992; Wimmer, 1996) suggesting that such decoding or letter-sound translation processes may be a specific area of difficulty for those with specific reading problems. Given that measures of non-word reading link phonological processing with processing written text, such measures would also be useful in a comprehensive assessment of phonological skills as part of the identification of reading weaknesses. Decoding involves the retrieval of chunks of segmented speech sounds and the blending of these to produce words, in addition to the ability to recognize the orthographic elements that can be related to phonological units. This active process would argue for larger associations with phonological awareness, though it would also require storage and retrieval processes to be working efficiently too.

Although phonological skills are important across different languages, their specific influence may vary depending on the orthographic depth of the language (see Eklund et al., 2018; Smythe et al., 2008; Ziegler, 2010). Orthographic depth refers to the degree of one-to-one correspondence between graphemes and phonemes. The more correspondence there is between graphemes and phonemes, the more transparent the orthography is for the reader/learner. Data suggest that more transparent orthographies show larger correlations with rapid naming skills (Wimmer, 1996) and the potential for earlier development of phonemic awareness (Seymour, Aro & Erskine, 2003). However, Arabic is an interesting case in terms of orthographic depth since it combines two versions of the orthography. One version is reasonably transparent and includes representations of short vowels via diacritics. However,

another less transparent version of the orthography does not include these short vowel diacritics, leading to the potential for a written letter string to be pronounced in several ways. Typically, the more transparent version is used in the primary stage of schooling when children are still not fluent enough in reading and their vocabulary is not rich enough to support context-related reading strategies: i.e., working out the correct pronunciation from the sentence in which an ambiguous word appears.

Despite the use of a more transparent orthography in early learning, the available evidence suggests that reading development in Arabic is not very different from learning to read English, especially in terms of the contribution of the different phonological processing sub-skills to reading accuracy and fluency. For example, consistent with data on English readers, phonological awareness has been found to be related to reading development in Arabic and also to differentiate between typically developing readers and children with reading disabilities (Abu-Rabia, Share, & Mansour, 2003; Al-Mannai & Everatt, 2005; Elbeheri & Everatt, 2007). Similarly, as in English, there is some evidence that the role of rapid naming increases with (reading) age and may be important in explaining variance among Arabic readers especially in relation to fluency, as opposed to accuracy(e.g. Saeigh-Haddad, 2007; Taibah & Haynes, 2011). Although the contribution of phonological memory in Arabic has been less well studied, it too may explain some variability in reading levels among more mature readers (Abu-Rabia, Share, & Mansour, 2003; Taibah & Haynes, 2011). Based on the above results, measures of phonological memory, rapid naming, phonological awareness and non-word decoding would seem useful for the identification of factors associated with reading difficulties in Arabic.

The aim of this article is to report on the development and the psychometric properties of two versions of a phonological processing test in Arabic to be used among other measures, such as morphological and orthographic processing[1],as part of the assessment of reading difficulties and the potential underlying reasons for these difficulties. The first version was developed to measure the phonological skills of primary school Arabic-speaking children in Kuwait from grade 2 to grade 5. Based on the data obtained from the first version, the second version was developed to cover the middle school years from grade 6 to grade 9 in Kuwait. Separate tests for primary and middle school were developed taking into consideration the content of school textbooks to support decisions about item selection.

Method

Participants

Consent to collect data from schools was obtained from the Ministry of Education and then the school directors. Consent to participate in the study was then given by the children and their parents/guardians. For both the primary and middle school tests, two pilot studies were conducted to develop materials and testing procedures, followed by a study involving much larger samples to produce standardization norms for the measures. Different schools were selected for each stage of the research, with care being taken to make sure that the latter comprised a representative sample of the all educational districts within Kuwait.

[1]Because our focus in this work is on phonological processing, we have not covered studies on the contribution of morphology and orthography in word reading and comprehension in Arabic (e.g., Mahfoudhi, Elbeheri, Al-Rashidi, & Everatt, 2010; Elbeheri, Everatt, Mahfoudhi, Abu Al-Diyar, & Taibah, 2011; Saiegh-Haddad & Taha, 2017).

For the primary battery, the first pilot included a sample of 200 students (100 males and 100 females) from grades 2 to 5 across four schools. The second pilot involved 107 boys and 106 girls from the same grades but from four schools that were different from those used in the first pilot. The standardization sample included 1255 children, 628 boys and 627 girls from different schools to those used in the pilots. There were 24 schools from all six educational districts within Kuwait: 4 schools per district (2 for boys and 2 for girls) with roughly equal numbers of children from each grade being assessed in each area (typically 52 or more children per grade in each area). Care was taken to ensure the schools represented all socio-economic classes within all the districts. Children were distributed well across the 4 grades targeted, with 313 (156 males) in grade 2, 315 (159 males) in grade 3, 315 (157 males) in grade 4 and 312 (156 males) in grade 5.

For the middle school measures, the first pilot included 240 children (120 boys and 120 girls) from grades 6 to 9 in four Kuwaiti schools. The second pilot was based on 320 children (160 boys and 160 girls) from grades 6 to 9 in four schools different from those used in the first pilot. The standardization data were based on 1200 children (600 boys and 600 girls) from twenty-four schools across the six educational districts in Kuwait. There were 300 children from each of the four grades, and roughly equal numbers of boys and girls from each grade.

Measures and procedures

The tests were administered by trained research assistants in quiet rooms in the schools. The administration of the standardized tests took about 25 minutes; though pilot testing took slightly longer given the larger number of items and breaks of about ten minutes were provided when needed. The same procedure was followed in the two pilot studies and the final standardization. If a child refused to continue with a

test, the session was stopped and only resumed if the child agreed to continue. All completed measures were included in the analyses. All items in all tests are in Standard Arabic, the language of formal education. However, the assessor was given the option to explain the task in the dialect of the student, Kuwaiti Arabic, if the student was having trouble understanding the task in the trial items.

The first pilot study included larger numbers of items, so as to reduce these to items that were most reliable and showed discrimination in performance and increase in difficulty as the child progressed through the measure. If items did not behave as expected (e.g., they did not correlate with other items in the measure), they were deleted. Items that did show evidence of reliability but were harder or easier than expected were either moved to later/earlier in the test or deleted. The second pilot was then used to ensure that the new version of the measure performed as expected. Both pilots also included additional measures to ensure that the best set of measures was selected for the battery. For example, a sound blending measure was also used to assess phonological awareness, but this showed low reliability with the primary school cohorts and was not included in the final tests. Also, a measure of rapid naming of digits was included in the primary measures, but was highly correlated with the letter naming measure, so only one was selected for the final battery. Based on this work, both primary and middle school test batteries included a measure of non-word reading (phonological decoding), a measure of sound deletion (phonological awareness), a measure of non-word repetition (phonological memory), and two measures of rapid naming (efficient phonological retrieval/access). The sub-sections below provide information on each of the measures: additional details can be found in Taibah et al. (2011) and Mahfoudhi, Everatt, Elbeheri, ElMorsi, and Haynes (2018).

Phonological decoding (non-word reading)

In this task, the child was given a number of letter strings that could be pronounced in Arabic but which did not have a meaning in Arabic. The child's task was to name each non-word as quickly and as accurately as possible. There were 25 non-words for the primary school version and 30 items for the middle school version, with some overlap in items across the two versions. However, for the middle school test several easier items in the primary version were replaced with more complex non-words – for example the non-word 'عاجَرٌ /ʕa:dʒarun/' was replaced with ' /ʔ انْفَرَكْحُنْ infarakħun/'. More complex non-words included longer letter strings, more complex syllabic structure and less frequently used grapheme-phoneme correspondences in the orthography. All items were presented on a sheet of paper and the child was asked to read each 'made-up-word' aloud to the assessor, proceeding from right to left and from the top of the page to the bottom. The items were positioned in order of increasing difficulty (based on pilot data). Practice items were used to explain the task. Children were assessed on the number of correctly pronounced non-words using Modern Standard Arabic grapheme-phoneme correspondence rules. Although fluency was also assessed by measuring the time taken to complete the items, the error data were found to show good levels of variability within all of the grades (from grade 2 to 9) and, therefore, the number of items read correctly formed the basis of the assessment of non-word reading performance.

Phonological awareness (sound deletion)

The child was asked to repeat a word spoken to them by the assessor, first as is and then without a particular sound (syllable or phoneme) within the word. For example,

an English example would be to ask the child to say the word 'cat' but without the /k/ sound. Items comprised deletions from the beginning, middle and end of the word, and there were 20 items in total for the primary version of the test and 29 for the middle school version. The middle school version included the first 19 items of the primary version in addition to 10 more complex items: complexity being based on the length of the spoken word, its syllabic structure and its frequency of use within the language books used in schools. For both primary and middle school measures, sounds were based on individual phonemes (e.g., repeat the word /lami:s/ 'female name' without /i:/) and consonant-vowel or consonant-vowel-consonant combinations (e.g., repeat the word /ʃari:f/ 'male name/ noble' without /ʃa/). These types of deletions provided a basis on which to assess the child's ability to recognize such sound units/combinations within real words.

Phonological memory (non-word repetition)

The child was asked to repeat a non-word spoken to them, with the non-words becoming longer in terms of the number of syllables as the test progressed (for example, from one to seven syllables). There were 20 items in total for the primary version and 23 items for the middle school version of the test. There was overlap in several items, but overall items were longer for the middle school measure – there were fewer two syllable non-words and more multi-syllabic non-words in the middle school measure. Items were recorded and played to the children to ensure that the tempo and stress were consistent across presentations. The number of items correctly repeated was the measure for this task and the order of the syllables repeated was taken into account when determining correct or incorrect responses. Children were asked to repeat the 'made-up-word' clearly for the assessor and examples were used in instructions followed by practice items to ensure understanding.

Phonological access (rapid naming)

Two sets of items were used, one comprising familiar objects, the other letters or familiar letter strings. For the rapid naming of objects, the child was given an array of pictures/line-drawings of familiar items that they were asked to name as quickly as possible. For primary and middle school children, different familiar objects were used to relate to materials used in school textbooks. The second rapid naming task for the primary schoolchildren (grades 2-5)required the naming of letters to assess the accessing of names associated withalphanumeric concepts. The assessor made sure the students knew the letters, and if they did not, they were not given the test. For the middle school children (grades 6-9), letters were replaced by words, again to provide an alphanumeric version of rapid naming to contrast with the object naming task. Although rapid word naming is not common in the literature, this was used to mirror the letter naming measure used in the primary version, but again provide something that the children would be more used to in their classroom activities. Words were selected based on them being frequently encountered in the students' schoolbooks to ensure familiarity.

For all tasks, familiarity of items was ensured by asking the child to name each individual item prior to the array of items being presented – there was no time element to this familiarity naming procedure. For each task, 9 different items were used, each repeated 4 times in the array. The time taken to name all items in the array was recorded and used as the measure; though a one second penalty was added to the time if a naming error occurred (these were very rare and less than 1% of responses). Each task was repeated twice to allow an assessment of internal consistency. For the younger cohort, we used the second trial as the score for the measure (taking the first trial as a practice trial for the very young students). For the older cohort, we used the addition of both trials as the final score for the tasks.

Results

Data from the final standardization sample are reported here to show the characteristics of the test measures for the most representative sample of Kuwaiti students. Overall, the measures showed a reasonable distribution in scores across the grades tested, and all showed improvements with grade (see Table 1 for the primary school results and Table 2 for the middle school results).

Table1. Primary school children (mean, standard deviation and minimum-maximum)

	Non-word Reading	Sound Deletion	Non-word Repetition	Rapid Object Naming	Rapid Letter Naming
Grade 2	9.38 (7.90) [0-25]	6.72 (4.13) [0-19]	8.97 (3.29) [2-17]	45.20 (11.25) [26-103]	39.18 (15.70) [17-109.5]
Grade 3	13.64 (7.51) [0-25]	8.94 (4.26) [0-19]	9.73 (3.51) [2-19]	41.05 (10.24) [18-77.5]	31.36 (11.41) [13.5-94.5]
Grade 4	15.09 (7.32) [0-25]	10.81 (3.93) [0-19]	10.45 (3.46) [2-20]	36.83 (8.49) [18-82]	27.16 (9.68) [14-72]
Grade 5	16.45 (6.51) [0-25]	12.22 (3.69) [0-20]	10.75 (3.68) [2-19]	34.56 (7.81) [15.5-65]	23.84 (7.63) [12-72]

Item reliability was good for all measures. The two rapid naming trials for objects (r = .84) and letters (r = .94) were inter-related for the primary school data. Similar reasonably sized correlations were found for the objects (r = .65) and words (r = .93) for the middle school data. The sound deletion task produced Cronbach alpha score of .87 with both the primary and middle school cohorts. The non-word repetition task showed Cronbach alpha values of .75 for the primary school data and .86 for the

middle school data. Non-word reading accuracy led to Cronbach alpha scores of .95 for the primary school measure and .94 for the middle school measure.

Table2. Middle school children (mean, standard deviation and minimum-maximum)

	Non-word Reading	Sound Deletion	Non-word Repetition	Rapid Object Naming	Rapid Word Naming
Grade 6	9.54 (7.78) [0-29]	16.14 (5.76) [1-28]	13.67 (4.50) [3-23]	96.65 (23.40) [27.5-92]	104.96 (50.23) [22.5-183.5]
Grade 7	12.02 (8.25) [0-28]	18.18 (5.75) [0-29]	13.99 (4.96) [1-23]	85.01 (20.31) [21-81]	83.71 (37.24) [16.5-150]
Grade 8	12.88 (8.36) [0-29]	19.42 (5.42) [2-29]	15.48 (3.84) [2-23]	76.71 (17.58) [19.5-79.5]	67.95 (27.75) [18-121]
Grade 9	14.05 (8.33) [0-30]	20.13 (5.29) [6-28]	14.83 (4.70) [3-23]	74.64 (17.34) [22.5-82.5]	60.76 (20.25) [16-83.5]

Measures were also reasonably inter-related across both batteries for each grade level (see Table 3). The correlations for each grade indicated that, with the exception of grade 2, the sound deletion measure showed the largest correlation with the non-word reading measure, with the rapid naming letters/words measure usually second – for grade 2, the correlation between the rapid naming letters measure and non-word reading was similar to that produced by the sound deletion measure and non-word reading. Differences between these two correlations for each grade were significant at the .05 level with the exception of grade 2, which was non-significant (the t-value for the difference between dependent correlations was 0.29), and for grade 6, which approached significance (the t-value for the difference between dependent correlations was 1.86, whereas the significance value for a sample size of 300 is 1.97). Overall, these

correlations suggested that phonological awareness skills were the most likely aspect of phonological processing to support decoding new words across the grade range tested.

Table3. Correlations between measures for each grade level – for each part of the table, correlations for the younger grade are in the right-upper area of the table

	Non-word Reading	Sound Deletion	Non-word Repetition	Rapid Object Naming	Rapid Text Naming
Grade 2/3					Letters
Non-word Reading		.485**	.347**	-.274**	-.501**
Sound Deletion	.602**		.303**	-.244**	-.307**
Non-word Repetition	.309**	.405**		-.040	-.069
Rapid Object Naming	-.309**	-.333**	-.138*		.593**
Rapid Naming Letters	-.413**	-.310**	-.092	.562**	
Grade 4/5					Letters
Non-word Reading		.665**	.394**	-.319**	-.470**
Sound Deletion	.592**		.535**	-.311**	-.395**
Non-word Repetition	.330**	.401**		-.231**	-.234**
Rapid Object Naming	-.350**	-.379**	-.227**		.510**
Rapid Naming Letters	-.410**	-.323**	-.040	.473**	
Grade 6/7					Words
Non-word Reading		.448**	.159**	-.239**	-.346**
Sound Deletion	.569**		.300**	-.328**	-.436**
Non-word Repetition	.201**	.340**		-.086	-.075
Rapid Object Naming	-.157**	-.197**	-.211**		.521**
Rapid Naming Words	-.347**	-.420**	-.216**	.520**	
Grade 8/9					Words
Non-word Reading		.497**	.237**	-.143*	-.288**
Sound Deletion	.475**		.252**	-.260**	-.446**
Non-word Repetition	.266**	.396**		-.131*	-.152**
Rapid Object Naming	-.199**	-.350**	-.288**		.473**
Rapid Naming Words	-.317**	-.491**	-.265**	.492**	

Factor analyses performed on the two batteries also supported the conclusion for the link between phonological awareness and decoding new words. The results for these procedures are presented in Table 4.

Table4. Factor analysis results for the primary and middle school tests

	Primary school measures			Middle school measures		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Principle components						
Eigenvalues	2.75	.97	.58	2.45	.93	.79
% explained	55%	19%	12%	49%	19%	16%
Varimax rotation (loadings)	Letter-sound	Efficient access	Storage	Letter-sound	Efficient access	Storage
Non-word Reading	**.887**	-.235	.134	**.911**	-.100	.047
Sound Deletion	**.779**	-.257	.322	**.738**	-.331	.262
Non-word Repetition	.237	-.072	**.954**	.155	-.099	**.975**
Rapid Object Naming	-.138	**.918**	-.165	-.071	**.901**	-.128
Rapid Letter/Word Naming	-.431	**.783**	.049	-.340	**.816**	-.030

For both batteries, principal component analyses and scree plots were used to determine the number of factors within the data sets. Each analysis produced one factor with a large Eigen value, indicative of a large amount of common variability within the measures. However, three factor solutions explained over 80% of the variability in both analyses and were consistent with the initial three component

model used to develop the two batteries. A fourth factor added less than 10% of variability in both analyses. When the three factors were rotated using a Varimax procedure (Kaiser normalization being used in the rotation), these factors fitted with the components of awareness, storage and rapid retrieval of phonological forms, with non-word decoding loading onto the awareness factor. (Alternative procedures, not assuming independent factors, produced similar results).

Discussion

The results of this study suggest that a three-dimensional model of phonological processing, consistent with that proposed by Wagner and Torgesen (1987) for English, may be appropriate for Arabic as well. These components would relate to measures associated with phonological awareness, phonological memory and rapid naming. The tests developed, and the findings derived from the work performed, should provide opportunities for the modification of assessment practices to include phonological processing skills, and the basis on which to adapt measures for use outside of the context of Kuwait. The measures developed should also provide opportunities for further research on the underlying skills associated with literacy acquisition in Arabic.

In this study, we also included a measure of decoding (non-word reading) along the traditional tests of phonological processing. The results suggest that this measure was associated most clearly with phonological awareness across the grade levels studied, with the potential exception of the grade 2 data where phonological awareness and rapid letter naming showed roughly equivalent levels of association with non-word reading. Interestingly, in these data, there was little evidence of a substantial reduction in the relationship between phonological awareness and decoding over the full range of school grades assessed (from 7-year olds to 14-year

olds): by grade 9, the correlation was still around .5. The potential implication of this for reading instruction is that phonological awareness should be given due attention even in the higher grades. However, this is not the case in most contexts where the Arabic orthography is taught. To the knowledge of the current authors, the vast majority of education systems where the Arabic orthography is taught, short-vowel diacritics are predominantly used in early readers.

As the individual progresses through school, the use of these diacritics is likely to diminish in texts. This is unsurprising given that most written texts that adults will experience will use diacritics sparingly – and the education system will want to prepare the young reader for this, and therefore the focus needs to shift to strategies that rely on context and the fluent retrieval of acquired words from memory. However, it means that in most cases, the emphasis on the relationship between letters and sounds will also diminish across the school years. If the current data are correct for more than the educational context of Kuwait, this may not support learning for those who struggle with literacy acquisition. This is not to argue that all texts should include all diacritic marks. Rather, it is to recognize the potential importance of the link between orthography and phonology, and ensure that the learning is supported to make these links at all ages of acquisition: for example, readers that support fluency that may have a reduction in diacritics, but also support materials that are appropriate for age level and which include key diacritics in order to allow the educator to emphasize phonological awareness as part of learning at any stage of acquisition.

The findings were consistent with the conclusion that phonological awareness is important in decoding new words (non-words). However, it is also important to check that this relationship occurs with real words, both in isolation and within context, to have a better idea of the relative importance of the different phonological skills assessed. The available evidence indicates that measures of phonological awareness show large correlations with word reading in the early grades (K-3) (e.g.,

Taibah & Haynes, 2011; Tibi & Kirby, 2017). Research would be useful to examine the role of phonological awareness in the later grades, such as those in middle school (grades 6 to 9) and with text with varying levels of diacritics included.

Conclusion

Overall, these measures should prove to be a valuable addition to work on Arabic literacy in general, provide opportunities for further research on the underlying skills associated with literacy acquisition, and to the Kuwaiti context in particular, where they will serve as an important component in any battery of language and literacy assessment. The tests can be easily adapted to similar contexts, especially in the Gulf region, where similar curricula are used – though further research, and subsequent modifications, may be necessary to ensure that any differences in spoken forms of Arabic across regions, or educational systems across countries, do not lead to varying levels in performance.

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