



# Morphological Complexity in Arabic Spelling and Its Implication for Cognitive Processing

Iyad Issa<sup>1</sup>

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## Abstract

Spelling poses a challenge to Arabic-speaking learners due to the complexity of the morphological and orthographic systems in Arabic. Arabic morphology has been argued to play a critical role in spelling since its morphological operations are built on a system consisting of a root that is interlocking into different patterns of vowels to form different categories of words. This study made a detailed classification of spelling errors in a word dictation task, based on morphological structures, undertaken by 107 Typically-developing learners (TD) and learners with learning disabilities (LD) attending the same schools in Jordan. All participants ranged in age from 7 years, 3 months to 15 years, 2 months (grades 2 to 8). The spelling task was made up of 400 common words representing most morphological forms in different conjugations and grammatical classes. The results indicated that TD and LD learners follow a similar pattern of complexity even though the LD group produced more errors than the TD group. Both groups encountered more difficulties in passive voice forms followed by active voice forms. Furthermore, both groups spelled nouns, verbal nouns and derivations more accurately than verbal forms (active and passive voice). The results provide additional evidence for the nonlinear growth of morphological knowledge in spelling. In addition, spelling errors suggested that the spelling process goes in a hierarchical way where words can be accessed and processed either according to the root or according to the stem. Therefore, roots or stems are firstly accessed and attached to basic word patterns (the grapheme without diacritics and affixes). Thereafter, prefixes and, then, suffixes are attached to the word pattern and, finally, diacritics are accessed and attached to the word pattern.

**Keywords** Arabic · Spelling errors · Morphological complexity · Learning disabilities · Morphographs · Morphological processing · Semitic languages · Root · Word pattern · Dual-route hypothesis · The morpheme-based theory · The stem/ word-based theory

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✉ Iyad Issa  
iyad.issa.ii@gmail.com

<sup>1</sup> Community Development Authority, P.O. BOX: 212288, Dubai, UAE

## Introduction

In general discussions on teaching and learning there is no agreement on the best way to teach spelling for young learners. Some spelling strategies adopt the phonemic approach (e.g., Treiman et al., 1994) where the focus is on understanding the relationship between the letters and their corresponding sounds in order to perform spelling successfully. This approach works well with regular words, i.e., words that are spelled the way they are pronounced, while words that are spelled differently from their pronunciation like ‘yacht’ pose a difficulty with this approach. The whole-word approach, which is mainly used in teaching spelling in Arabic (e.g., Abu-Hamour, 2013), relies on memorizing word spellings and ignores their phonological and morphological structures. In this approach, learners are given lists of words to practice without clear instructions on how to learn them. Another approach is the morphemic approach which depends on teaching morphographs (e.g., Ravid, 2012), the smallest meaningful unit in writing, such as prefixes, suffixes, roots, etc., and teaching principles and rules that are followed in combining morphographs to spell words properly. For example, the word *uncovered* comprises of the prefix *un*, the base *cover*, and the suffix *ed*. Using morphographs in teaching spelling, the morphemic approach, has many benefits in comparison with other approaches. In English, Simonsen and Gunter (2001, p. 101) indicates that “teaching students to spell morphographs and teaching the rules for combining morphographs will allow students to spell a far larger set of words accurately than by teaching individual words through rote memorization of weekly spelling lists”. This approach may work well with Arabic language since morphographic units (roots and word patterns) are the main components in Arabic words and can capture the internal structure of Arabic words such as vocalization and affixes (e.g., Ravid, 2012; Taha & Saiegh-Haddad, 2017).

In general, young learners are first exposed to Modern Standard Arabic (MSA) upon beginning first grade where it is the language of school instruction. In the early years of schooling, children use books with fully vowelized orthography including both letters and diacritics. They are taught to read and write words with short vowels. In advanced grades, the use of diacritics is reduced. In general, Arabic writing uses short vowels in children’s and schools’ books, religious texts and poetry while newspapers, books, magazines lack short vowels.

In Jordan and since 1987, the Ministry of Education has adopted policies and guidelines for implementing and developing inclusive education for students with LD in mainstream schools (Ministry of Education, 2017). The regular classrooms are commonly comprised of both TD and LD students. For this reason, it seems very important to investigate spelling error patterns of both LD and TD students in order to better understand the spelling development and strategies that are used by language learners (Nunes et al., 1997; Steffler, 2001), so that appropriate classroom instruction and strategies in teaching spelling for both groups could be developed.

Spelling in Arabic poses significant challenges to language learning for both young and old learners and especially for students with LD due to the morphological and orthographic complexity in the Arabic writing system, in addition to the diglossic situation in Arabic.

Arabic morphology has been argued to play a critical role in spelling due to the uniqueness of the morphological and the orthographic systems in Arabic (e.g., Asadi et al., 2017; Issa, 2020; Saiegh-Haddad, 2013). Arabic morphology “exhibits rigorous and elegant logic” (Ryding, 2005, p. 45) since its morphological operations, unlike English and other

Indo-European languages, depend mainly on discontinuous morphemes. It comprises, mainly, of a system consisting of a root that is interlocking into different patterns of vowels to form different categories of words. Roots are abstract entities that convey the semantic information in the Arabic word, and often are of trilateral or quadrilateral consonants, i.e., they comprise of three or four consonants. In addition, word patterns are constructed out of short vowels built onto roots; short vowels are interleaved between the root consonants to produce different word entities (grammatical functions) and, at the same time, do not disrupt the orthographic order of the consonantal root. Thus, the consonantal root and the word pattern cannot be used in isolation; they need to be combined in order to construct a real word. For example, شَرِبَ [ʃariba] ‘he drank’ is constructed from the root morpheme ش ر ب {rjb} ‘notion of drinking’ and the pattern morpheme ’a-i-a’. The two morphemes are arranged according to the word pattern فَعِلَ [faʕila]<sup>1</sup> /CaCiCa/ (consonant–vowel sequence). Thus, شَرِبَ [ʃariba] ‘he drank’ conforms to the word pattern [faʕila].

A considerable amount of literature in the context of oral production has been published on morphological processing in Semitic languages and particularly Arabic (e.g., Bat-El, 1994; Issa, 2006; Safi-Stagni, 1995; Prunet et al., 2000). These studies attempted to offer a better understanding of the underlying representation and processing of Arabic words in the mental lexicon—“the listener’s mental representation of what words sound like and what they mean” (Marslen-Wilson et al., 1994, p. 3) during spoken, reading and spelling tasks and, consequently, provide an understanding of the potential underlying deficits in reading and spelling.

Overall, there are two main contending views of the mental representation and processing of Arabic words which have implications for the patterns of errors in reading and spelling. One view is the morpheme-based theory where complex words are mentally decomposed before any access occurs (e.g., Boudelaa, 2014). This hypothesis first appeared in the pioneering work of Taft and Forster (1975). They argued that morphemes are represented separately and independently in the mental lexicon, i.e., roots, and derivational and inflectional affixes are represented as independent units.

The stem/ word-based theory is another main view of Arabic morphology which has implications for the mental representation and processing of Arabic words. This approach claims that words are stored and processed according to their stems in long term memory, excluding the effect of morphological complexity on processing and representation. Therefore, it does not allow morphological operations (accessing and processing) on units smaller than a word. This approach failed to explain findings of many studies arguing for the lexical status of the root and the pattern in Arabic words, such as those of Berg and Abd-Al-Jawad (1996) and Prunet et al. (2000). However, this approach received some supports from studies on Hebrew (a Semitic language) such as those of Bat-El (1994) and Ussishkin (1999) who proposed that Semitic words are represented according to their full surface forms in the mental lexicon rather than their morphemic components (root and template). Bat-El (1994, p. 593) argued that “the process of stem modification never requires a consonantal root, and therefore such a unit is not relevant to the grammar; it does not exist”.

As a result, the lexical (morphemic) status of the consonantal root and the word pattern in Semitic languages, and particularly Arabic, has been debated. Some studies (e.g., Bat-El, 1994; Ratcliffe, 1997; Ussishkin, 1999) focusing on morpho-phonological and

<sup>1</sup> Arab grammarians, traditionally, use the root فعل [faʕl]—a basic meaning of ‘to do’—to represent the three consonants of the Arabic root as a generic one to exemplify the root and word patterns.

morpho-syntactic phenomena suggested that Arabic words are mentally represented according to their full surface form rather than their underlying consonantal roots. Other studies such as that of Benmamoun (1999, 2003) postulated that Arabic words are represented according to their imperfective stems ignoring the role of the root and the word pattern. However, other studies, based on speech outcomes of aphasics, slips of the tongue, and Arabic hypocoristics, such as Boudelaa and Marslen-Wilson (2001), Issa (2006), Prunet, et al. (2000), and Idrissi and Kehayia (2004) have provided a considerable amount of evidence, which converges to support that Arabic words are mentally represented, accessed and processed according to their morphemic components, i.e., the root and the word pattern. These studies highlighted the centrality and the important role of the root and the word pattern as distinct lexical entities.

The Arabic orthographic system represents consonants and the three long vowels (أ, و, ي) /aa, uu, ii) by letters, while short vowels are marked by small diacritics. Consequently, consonantal roots are fully represented in the orthographic system while vocalic components (short vowels) of the word patterns, which are represented by diacritics, are optional in writing. For example, كَتَبَ [kataba] ‘he wrote’, and كُتِبَ [kutiba] ‘was written’ are two words that have different meanings although they have the same grapheme representation كَتَبَ when they are written without short vowels. Thus, Arabic orthography varies in transparency between phonemic-graphemic relation depending on whether short vowels are used or not. In sum, the optional system of diacritics in the Arabic orthography leads to two forms of orthography – a form of diglossia: a shallow orthography where short vowels are represented by diacritics and a deep orthography when short vowels are absent (Abu-Rabia, 1996, 1997; Azzam, 1989). Consequently, the Arabic learner needs to use morphological structure to read or spell unvowelled words due to the ambiguity that is caused by the absence of the short vowels (Elbeheri et al., 2011; Saiegh-Haddad, 2013).

Saiegh-Haddad (2013, p. 172) points out that “while opaque in the relationship between the orthographic form of the word (letters only) and its full phonological structure, the unvowelled orthography is highly transparent in the relationship between the orthographic form of the word and its morphological structure: root and word-pattern”. In the same direction, Elbeheri et al., (2011, p. 125) suggests that “there is an overriding tendency of Arabic orthography to give precedence to morphological and syntactic clues over phonological transparency, leading to a preference for non-vowelized text, particularly after initial literacy learning school grades”.

Another challenge to learning spelling in Arabic and one which necessitates using morphological structures in teaching spelling is the fact that Arabic speakers are familiar with two forms of Arabic: the literary Arabic (Modern Standard Arabic (MSA)) and the local (non-standard) Arabic dialects that exist in every country. MSA (written and oral forms) acts as a universal form of language that is used and understood in formal communication, and in media such as radio, TV, books and newspapers. It is also used and taught in universities and schools at all stages of education. Spoken dialects, on the other hand, are just used in daily communication. Therefore, Arabic is considered a diglossic language that is characterized by the presence of two or more varieties of the language, spoken and written (Coulmas, 1996). As a result, phonological variations can occur between the spoken dialect and MSA and that may challenge the traditional instruction used in teaching spelling, especially the ones depending on the phonological information of the word or memorizing the spelling of the word. For example the word, ضرب [ḍaraba] ‘hit’ in MSA is articulated as ظرب [ḍaraba] in some local dialects, and the word قلم [qalam] ‘a pen’ in MSA is articulated as [galam], [ʔalam], or [kalam] in some dialects in Jordan. The phoneme /q/ in MSA can be articulated as /ʔ/, or /g/, or /k/ in Jordan depending on the place where speakers live or

**Table 1** Details of the participants

Class	Typically Developing Children			Children with Learning Disabilities			Total
	Average Age	Males	Females	Males	Females	Average Age	
2nd	7.7	5	5				10
3rd	8.8	5	5				10
4th	9.6	5	5	3	3	10.2	16
5th	10.6	5	5	5	5	11.3	20
6th	11.5	5	5	5	3	11.9	18
7th	12.5	4	5	4	3	13.4	16
8th	13.8	5	5	4	3	14.0	17
Total	10.6	34	35	21	17	12.2	107

come from. These phonological variations add more difficulties to learners particularly in the early years. Therefore, “the use of the morphological word pattern to recover the standard Arabic phonological form might be particularly important in such instances especially as the word-pattern captures the phonological structure of the word” (Taha & Saiegh-Haddad, 2017, p. 35).

Morphographic principles, which consider the root and the word pattern as the basic units in the word, can provide an effective strategy in Arabic which is considered a very systematic language based on root-pattern morphology. Most Arabic words are formed from trilateral and quadrilateral roots by attaching these roots to predetermined word patterns. Therefore, morphographic units or roots and word patterns in Arabic are the best means by which one can capture the internal structure of Arabic words such as vocalization, diacritics, phonetics and allomorphic variations. Therefore, using morphographs in teaching spelling offers an opportunity to provide graphemic regularities that cannot be offered by phonological approaches in Arabic. This study argues for adopting the word pattern and the root as the basic morpho-graphemic units in Arabic words that young learners should be exposed to and taught from early on in a systematic way based on the complexity hierarchy to improve spelling abilities. Therefore, investigating the hierarchy of morphological complexity is an important step to adopt in teaching young learners.

## The Study

This study made a detailed classification of spelling errors in a word dictation task undertaken by 107 grade school learners attending the same schools in Jordan. The aim of the study was to define the hierarchy in which morphological forms were mastered across grade and group levels in order to incorporate and take advantage of the complexity of Arabic morphological forms, including their word patterns, in spelling.

## Participants

Two groups of participants took part in the study, referred to as TD and LD learners ( $N = 107$ ). Sixty-nine (69) TD learners ranged in age from 7 years, 3 months to 14 years, 7 months (grades 2 to 8) with an average age of 10 years, 6 months participated in this study (see Table 1). Thirty-four were boys and thirty-five were girls. Each grade exhibited

an equal representation of male and female learners ( $N=5$ ) except grade 7. TD learners are defined as those who have been reported by their teachers to be of normal academic performance and have no history of receiving special education assistance.

The LD group were classmates of the TD learners and they comprised thirty-eight (38) participants (21 males and 17 females) ranged in age from 10 to 15 years, 2 months (grades 4 to 8), with an average age of 12 years, 2 months.

LD learners had been already identified as having specific learning disabilities in reading, spelling, and writing skills by a resource room teacher and had met the criteria of the Jordanian Ministry of Education for having learning disabilities. They had also received a comprehensive evaluation based on the Ministry of Education regulations in Jordan. This group included some learners who had repeated grades. The LD learners attended resource rooms which provided remedial and special education services and were located within the same public schools. Generally, resource rooms follow the ‘pull out’ mode where a student is temporarily pulled out from his/her regular class for a period of time, varying from one to three class periods each day.

All participants were native speakers of Arabic and were recruited in two governmental single-sex schools in Irbid city, in north Jordan where Arabic is the mother tongue. All participants were attending mainstream schools that have resource rooms and came from the same area of Irbid. They also came from middle socio-economic classes. All learners had no sight, hearing, or serious health problems.

## Materials

### The Morphologically-Based Spelling Task

The morphologically-based spelling task, which was designed to investigate the developmental complexity of morphological forms among TD and LD learners in spelling, is an isolated word spelling task that serves as a measure of spelling ability. This dictated spelling task was designed to measure the student’s accuracy in spelling morphological forms and not for speed, and also to determine the morphological complexity across grades and groups.

For the purpose of the current study, the morphologically-based spelling task was made up of 400 common real words representing all morphological forms in different conjugations and grammatical classes. The examiner can choose these words from lists comprising of 694 words. These words were distributed and coded into eight (8) main morphological forms (see Table 2), which were then further classified into minor coded forms. Each morphological form comprised of words that express different grammatical notions such as tense/aspect, person, voice, mood, gender, number, case and definiteness.

Words were randomly distributed into thirty-five testing sheets. Each sheet had a serial number and was divided into twenty numbered boxes. Numbers of the boxes referenced the target words and their morphological forms. A copy with a complete list of words and their reference numbers was used by the experimenter to read out target words.

The morphologically-based spelling task was administered to groups that ranged in size from five to ten participants. Firstly, the experimenter ensured that all learners were on the same page. For example, the experimenter said: “page number one, box number one”, and thereafter he reads out the target word with full consideration for the proper pronunciation of diacritics. Each word item was first read aloud, then repeated two more times.

**Table 2** Main morphological forms of the morphologically-based spelling task

No	Morphological form in Arabic	Translation in English	IPA	Code used in the study
1	الأفعال الصحيحة المبينة للمعلوم	Active voice intact/ strong verbs	ʔal-ʔaffa:l ʔaʕ-ʕahi:ħa	ASV
2	الأفعال الضعيفة	Active voice weak verbs	ʔal-ʔaffa:l ʔad-ɗafi:ħa	AWV
3	الأفعال المزيدة	Augmented verbs	ʔal-ʔaffa:l ʔal-mazi:da	AUV
4	الأفعال الصحيحة المبينة للمجهول	Passive voice strong (intact) verbs	ʔal-ʔaffa:l ʔaʕ-ʕahi:ħa ʔal-mabnijja lil- majhu:l	PSV
5	الأفعال الضعيفة المبينة للمجهول	Passive voice weak verbs	ʔal-ʔaffa:l ʔal-ɗafi:ħa	PWV
6	المشتقات	Derivations	ʔal-muʕtaqa:t	DER
7	الأسماء	Nouns	ʔal-ʔasma: ʔ	NOUN
8	المصادر	Verbal nouns	ʔal-maʕṣa:dir	VN

English translation for most Arabic morphological terms in this study is borrowed from Sawalha and Atwel (2013)

Learners were instructed to write the target words they heard with diacritics on their sheets. The experimenter collected each sheet whenever a single sheet was completed.

## Procedures

All tasks were conducted on the school campus in the resource room and the library. The tasks took place during the regular school hours in coordination with the classroom teacher and the school management. Each testing session was about 45 min and each participant needed over five testing sessions on different days to complete the tasks. The whole testing procedure was completed within a period of five weeks. All tasks were conducted by the researcher, the school's specialist in learning disabilities and two other graduate students who were trained in administering the tasks. Experimenters administered practice items before each task.

## Scoring Procedure

Target words in the morphologically-based spelling task were coded and classified in terms of morphological forms. Each target word falls under only one main morphological form and one minor form. The aim of the morphologically-based spelling task was to define the hierarchy in which morphological forms were mastered across grade and group levels rather than focusing on types of spelling errors among learners. Therefore, an error was defined as any error or misspelling that changes the structure and/or the meaning of the morphological form. Such errors could involve letters and diacritics in terms of sequencing, additions, omissions, reversals, inversions, incorrect sound-symbol associations, segmentation, or directionality. In addition, diacritics were considered in scoring if they were necessary to make a word unambiguous. Therefore, leaving diacritics in a word was considered as an error if their absence made the word ambiguous such as in the passive voice



form. For example, كَتَبَ /kataba/ ‘wrote’ and كُتِبَ /kutiba/ ‘was written’ have the same grapheme and are only differentiated when using diacritics. Therefore, diacritics are necessary in this case.

Each word in the spelling task received a score out of three: three points for the correct spelling, i.e., without any errors, two points if the spelling comprised of one error, and one point for two errors, while spelling with more than two errors received a zero point. The number of scores associated with each morphological form was calculated to determine the total score in each form across grades and groups. Total scores of all morphological forms for each participant across grades and groups were summed up to determine the general performance in the morphologically-based spelling task.

In order to allow a direct comparison between all morphological forms across grades and groups to reference the complexity of morphological forms, data were normalized across learners. Following the procedure presented by Biber et al. (1998), the totals for each morphological form were divided by the total number of words in the form and then multiplied by the average number of words in each morphological form which was nine in the present study.

## Data Analysis

The statistical analysis was carried out using SPSS v22 (Statistical Package for the Social Sciences) to find out the complexity hierarchy in spelling morphological forms.

Multivariate analysis of variance (MANOVA) was conducted to examine main effects and interactions between the two groups (LD and TD) and grade levels (two to eight) regarding learners’ performance in spelling morphological forms. Next, post-hoc analyses were performed to compare spelling performance in each morphological form separately.

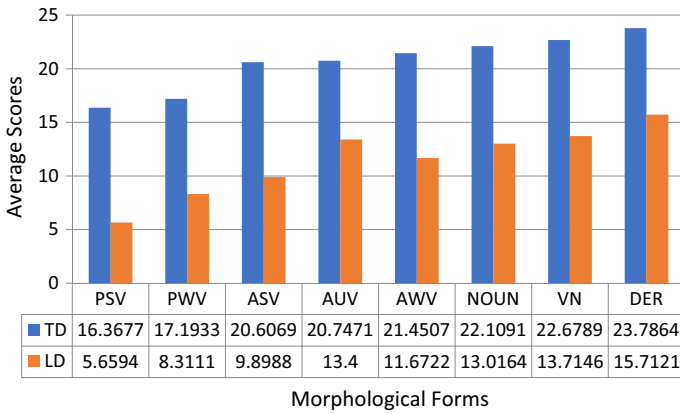
Descriptive statistics were employed to describe the performance complexity of participants on the morphologically-based spelling task. Descriptive statistics were also utilized to examine the non-linear growth of the morphological knowledge through the spelling performance and the morphological patterns of complexity that LD and TD learners tend to follow. In addition, separate t-test procedures were performed to determine performance differences between LD and TD groups in spelling.

## Results

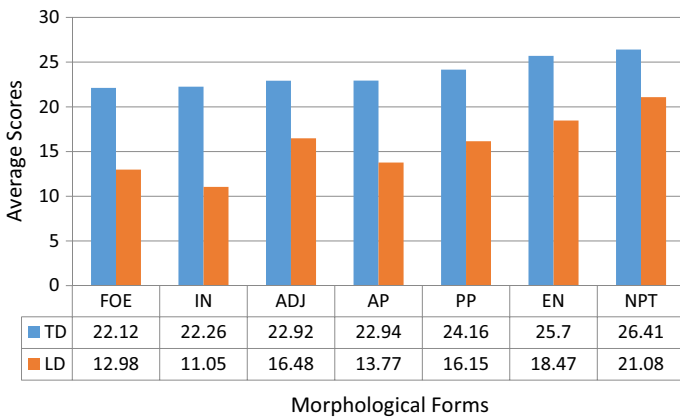
The statistical results indicated that both groups—TD and LD—found derivations (DER) and verbal nouns (VN) the easiest morphological forms in the morphologically-based spelling task. On the other hand, and giving the difficulty of using diacritics due to the heavy memory load required to process them, passive voice/ strong (intact) verbs (PSV) and passive voice/ weak verbs (PWV) were found to be the most difficult forms for both groups. They only differed in the difficulty of augmented verbs (AUV). LD found active voice/ weak verbs (AWV) more difficult than augmented verbs (AUV), while TD performed better on active voice/ weak verbs (AWV) compared to augmented verbs (AUV) as shown in Fig. 1.

Therefore, TD and LD learners made primarily more errors within the passive voice/ intact verb (PSV) form followed by the passive voice/ weak verb form (PWV), while verbal nouns (VN) and derivations (DER) received the highest scores of the respondents. As a





**Fig. 1** Morphological complexity of TD and LD learners. Note: PSV=Passive voice/ strong or (intact) verbs, PWV=Passive voice/ Weak verb, ASV=Active voice/ strong (intact) verbs, AUV=Augmented verbs, AWW=Active voice/ Weak verbs, Noun=Nouns, VN=Verbal Nouns, DER=Derivations,

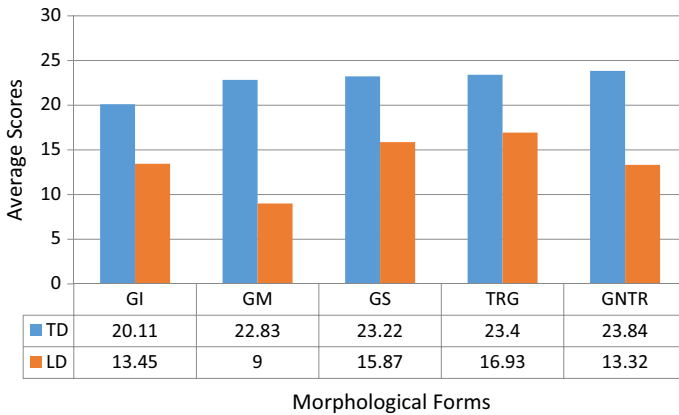


**Fig. 2** Morphological complexity of derivation among TD and LD. Note: FOE=Form of exaggeration, IN=Instrumental noun, ADJ=Adjective, AP=Active participle, PP=The passive participle, EN=Elative noun, NPT=Nouns of place and time

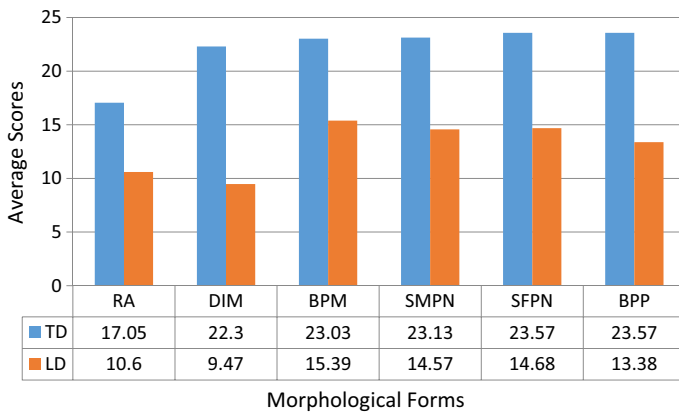
result, the complexity of morphological forms for both LD and TD followed a pattern of complexity (from the easiest to the most difficult) of:

1—Derivations (DER) received the highest scores in spelling among TD learners (Mean=23.7864, SD=3.13581) and LD learners (M=15.7121, SD=5.79163). With respect to the minor forms, descriptive data was examined and indicated that TD found forms of exaggerations (FOE) followed by instrumental nouns (IN) as the most difficult forms in the spelling task while LD found the opposite; instrumental noun (IN) followed by forms of exaggerations (FOE) as the most difficult forms. Elative nouns (EN) and nouns of place and time (NPT) were the easiest forms in both groups as shown in Fig. 2.

2—Verbal nouns (VN) was the second easiest form for both TD (M=22.6789, SD=3.63524) and LD (Mean=13.7146, SD=4.69798). The TD followed a complexity pattern of: (a) Verbal nouns of non-trilateral root (GNTR), (b) Trilateral root verbal nouns



**Fig. 3** Morphological complexity of verbal nouns among TD and LD. Note: GI= Verbal nouns of instance, GM=Verbal nouns with initial miim, GS=Verbal nouns of state, TRG=Triliteral root verbal nouns, GNTR= Verbal nouns of non-triliteral root

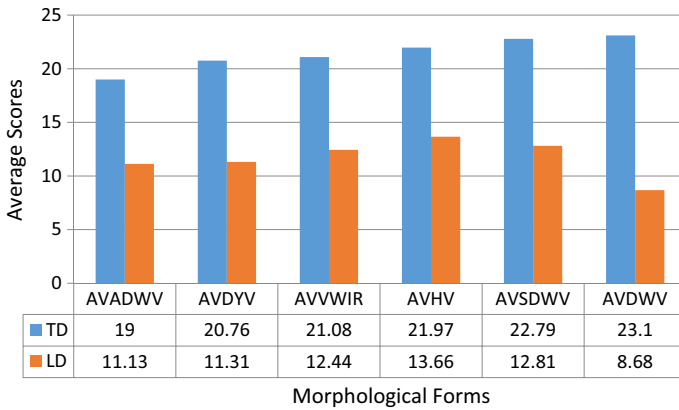


**Fig. 4** Morphological complexity of noun forms among TD and LD. Note: RA=Relative adjective, DIM=Diminutive, BPM=Broken Plural of multitude, SMPN=The Sound Masculine Plural Noun, SFPN=The Sound Feminine Plural Noun, BPP=Broken Plural of paucity

(TRG), (c) Verbal nouns of state (GS), (d) Verbal nouns with initial miim (GM), (e) Verbal nouns of instance (GI), while, on the other hand, the LD followed a complexity pattern of: (a) TRG, (b) GS, (c) GI, (d) GNTR, (e) GM (see Fig. 3).

3—Nouns (NOUN) was the third complex form for TD ( $M=22.1091$ ,  $SD=3.77724$ ) and the fourth complex form among LD ( $M=13.0164$ ,  $SD=6.20389$ ). NOUN has six minor forms; the sound masculine plural noun (SMPN), the sound feminine plural noun (SFPN), broken plural of paucity (BPP), broken plural of multitude (BPM), relative adjective (RA), and diminutive (DIM). TD followed a complexity pattern of: a) BPP and SFPN with a same average, b) SMPN, c) BPM, d) DIM, e) RA. LD, on the other hand, followed a complexity pattern of: a) BPM, b) SFPN, c) SMPN, d) BPP, e) RA, f) DIM (see Fig. 4).

4—Active voice/weak verb (AWV) was the fourth complex form for TD ( $m=21.4507$ ,  $SD=3.27421$ ), and the fifth complex form for LD ( $M=11.6722$ ,  $SD=4.77058$ ). AWV



**Fig. 5** Morphological complexity of active voice/ weak verb forms. Note: AVADWV = Active voice/ adjacent doubly-weak verb, AVDYV = Active voice/ defective with yaa? Verb, AVVWIR = Active voice/ verbs with a weak initial radical, AVHV = Active voice/ hollow verb, AVSDWV = Active voice/ separated doubly-weak verb, AVDWV = Active voice/ defective with waw verb

comprises of six minor forms; active voice/ adjacent doubly-weak verb (AVADWV), active voice/ defective with yaa? verb (AVDYV), active voice/ defective with waw verb (AVDWV), active voice/verbs with a weak initial radical (AVVWIR), active voice/ hollow verb (AVHV), active voice/ separated doubly-weak verb (AVSDWV).

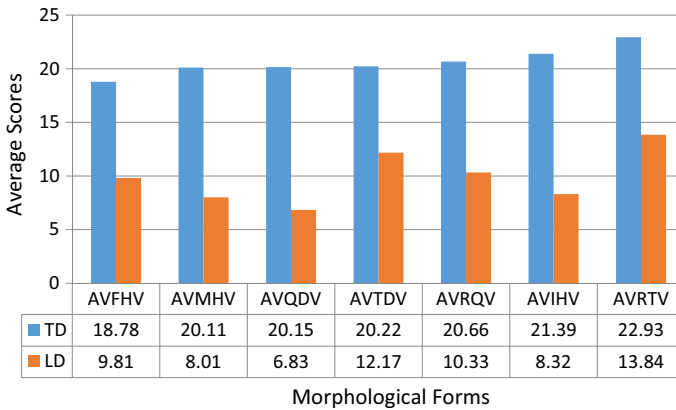
This pattern is particularly striking for AVDWV form (defective with waw verb), which has waw ‘و’ [w/uu] as the last consonant of the root and may disappear in the orthographic representation of some conjugations. For example, the و [w/uu] of the root دعو [dʕw] ‘to invite’ appears in دَعَوْتُ [daʕawtu] ‘I invited’ while it is dropped in دَعَا [daʕaa] ‘he invited’ and دُعِيْتُ [duʕiitu] ‘I was invited’. LD learners found AVDWV as the most difficult form while, on the other hand, TD achieved the highest scores in AVDWV and that might reflect the educational strategies that LD tend to use when reading and writing words which depends, mainly, on analyzing words into its contents.

LD followed a pattern of (see Fig. 5): (a) AVHV, (b) AVSDWV, (c) AVVWIR, (d) AVDYV, (e) AVADWV, f) AVDWV. TD found AVDWV as the easiest form in spelling and followed complexity patterns of (a) AVDWV, (b) AVSDWV, (c) AVHV, (d) AVVWIR, (e) AVDYV, and f) AVADWV which exhibited the most difficult form.

5—Augmented verbs (AUV) is the fifth complex form for TD (M=20.7471, SD=3.83210) and the third complex form for LD (M=13.40, SD=6.26588). In general, AUV exhibited a moderate complexity in both groups. It comprises of two minor forms; trilateral verb augmented by one letter (TA1), and trilateral augmented by two letters (TA2). TD and LD followed the same complexity pattern where TA1 was easier than TA2.

6—Active voice/ strong (intact) verb (ASV) is the sixth complex form for both TD (M=20.6069, SD=3.84695) and LD (M=9.8988, SD=4.52428).

TD followed a complexity pattern of: (a) Active voice/ regular trilateral intact verb (AVRTV), (b) Active voice/ initially-hamzated verb (AVIHV), (c) Active voice/ regular quadrilateral intact verb (AVRQV), (d) Active voice/ trilateral-Doubled verb root (AVTDV), (e) Active voice/ quadrilateral-doubled verb (AVQDV), (f) Active voice/ medially-hamzated verb (AVMHV), (g) Active voice/ finally-hamzated verb (AVFHV), while



**Fig. 6** Morphological complexity of active voice/ strong (intact) verb forms. Note: AVFHV = Active voice/ finally-hamzated verb, AVMHV = Active voice/ medially-hamzated verb, AVQDV = Active voice/ quadriliteral-doubled verb, AVTDV = Active voice/ trilateral-Doubled verb root, AVRQV = Active voice/ regular quadriliteral intact verb, AVIHV = Active voice/ initially-hamzated verb, AVRTV = Active voice/ regular trilateral intact verb

LD followed a pattern of: (a) AVRTV, (b) AVTDV, (c) AVRQV, (d) AVFHV, (e) AVIHV, (f) AVMHV, (g) AVQDV (see Fig. 6).

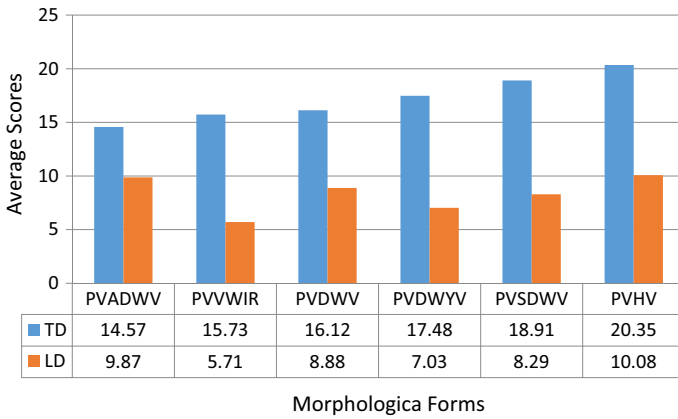
7—Passive voice/ weak verb (PWV) is considered as the second most difficult morphological form in spelling for both LD ( $M=8.3111$ ,  $SD=4.52384$ ) and TD ( $M=17.1933$ ,  $SD=5.02045$ ) learners.

TD followed a complexity pattern of: (a) Passive voice/ hollow verb (PVHV), (b) Passive voice/ separated doubly-weak verb (PVSDWV), (c) Passive voice/ defective with yaa? verb (PVDWYV), (d) Passive voice/ defective with waw verb (PVDWV), (e) Passive voice/ verbs with a weak initial radical (PVVWIR), (f) Passive voice/ adjacent doubly-weak verb (PVADWV) while LD group followed a pattern of: (a) PVHV, (b) PVADWV, (c) PVDWV, (d) PVSDWV, (e) PVDWY, (f) PVVWIR as shown in Fig. 7. Here, it seems that the extent to which the weak radicals appear in the orthographic representation play a role in the complexity hierarchy. For example, learners received higher scores in PVHV (hollow verb) which comprises a weak radical in the second root consonant which is dropped and replaced by | [aa], a long or a short vowel, or a hamza ‘glottal stop /ʔ/’ in most conjugations. For instance, the weak radical و [w] of the hollow root خوف [xwf] ‘notion of fear’ disappears in most conjugations such as: خُفْتُ [xuftu] ‘I was afraid’, خِيفَتْ [xiifat] ‘she was afraid’. In addition, these passive forms are formed differently in local dialects which might have an impact on their spelling in MSA.

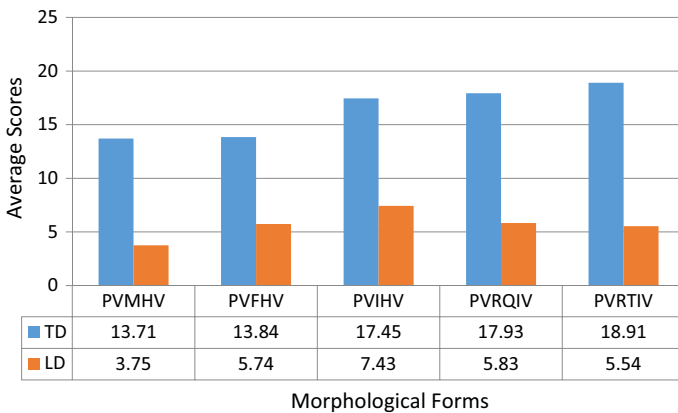
8—Passive voice/ strong (intact) verb (PSV) was found as the most difficult form for both TD ( $M=16.3677$ ,  $SD=4.39740$ ) and LD ( $M=5.6594$ ,  $SD=2.99431$ ) in spelling task.

As shown in Fig. 8, TD followed a complexity pattern of: (a) Passive voice/ regular trilateral intact verb (PVRTIV), (b) Passive voice/ regular quadriliteral intact verb (PVRQIV), (c) Passive voice/ initially-hamzated verb (PVIHV), (d) Passive voice/ finally-hamzated verb PVFHV), (e) Passive voice/ medially-hamzated verb (PVMHV), while LD followed a complexity pattern of: (a) PVIHV, (b) PVRQIV, (c) PVFHV, (d) PVRTIV, (e) PVMHV.

It is noted that learners made more errors within hamzated verbs, which involve a hamza (ʔ) ‘the glottal stop /ʔ/’ in the first, second, or the third consonant. Learners

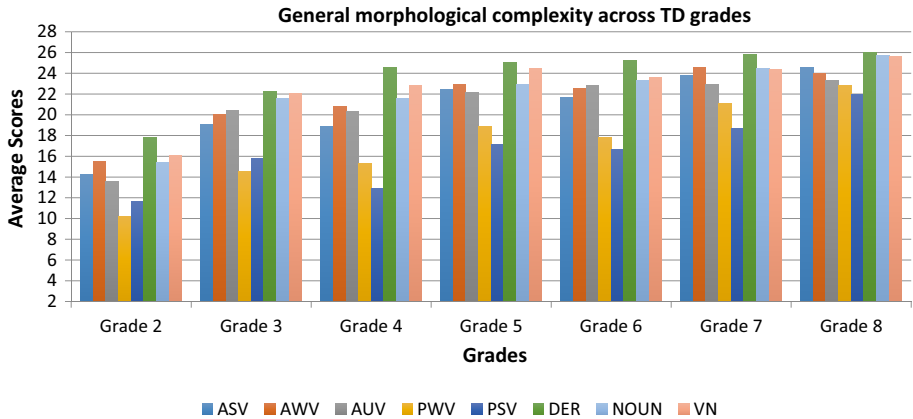


**Fig. 7** Morphological complexity of passive voice/ weak verb forms. Note: PVADWV=Passive voice/ adjacent doubly-weak verb, PVVWIR=Passive voice/ verbs with a weak initial radical, PVDWV=Passive voice/ defective with waw verb, PVDWYV=Passive voice/ defective with yaa? verb, PVSDWV=Passive voice/ separated doubly-weak verb, PVHV=Passive voice/ hollow verb



**Fig. 8** Morphological complexity of passive voice/ intact verb forms. Note: PVMHV=Passive voice/ medially-hamzated verb, PVFHV=Passive voice/ finally-hamzated verb root, PVIHV=Passive voice/ initially-hamzated verb, PVRQIV=Passive voice/ regular quadriliteral intact verb, PVRTIV=Passive voice/ regular trilateral intact verb

found medially-hamzated verbs (PVMHV) more difficult than other forms. Such findings might be due to the fact that a hamza (ء) ‘the glottal stop /ʔ/’ in medially-hamzated verbs require a seat either in the form of an alif | [aa] such as سُئِلَتْ [tusʔalu] ‘she is asked’ or in the form of nabira, which looks like ٱ [y], such as سئِلَتْ [suʔilat] ‘she was asked’. Therefore, this situation causes a confusion for learners in choosing the proper orthographic representation for the hamza.



**Fig. 9** General morphological complexity across TD grades. Note: ASV = Active voice/ strong (intact) or strong verbs, AWW = Active voice/ weak verbs, AUV = Augmented verbs, PSV = Passive voice/ strong (intact) verbs, PWV = Passive voice/ weak verb, DER = Derivations, NOUN = Nouns, VN = Verbal nouns

### Morphological Complexity Across TD and LD Grades

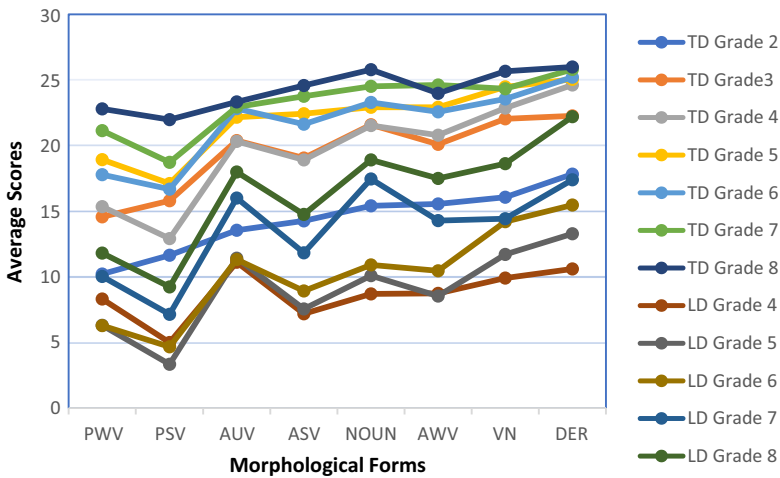
Investigating morphological complexity across grades is of high importance in order to understand patterns of complexity in each grade that can help in designing the appropriate assessment and educational/ therapeutic strategies to overcome spelling difficulties.

Generally, it was expected that individual grades would vary in their complexity patterns reflecting different conditions surrounding the educational process such as teaching instruction inside the classroom, teacher experience, and grade level, etc. However, the descriptive data of grades indicated that almost all grades share common patterns (see Fig. 9).

In sum, passive voice/ weak verb (PWV), and passive voice/ strong (intact) verb (PSV) were found to be the most difficult forms across grades while nouns (NOUN), verbal nouns (VN) and derivations (DER) were the easiest. Augmented verb (AUV), active voice/ strong (intact) verb (ASV), and active voice/ weak verb (AWV) exhibited a moderate difficulty.

The data indicated that all learners achieved the highest scores in DER followed by VN except grade 7 and grade 8 where the easiest form was DER followed by NOUN. Grade 2 and grade 3 exhibited almost the same complexity pattern. Grades 2 and 3, in contrast to other grades, found passive voice/ weak verb (PWV), followed by passive voice/ intact verb (PSV) as the most difficult forms in spelling which might be due to the difficulty in using diacritics properly while verbal noun (VN) and derivation (DER) were the easiest forms in spelling. Also, it is notable that grade 2 found active voice/ weak verb (AWV) easier than nouns (NOUN) which could reflect the intensive teaching of stem and whole words in the second grade. on the other hand, grade 3 found the opposite; nouns (NOUN) were easier than active voice/ weak verbs (AWV).

The pattern of complexity in grade 4 and above changed from PWV as the most difficult form, followed by PSV, to PSV as the most difficult form followed by PWV, while VN and DER continue to be the easiest forms until grade 6. In these grades, NOUN was easier than AWV and ASV. In grade 7 and grade 8, and similar to the previous grades, learners found PSV followed by PWV as the most difficult forms, which could be due to difficulties in accessing the appropriate diacritics, while DER followed by AWV were the



**Fig. 10** Patterns of morphological complexity across TD and LD grades. Note: ASV = Active voice/ strong (intact) or strong verbs, AWW = Active voice/ weak verbs, AUV = Augmented verbs, PSV = Passive voice/ strong (intact) verbs, PWV = Passive voice/ weak verb, DER = Derivations, Noun = Nouns, VN = Verbal nouns

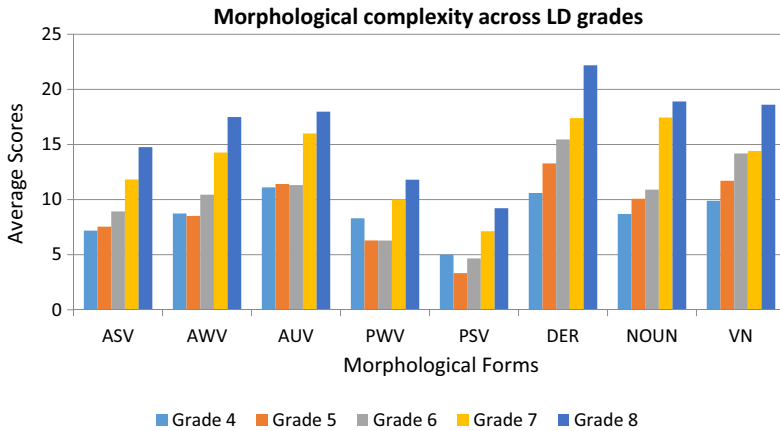
easiest in grade 7 and DER followed by NOUN in grade 8. In addition, AWW was found to be easier than NOUN in grade 7, which is similar to results in grade 2, while NOUN was easier than AWW in grade 8. Clearly, weak verb roots and diacritics play an important role in determining the complexity of the form in spelling. For instance, passive voice forms, which require diacritics to disambiguate from other forms, tend to be more complex than other forms that can be understood without using diacritics. In addition, weak root verbs seem to be easier than strong ones. The results suggest three levels of complexities among grades; the first level includes grade 2 and grade 3 where they almost exhibit similar patterns of morphological complexity, second level includes grade 4, grade 5, and grade 6, while grade 7 and grade 8 represent the third level of complexity.

LD complexity pattern was suggested to vary from TD due to the morphological difficulties that LD exhibit and the different teaching instruction they received in resource rooms. However, LD grades have shown common patterns of complexity and exhibited a similar pattern to the TD one as shown in Fig. 10.

In general LD grades, similarly to TD grades, found most difficulties in PSV and PWV, while VN, NOUN and DER were the easiest in most grades. LD grades (except grade 4), and in contrast to TD grades, have shown almost constant patterns of complexity as shown in Fig. 11. Such findings may reflect the fact that both groups process morphological information in the same way even though TD performed better than LD.

An independent-samples t-test was conducted to compare performance on spelling morphological forms among LD and TD groups. Results indicated a significant difference in all spelling scores for TD and LD learners ( $P < .001$ ). Groups and grades were all entered into the MANOVA independent variables and scores of spelling as dependent variables. First, we examined group and grade impacts on spelling the eight main morphological forms. Our results revealed that performance of LD and TD obtained a statistically significant MANOVA effect, a main effect was found based on group, Wilks' Lambda = 0.132,  $F(8, 88) = 72.253$ ,  $p < 0.001$ , while grade obtained a statistically significant effect, Wilks'





**Fig. 11** Morphological complexity across LD grades. Note: ASV=Active voice/ strong (intact) verbs, AWV=Active voice/ weak verbs, AUV=Augmented verbs, PWV=Passive voice/ weak verb, PSV=Passive voice/ strong (intact) verbs, DER=Derivations, Noun=Nouns, VN=Verbal nouns

Lambda=0.162,  $F(48, 437) = 4.073$ ,  $p < 0.001$ . The results showed a statistically significant difference with a high effect size for group estimated at 0.868, which implies that 86.8% of multivariate variance of the dependent variables was accounted for by group while grade, in contrast, obtained a smaller multivariate effect size estimated at 0.262.

With respect to the interaction between group and grade, results also revealed a significant interaction between the effects of the group and the grade on spelling morphological forms, Wilks' Lambda=0.365,  $F(32, 326) = 3.206$ ,  $p < 0.001$ . The multivariate effect size was estimated at 0.223, which implies that 22.3% of the multivariate variance of the dependent variables was accounted for by the interaction between group and grade factors. This result indicates that the performance on spelling morphological forms varies between LD and TD and among grades even though group has more effect than grades on spelling performance.

Due to the statistically significant differences between group and grade on the morphologically-based spelling task, the Tukey post-hoc test was also used to examine the performance differences between group and grade levels on each morphological form. The comparison based on group and grade revealed a statistically significant difference in all morphological forms. On the other hand, the interaction between group and grade exhibited a statistically significant difference in AWV, PSV, DER, NOUN, and VN, while ASV, AUV, and PWV exhibited no significant differences.

Further, the effect size was examined to define the percentage of variance that is accounted for by group and grade. With regards to group, the highest value of effect size was for ASV=0.813 indicating that 81% of the variance is accounted for by group effect, whereas AUV received the lowest size effect where 52% of the variance was accounted for by group effect. In general, the effect size for ASV, AWV, AUV, PWV, PSV, DER, NOUN, and VN across groups was high, (partial  $\eta^2 = 0.813, 0.821, 0.525, 0.663, 0.788, 0.687, 0.670, \text{ and } 0.735$  respectively).

The performance across grades also received statistically significant differences in all morphological forms. The effect size across grades for ASV, AWV, AUV, PWV, PSV, DER, NOUN, AND, and VN was moderate to high (partial  $\eta^2 = 0.578, 0.615, 0.384, 0.484, 0.491,$

0.503, 0.513, and 0.504 respectively). The interaction between group and grade also exhibited statistical differences on all morphological forms with small-to-moderate effect sizes.

## Discussion

The current study investigated the complexity of common Arabic morphological forms in spelling among TD and LD learners to determine the hierarchy which young learners tend to follow in mastering morphological forms in the early years of schooling. The morphological complexity in spelling is determined by the morphologically-based spelling task which includes eight main common morphological forms and forty-four minor forms in which each spelling error falls under only one main morphological form and one minor form.

It is notable that both TD and LD learners almost follow a similar pattern of complexity which goes in line with previous cross-linguistic research studies such as Jiménez (2008) for Spanish (cited in Diamanti et al., 2014), Diamanti et al., (2014) for Greek and Curtin et al. (2001) for English. With respect to Arabic, I have not heard about any study investigating the morphological complexity in the context of writing; however, some previous studies were mainly based on the oral production of learners (e.g., Mohammad, 2000; Omar, 1973).

The findings of this study provide some empirical evidence to support some current theories of spelling development such as the early model of spelling which suggests that morphological knowledge starts from early on and increases through spelling development. Also, this model suggests that spelling development requires multiple linguistic awareness skills (morphology, phonology and orthography) that simultaneously interact across development rather than taking place in specific phases (e.g., Bahr et al., 2012; Reece & Treiman, 2001; Silliman et al., 2006). Specifically, these findings are best explained by the “repertoire theory” of spelling development (Apel et al., 2004; Sulzby, 1996) which suggests that learners, from early on, have access to and utilize morphological knowledge at all stages of development. Accordingly, reliance on morphological knowledge in spelling is coordinated with other linguistic knowledge such as phonological and orthographic knowledge and may vary depending on the requirements of the spelling task.

Learning to read and spell requires learners to store information of the word forms in the mental lexicon and access and process them later when needed. Sandra (1994) indicates that the mental lexicon involves two basic components: a memory store that has the representation of the word and the mechanism that is involved in retrieving the word’s representation. Therefore, reading and spelling errors raise a critical question regarding the basic units of the word in the mental lexicon: how they are organized, accessed, and processed. An understanding of these mental mechanisms can play a role in providing proper educational and therapeutic strategies to improve spelling and reading abilities. The question revolves around whether words are stored according to their full forms as if they are simple words (e.g., Butterworth, 1983) or according to their morphological components, i.e., in decomposed morphemic structures (e.g., Taft, 2004; Taft & Ardasinski, 2006; Taft & Forster, 1975), and, therefore, how lexical representations are accessed and processed during reading, speaking or spelling tasks.

In line with Taft (2004), Boudelaa (2014), based on priming experiments, suggested the obligatory morphological decomposition (OMD) in Arabic, a root and pattern based account, which proposed that both the root and the word-pattern play a crucial role in

lexical representation and processing of Arabic words. This model suggested that Arabic words are organized in the mental lexicon according to their morphemic components “whereby their roots and word patterns are accessed as lexical entries” (Boudelaa, 2014, p.47).

Arabic weak roots, which comprise a long vowel in their lexical roots, undergo some kinds of allomorphy and poses another challenge to young learners in spelling and also question the root-and- pattern account and its implications for morphological processing. These roots, typically, consist of one of the weak radicals و [w/u] or ي [y/ii] or both in the root (e.g., نوم {nwm} ‘notion of sleeping’, قوم {qwm} ‘notion of standing’) and they may not surface in the full form of the word. These roots exhibit no allomorphy if their weak radicals surface on the final form such as وَفَّقَ [waffaqa] ‘made straight/correct’ from the root وَفَّقَ {wfq} ‘being successful’ where و [w] surfaced on the form وَفَّقَ<sup>2</sup> [waffaqa]. On the other hand, the weak radicals may not surface on the final output in other forms such as اِتَّفَقَ [ʔittafaqa] ‘agreed’ instead of اِوْتَفَّقَ [ʔiwtafaqa] where the و [w] surfaced as ت [t] but not و [w]. Such allomorphy occurs because “the glide undergoes regressive assimilation from the word pattern consonant immediately following it, and an allomorphic form obtains” (Boudelaa & Marslen-Wilson, 2004, p. 107).

The mechanism of selecting a specific allomorph for a word rather than another one is still one of the most extensively debated topics in the allomorphy research. Nevins (2011) indicated that “a much harder and unresolved question is the mechanism for allomorph selection, where many theoretical alternatives are good at capturing some generalizations but in doing so may fail to capture others” (p. 24).

In Arabic, allomorphic variations, which affect the surface realization of words, draw attention to the importance of the underlying representation and processing of Arabic words (e.g., Boudelaa & Marslen-Wilson, 2001, 2004; Davis & Zawaydeh, 2001; Issa, 2006). It raises a question regarding the lexical (morphemic) status of the consonantal root in Arabic. For example, a word such as اِتَّفَقَ [ʔittafaqa] ‘agreed’, which is constructed from the root وَفَّقَ {wfq} where the و [w] surfaced as ت [t] instead of و [w], raises questions of whether اِتَّفَقَ [ʔittafaqa] is represented according to its surface form اِتَّفَقَ [ʔittafaqa] or according to its underlying representation اِوْتَفَّقَ [ʔiwtafaqa]. Understanding the underlying (mental) representation, accessing and processing of words can help in understanding the underlying deficits in reading and spelling and, therefore, establish a theoretical background that can help in designing appropriate assessment tools and educational curriculum to overcome spelling difficulties.

Contrary to expectation, the results of the current study indicated that learners perform better on weak verbs, which involve weak radicals in their roots and tend to undergo some changes and modifications in the orthographic representation, than strong (intact) verbs which are fully represented in the orthography. For instance, LD learners performed better on PWV than PSV; however, these forms are passive forms and require more diacritics and involve weak radicals. On the other hand, TD learners found PWV more complex than PSV in the first two grades while other grades found PWV to be easier. In addition, both groups (TD and LD) found the active voice forms of the weak verbs (AWV) easier than the strong (intact) verbs (ASV). Such findings raise a question regarding the impact of weak roots in spelling and also may reflect the intensive teaching of stem and whole words in the early grades.

<sup>2</sup> وَفَّقَ has a geminated ف [f].

It is a well-documented finding that high-frequency words are easier and are processed faster than low-frequency words upon hearing the target word in spelling-to-dictation tasks (Chua & Liow, 2014). Consequently, it seems appropriate to compare our results with the most frequent verbal forms in school reading books to shed light on the frequency effect on spelling. AL-Harashhe (1990) analyzed the most common morphological forms in reading texts in the reading books of the first and second grades in Jordan and found that 55.54% of circulated verbs are intact/ strong verbs while weak verbs form 44.46% of the verbs. In our study, the morphologically-based spelling task comprised 242 active and passive intact/ strong verbs while active and passive weak verbs were 176. Therefore, intact/ strong verbs were found to be more frequent than weak verbs. However, our results indicated that weak verbs were, in general, easier than the intact ones. Such indications exclude the frequency effect and argue further for the differential accessing and processing of strong and weak root verbs.

The findings of this study were unexpected and, theoretically, suggests that weak verbs, in contrast to early findings, are not processed the same way as the intact verbs, i.e., they are not processed according to their root and word pattern. If we supposed that weak verbs are processed similarly to strong (intact) verbs and according to their morphemic units, root and word pattern, we would expect that the cognitive load for accessing and processing diacritics and decomposed components, in addition to the allomorphic variation that may affect weak verbs, would result in more errors and difficulties. This suggests a differential accessing and processing of the two forms, the weak and the strong (intact) verb forms. Thus, this finding for the weak verb seems to be incompatible with the morpheme-based theory of the Arabic mental lexicon (e.g., Boudelaa, 2014).

There are two possible explanations for this result. Firstly, it seems that weak verbs are processed differently from intact verbs which promoted their proper accessing and processing. It is suggested that these forms are possibly to be processed according to their stem rather than their root. This suggestion aligned with the stem-based theory, which contrasts with the morpheme-based theory, and suggests that the root and the word pattern play no role in word formation and mental representation of Arabic words (Benmamoun, 1999, 2003). It also proposes that the imperfective stem is the main unit used in deriving surface word forms.

Benmamoun (2003, p. 105) postulated that “the fact that lexical relations involve more than just the root but vowel length and derivational morphemes strongly indicates lexical relations, like in English, are established over words or lexemes” and therefore, he argued that “the imperfective is the default morphological verbal form in Arabic” (p. 109). Therefore, and according to the stem-based model, a word such as مُعَلِّم [muʔallim] ‘a teacher’ is not processed according to its root عِلْم [ʔlm] and the word pattern مَفْعَل [mufaʔʔil/ muCaC-CiC] rather derived according to the imperfective verb يُعَلِّم [yuʔalim] ‘he teaches’ by prefixation of the nominal prefix مـ [m] where the stem ʔallim can be used to derive different words by adding suffixes and prefixes.

From the previous discussion, it can be seen that processing of some weak forms cannot be explained within the morpheme-based theory (root-word pattern model), and therefore it would be suggested that these forms are processed according to their stem where the perfective form, in contrast to Benmamoun (2003), play a role in the processing and representation. Given the fact that weak radicals are orthographically represented in some conjugations, it is proposed that the stem-based model is applied to weak verbs when some weak radicals are dropped in the orthography, while conjugations that represent their weak radicals in the orthographic representation are processed according to their root and word pattern, i.e., the morpheme-based theory. For example, forms that are based on the weak

root قول [qw/ul] ‘to say’ such as قَوْل [qawl] ‘an utterance’, قولوا [quulu] ‘say-IMP. PL.’ are supposed to be processed according to their roots and word patterns while, on the other hand, words such as قال [qaala] ‘he said’, قِيلَ [qiila] ‘was said’, where the second weak radical و [w/u] was replaced by ل [aa], and ي [ii] respectively, are suggested to be processed according to their perfective stem قال [qaala]. In the word قِيلَ [qiila], the second radical was changed to ي [ii] to follow the passive voice pattern.

Another explanation that might play a role in supporting our suggestion is that teaching instruction used in early schooling depends mainly on memorizing and teaching stems (perfective) and that seems to help learners to access and process weak verbs more accurately than intact verbs which may require another way of teaching. Taft (2004) postulated that the frequency of usage of the stem influences the processing at the early stage while the frequency effect of the full form takes place in the last stage of processing.

As a result, the findings of this study suggested combining the three theoretical models to understand the complex hierarchy of spelling errors and to shed light on the potential lexical representation and processing involved in spelling Arabic words: the dual-access hypothesis, the morpheme-based hypothesis, and the stem-based hypothesis. The findings of this study suggest that accessing weak verbs according to their stems does not ignore the word pattern.

The dual-access theory (e.g., Taft, 2004; Caramazza et al, 1988; Schreuder and Baayen, 1995) combines the morpheme-based theory and the stem/ word-based theory and proposes a dual mechanism to describe the processing and representation of complex morphological words. This hypothesis has been developed as a result of the incapacity of the two previous models, the morpheme-based theory and the stem/ word-based theory, to clarify the potential processing of complex words. It takes advantage of these models and postulates that morphologically complex forms can be either accessed by decomposing the word form into its morphological components or by accessing the word’s full surface form.

Caramazza et al. (1988), and based on his model “the Augmented Addressed Morphology (AAM)”, proposed that a word activates in parallel both the whole-word representation and the decomposed components of the complex word (i.e., roots and affixes). He claimed that accessing and processing the whole form to be faster than the decomposed one. In the same line, Schreuder and Baayen (1995) introduced the Meta-Model for Morphological processing to handle morphologically complex inputs (words or speech) where both the whole-word form and the decomposed units interactively converge on the potential representation. This model has three levels, i.e., “segmentation into affixes and stems, licensing based on appropriateness of morpheme combination, and composition based on semantic and syntactic properties of the constituents” (Schreuder & Baayen, 1995, p. 149).

Taft (2004) explained that “it may be that the word is decomposed and that there are then two pathways to the full information about the word: recombination via functional information associated with its individual constituents, and activation of a precompiled whole-word representation via the constituents. In this way, there would be two parallel pathways, but rather than these being a whole-word and a decomposition route, they would be a whole-word and a recombination route” (p. 763).

As a result, we suggest a dual model which combines both morpheme-based and stem-based mechanisms to understand spelling errors and their implication for cognitive processing. This study suggests that the spelling process goes in a hierarchical way where words can be accessed and processed according to either their root or according to their stem. Thereafter, the root or the stem is attached to the proper word pattern. At this stage, the accessing just involves the grapheme without diacritics and affixes. Afterwards, prefixes followed by suffixes are attached and, finally, diacritics are accessed and attached to

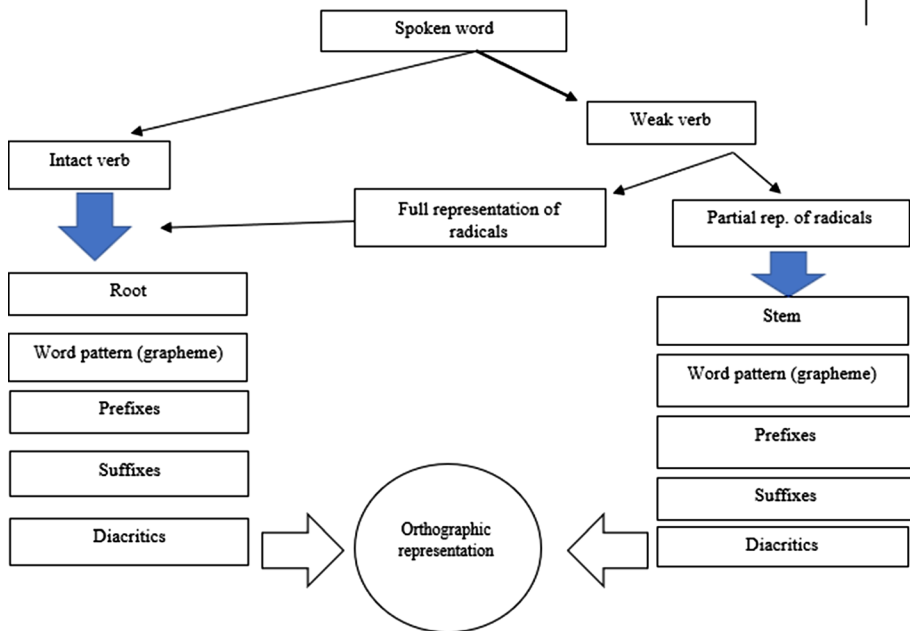


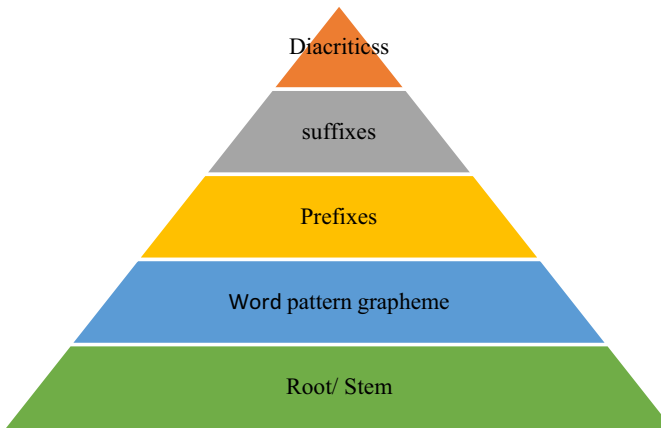
Fig. 12 A suggested model for processing Arabic spelling

the word pattern as demonstrated in Fig. 12. Weak verb forms, where radicals undergo changes or modifications, are represented according to their stem, while forms, where radicals are fully represented in the spoken word, are represented according to their root and word pattern.

Therefore, in a word such as *مُعَلِّمُونَ* [muʕalimuun] ‘teachers’, the learner first accesses the root *علم* [ʕlm] and then attaches it to the basic word pattern (i.e., the grapheme without diacritics) *فعل* [faʕil/ CaCiC]. Thereafter, the prefix *مُ* [mu-] is attached followed by attaching the suffix *ون* [-uun]. Diacritics are accessed later and attached to the word pattern. In the case of weak verbs such as *قالوا* [qaaluu], where radicals are modified in the surface form, the perfective stem *قال* [qaala] ‘said’ rather than the root *قول* [qwl] is accessed and applied to the word pattern *فعل* [faʕ], and thereafter, the plural suffix *وا* [-uu] is attached followed by diacritics. Such a proposal postulates that spelling errors occur in a hierarchical way and may involve errors at the level of root/ stem, word pattern, prefixes, suffixes, or diacritics as demonstrated in Fig. 13.

Abu-Rabia and Taha (2004) proposed a dual model for spelling processing among native Arabic learners. This model was proposed mainly to explain and justify the predominance of phonetic errors in spelling. Their dual model adapted two routes for processing Arabic words; one relies on direct phoneme-grapheme encoding for unfamiliar words, and the other is a lexical route for spelling familiar words. The lexical route involved morpho-orthographic information of the word. However, this route did not offer an explanation of how morphological knowledge, which was supposed to be an essential aspect of the orthographic lexicon, is accessed and processed in spelling.

Contrasting with the previous view, our model suggests how to understand phonetics and phonological operations within the root-word pattern framework. Our model claims that phonetic and phonological errors are due to environmental factors such as late



**Fig. 13** Hierarchy of spelling errors in morphological forms

exposure to MSA, diglossic situation and teaching instruction used in classrooms. Therefore, it is proposed that these environmental factors may affect the accuracy and speed of processing spelling words; however, they are not involved in the processing itself.

In the same direction, the results of the current study have also shown that learners tended to make frequent phonetic and phonological errors within the root and the word pattern framework involving emphatic sounds, glottal stops, writing the consonant or diacritics at the end of the word, the correct order of consonants and vowels in word patterns. It was observed that learners tended to replace emphatic consonants with their counterparts of non-emphatic consonants such as using س [s] instead of ص [s̥] or د [d] instead of ض [d̥] while the glottal consonant ء [ʔa] was tended to be replaced by و [w] or ا [aa].

In this regard, phonetic and phonological errors received intensive attention from Arab scholars on spelling (e.g., Azzam, 1993, Abu-Rabia & Taha, 2004, 2006; Abu-Rabia and Sammour, 2013). These studies tended to categorize spelling errors into phonetic and phonological errors and, therefore, their outcomes indicated that phonetic errors were the predominant errors among learners. For instance, Abu-Rabia & Taha (2004, 2006), and Abu-Rabia and Sammour (2013) used almost the same phonetic and phonological categories in analyzing spelling errors such as phonetic errors, semiphonetic errors, dysphonetic errors, visual letter-confusion errors, irregular spelling rules, word omission, and functional words omission. Consequently, it was proposed that “phonology poses the greatest challenge to students developing spelling skills in Arabic” (Abu-Rabia & Sammour, 2013, p. 60). However, these studies indicated that learners tend to use morphological knowledge in spelling from early on and highlighted the importance of the morpho-orthographic knowledge in facilitating spelling. For instance, Taha (2013), emphasized the importance of the morpho-orthographic knowledge on spelling and postulated that “morpho-orthographic knowledge among Arabic spellers can be used as a cost-effective strategy because, while spelling a word, the awareness to the specific pattern that this word was inflected on and the awareness to the root letter sequences of the specific word could produce a monitoring system in spelling”. Such explanations highlight the importance of the systematic learning of morphological patterns in facilitating the orthographic representation of words.

The current study postulates that phonetic errors are best understood within the framework of the root and the word pattern which can have pedagogical and clinical implications



for teaching spelling, while focusing on phonetic errors as independent errors may not help in developing any educational or clinical tools for some reasons. First of all, difficulties of representing Arabic sounds into orthographic forms could be due to the diglossic situation in Arabic (Saiegh-Haddad, 2004, 2005) where phonological variations exhibit between MSA taught in schools and local spoken dialects. Therefore, and considering the fact that children use dialectal forms from early on, learners may use dialectal variants as a preference rather than production difficulty (Hamdan & Amayreh, 2007).

Thus, it is expected that learners encounter difficulties in emphatic sounds due to the absence of the emphatic phoneme in the local dialects. Taha (2013, p. 723) explained that such difficulties are “simply because there are always new emphatic words which the speller must be exposed to, while he/she does not yet have any stored orthographic patterns of those words”. In addition, phonetic difficulties are expected among young learners due the fact that difficulties in mastering Arabic phonemes can continue even in the end of elementary grades and the full mastering of the MSA forms may take an even longer time even in the secondary grades (Arabaa, 1986). Amayreh and Dyson (1998) investigated the acquisition of Arabic consonants among Jordanian children ranging in age between 2;0–6;4, and found that many consonants were not acquired by older children such as /ʔ/, /ð/, /θ/, /z/, /ʒ/, /dʒ/, /j/, /t/, /d/, /s/, /ð/, and /q/. In the same direction, Amayreh (2003) indicated that some MSA consonants might take a longer time to be acquired by approximately 8; 6–9; 0 years.

Therefore, phonological difficulties in such cases are explained by the impact of the environmental factors such as the diglossic nature of Arabic and the late or limited exposure to the MSA either before the formal schooling or even during formal schooling. As a result, Hamdan and Amayreh (2007, 63) suggested that “maximizing exposure to SA (Standard Arabic) forms during the preschool stage may play a positive role in unifying the consonant inventory of children at the onset of formal schooling” and, consequently, that will play a role in improving learners’ ability in reading and spelling. Furthermore, Amayreh (2003) indicated that learners tend to replace some late acquired consonants with dialectal variants which have relatively less difficulties in articulating these consonants and, therefore, spelling errors involving glottal stops /ʔ/ can be explained within this framework. In order to overcome phonological variations between MSA and local dialects in spelling, learners should be exposed to morphological forms from early on to bridge the gap with local dialects and enhance the morpho-orthographic knowledge which can play a role in recovering phonological information and representing it in orthographic forms. In sum, the current study suggests that all previous phonetic categories (e.g., Abu-Rabia & Taha, 2004; Azzam, 1993) can be understood and explained within the framework of the root and the word pattern.

## Summary

The overall descriptive data indicated that, generally, learners share common patterns of morphological complexity. The data has shown that all grades found passive voice/ weak verb (PWV) and passive voice/ strong (intact) verbs (PSV) to be the most difficult forms in spelling, while nouns (NOUN), verbal nouns (VN), and derivations (DER) were the easiest. Augmented verbs (AUV), active voice/ strong (intact) verbs (ASV), and active voice/ weak verbs (AWV) exhibited a moderate difficulty across grades. In contrast to all grades, grades 2 and 3 found passive voice/ weak verb (PWV) to be the most difficult, followed

by passive voice/ strong (intact) verb (PSV). Other grades, on the other hand, found passive voice/ intact verb (PSV) to be the most difficult in spelling, followed by passive voice/ weak verb (PWV). Such findings may necessitate further investigation to shed light on the potential accessing and processing of verbal forms; specifically strong and weak forms.

The most striking observation to emerge from the data was learners' performance on weak verbs. Learners spelled weak verbs, which involve some changes and modifications to the weak radicals in the orthographic representation, more accurately than intact ones which are fully represented in the orthographic representation. Theoretically, these findings postulate that both forms are processed differently in spelling. Therefore, the current study suggests a dual model to explain the potential processing of Arabic words in spelling. The model proposes that the spelling process goes in a hierarchical way where words can be accessed and processed according to either their root or to their stem. This hierarchy proposes that, in order to spell a word, the learner should firstly access the root/ stem which is, thereafter, attached to the proper grapheme of the word pattern. Then, the learner accesses prefixes followed by suffixes and, finally, diacritics are attached to the word pattern. Intact verbs are proposed to be accessed according to their root while weak verbs, on the other hand, could be accessed and processed according to either the root or the stem. Weak verb forms, which undergo some changes or modifications to their weak radicals, are accessed and processed according to their root, while weak forms, which their weak radicals are represented in the spoken word, are accessed and processed similarly to intact verbs, i.e., according to their root.

A growing body of literature investigating the acquisition of morphological structures in spelling among children (e.g., Bourassa et al., 2006; Silliman et al., 2006) highlights the importance of morphological knowledge in spelling and attributes spelling difficulties to failure in making full use of morphology (e.g., Carlisle, 1987; Treiman and Cassar, 1996). In the same vein, Nagy and Anderson (1984) found that half of the words in English school materials that fifth graders read and learn every year in the USA are derivational and inflectional forms and that emphasizes the importance of teaching morphological forms in the early stages.

Thus, and to overcome the spelling errors among young learners, the study suggests a systematic teaching of morphological forms from early on in the educational curriculum of young learners based on the hierarchy of morphological complexity in spelling. The outcomes of the current study can hopefully provide the hierarchy of the complexity that learners should follow from early on to overcome spelling difficulties and the diglossic effect. This hierarchy can be developed to be used as an assessment and therapeutic tool. In addition, and given the impact of the allomorphic variation on the surface forms of Arabic words, early exposure to morphological forms and learning the word patterns will help learners to understand the effect of allomorphic variation on the surface forms in spelling.

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## Declarations

**Conflict of interest** Iyad Issa declares that there is no conflict of interest.

**Research involving human participants and/or animals** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research com-

mittee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by the author.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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