A New Intelligent Methodology for Computer based Assessment of Short Answer Question based on a new Enhanced Soundex phonetic Algorithm for Arabic Language

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ABSTRACT

Today most e-tests that created using the commercial tools for e-test generation or the Learning Management Systems (LMSs) such as Moodle or others don't provide a methodology for a perfect assessment of short answer questions. Unfortunately all of them provide a binary assessment that can be 1 (for completely True) or 0 (for completely false) even if the answer is partially true or partially false. So in this paper the author presents a new intelligent methodology, and its implementation, for computer based assessment of the student's short answer in e-test with English or Arabic language. This methodology is based on applying the Soundex phonetic algorithm on the answer's word for English or Arabic language to facilitate a computer based intelligent marking method. The student who responds with the correct spelling answer's word takes the total point of the question while the student who responds with the correct sounding but not correct spelling word may take points less than or equal to the total points according to the considered subject and the instructor's opinion. This intelligent marking method can be used for subjects that are not required correct spelling answers such as Science, Humanities and other subjects rather than the "languages" subjects. This paper also presents a new enhanced Soundex algorithm for Arabic language that achieved less error rates than the present algorithms as shown in the experimental results.

General Terms

Natural Language Processing, E-learning, Arabic Phonetic Algorithms.

Keywords

Computer based assessment, e-assessment of short answer questions, Soundex Algorithms for Arabic language.

1. INTRODUCTION

On-screen assessments are increasingly replacing the traditional pencil and paper tests we all know so well. The downside of computerized tests is that they rely on closed question types such as: multiple choice (and variants), True or False, drag and drop or matching, image hot-spot etc. "free-text" or "essay" questions are almost completely absent, for the very practical reason that free-text questions are difficult to mark by computer. With the advent of new technology however, some free-text question types can now be automatically marked using assessment engines which aim to mimic human marking of free-text.

We know that, the simple type of free-text question is the short answer question. The short answer question (also called supplied response or constructed response item) requires students to supply the appropriate words, numbers, or symbols to answer a question or complete a statement. Short-answer questions are traditionally used throughout the learning process because they are an effective measure of a student's ability to accurately recall specific, target information. They are believed to reinforce learning and help develop cognitive skills. They are the preferred instrument of the examiner because they effectively assess understanding without offering prompts or clues (i.e. they minimize guessing). As opposed to traditional objective measures (true-false, matching, multiple-choice, etc.) that assess the recognition of correct information, short answer questions require students to independently generate their own response. While this type of recall assessment is more cognitively demanding, the independent nature of the responses makes scoring (marking) much more subjective [1].

We can summarize the limitations for using the short answer question as follows:

- Difficult to phrase the question or incomplete statement so that only one answer is correct.
- More difficult to score since multiple answers may have to be considered if the question was not properly written.
- More time consuming to score than multiple-choice or true-false questions.
- The misspelling problem.

Most of the above problems with short-answer questions can be overcome by careful writing the question. But the main problem that isn't solved in almost all traditional tools and LMSs such as [2],[3],[4],[5] and many others, that used to build the e-tests, is the misspelling problem. Most of these tools don't provide a facility to check the misspelling when the computer marked the short-answer question. Unfortunately all of them provide a

binary assessment that can be 1 (for completely True) or 0 (for completely False) even if the answer is partially True or partially False. So in this paper the author presents an intelligent methodology that can be used in computer based assessment of the student's short answer for the "Complete" type question that required one word answer. This methodology is based on applying the Soundex phonetic algorithm on the correct answer's word(s). It can be used for e-test in English or Arabic language. This feature enables the e-test system to assess the student answer's word(s) against the similar sounding word(s) to the correct answer(s) to facilitate a computer based intelligent marking method, that making test scores a mixture of content learning and spelling skill. This intelligent marking (scoring) method can be used for subjects that do not require a correct spelling answer(s) such as Science, Humanities and other subjects rather than the "languages" subjects. This paper also presents a new enhanced Soundex algorithm for Arabic language that achieved less error rates than the present algorithms as shown in the experimental results.

The reminder of this paper will proceed as follows: Section 2 presents the related work. Section 3 explains the Soundex phonetic algorithm for English language, the previous work for Arabic soundex algorithms, the proposed Arabic soundex algorithm and the experimental results for the proposed algorithm. Section 4 illustrates how to use the Soundex algorithm for assessment in e-test system. Section 5 presents a prototype implementation for the author's proposed methodology in e-test system. Finally conclusions and future work will be in Section 6.

2. RELATED WORK

Many research has been done for computer based assessment (automated scoring) of free text questions or what we can say, essay questions. Short answer question is the simple case of essay question.

Several different techniques used by the various Automated Essay Assessment (AES) programs. The most common models are Bayesian Text Classification, Latent Semantic Analysis (LSA) and Natural Language Processing (NLP) [6]. [7] discussed the following famous systems and their use in classrooms and in standardized testing: Project Essay Grader™ (PEG), Intelligent Essay Assessor™ (IEA), BETSY, IntelliMetric™, and e-rater®.

Intelligent Essay Assessor™ (Pearson Knowledge Analysis Technologies): The Intelligent Essay Assessor (IEA) uses the Latent Semantic Analysis (LSA) method. The program's main focus is more on the content-related features (quality of content) rather than formulated ones; however, IEA does include scoring and feedback on grammar, style and mechanics as well as validation and plagiarism detection [8].

Bayesian Essay Test Scoring sYstem (BETSY): classifies text based on trained material. It was designed for automated essay scoring but can be applied to any text classification task. It is based on the Bayes Text Classification technique [9].

Project Essay Grader™ (PEG): This program primarily relies on style analysis of surface linguistic features of a block of text, or in other words, it predominantly grades on the basis of surface linguistic features, taking no account of content. Project Essay Grader™ uses regression coefficients calculated from training essays marked by human raters to predict the intrinsic quality of the essays to be scored [10].

IntelliMetric™: was developed by Vantage-Learning as the first essay-scoring tool that was based on artificial intelligence (AI), specifically NLP. IntelliMetric™ combines scores from focus and unity (coherence), organization, development and elaboration, sentence structure, mechanics and conventions to attain a final score [11].

E-rater® (Educational Testing Service ETS) : Both versions of e-rater® use natural language processing techniques. E-rater® evaluates the quality of an essay by identifying linguistic features in the text. It employs a corpus-based approach to model building which usually requires researchers to use copyedited text sources like newspapers [12].

Several other programs for AES are present e.g., SAGrader, WriteToLearn85 , and ETIPS86. Other academic researches for AES include: [13], [14] and [15] but unfortunately they considered only the essays in English language. IntelliMetric™ evaluates essay responses in multiple languages including English, Spanish, Hebrew, and Bahasa. Thus researches for Automated Essay Scoring in Arabic language are very rare.

Short Answer question is a simple case of the essay question that requires students to supply the appropriate words, numbers, or symbols to answer a question or complete a statement. Recently many commercial tools and Learning Management Systems (LMSs) such as [2],[3],[4], [5] and many others are used for building a complete e-test that can be composed of questions of different types such as MCQ, Match, True/False, "Short answer" (or Complete) questions etc. Unfortunately, all of these tools don't provide a facility to check the misspelling when the computer marked the student's short answer response. They provide a binary assessment that can be 1 (for completely True) or 0 (for completely False) even if the answer is partially True or partially False. Also rare of them provide the facility to build e-test in Arabic language and even so, binary assessment of student's short answer responses is the used criteria.

So in this paper the author presents an intelligent methodology that can be used in computer based assessment of the student's short answer for the "Complete" type question that required one word answer in e-test with English or Arabic language. This methodology is based on applying the Soundex phonetic algorithm on the correct answer's word(s) in English or Arabic language. This feature enables the e-test system to assess the student answer's word against the similar sounding word to the correct answer(s) and then facilitates a computer based intelligent marking method, that making test scores a mixture of content learning and spelling skill. This intelligent scoring method can be used for subjects that do not require correct spelling answer(s) such as Science, Humanities and other subjects rather than the "languages" subjects. This paper also presents a new enhanced Soundex algorithm for Arabic language that achieved less error rates than the previous algorithms as shown in the experimental results.

3. SOUNDEX PHONETIC ALGORITHM

A phonetic algorithm is an algorithm for indexing of words by their pronunciation. Most phonetic algorithms were developed for use with the English language. Among the best-known

phonetic algorithms is the "Soundex" algorithm, which was developed to encode surnames for use in censuses.

3.1 English Soundex Algorithms

The Soundex code came to prominence in the 1960s when it was the subject of several articles in the Communications and Journal of the Association for Computing Machinery (CACM and JACM) [16].

The National Archives and Records Administration (NARA) maintain the current rule set for the official implementation of Soundex used by the U.S. Government. These encoding rules are available from NARA, upon request, in the form of General Information Leaflet 55, "Using the Census Soundex" and it can be found in [16], [17] & [18]. Census Soundex stands on grouping similar sounding letters depending on special sounding features, as shown in Table 1. The Soundex code for a name consists of a letter followed by three numerical digits: the letter is the first letter of the name, and the digits encode the remaining consonants.

Disregard the letters A, E, I, O, U, H, W, and Y. The numbers are assigned to the remaining letters of the name according to the Soundex guide shown in Table 1. Zeroes are added at the end if necessary to produce a four-character code. Additional letters are disregarded. For Examples: **Washington** is coded W-252 (W, 2 for the S, 5 for the N, 2 for the G, remaining letters disregarded) & **Lee** is coded L-000 (L, 000 added). Additional rules include:

1. If the name has any double letters, they should be treated as one letter.
2. If the name has different letters side-by-side that have the same number in the Soundex coding guide, they should be treated as one letter.
3. If a vowel (A, E, I, O, U) separates two consonants that have the same Soundex code, the consonant to the right of the vowel is coded.
4. If "H" or "W" separates two consonants that have the same Soundex code, the consonant to the right of the vowel is **not** coded.

Table 1. Soundex Codes for English language.

Characters	Soundex Code
b, f, p, v	1
c, g, j, k, q, s, x, z	2
d, t	3
L	4
m, n	5
r	6

3.2 Previous Work for Arabic Soundex Algorithms

Most phonetic algorithms were developed for use with the English language; consequently, applying the same rules to words in other languages might not give a meaningful result. And, only a few programs support this feature for Arabic language (like the Google Spelling Corrections). You can find a lot of examples for English Soundex but what about for the Arabic language? Really, the resources for using Soundex with the Arabic language are rare. After long search and study, I found some academic researches such as [19], [20] & [21]. Lastly I found the article on [22] which modify the algorithm of the paper in [19] as explained in the following.

The Arabic Soundex algorithm stands on grouping similar sounding letters depending on special sounding features, as shown in table 2 [19].

Table 2. Soundex Codes for Arabic Language

Soundex Code	Arabic Characters
0	ا,أ,إ,ح,ع,غ,ش,و,ي
1	ف,ب
2	خ,ج,ز,س,ص,ظ,ق,ك
3	ت,ث,د,ذ,ض, ط
4	ل
5	م,ن
6	ر

But [22] added some improvement to the research in [19] as follows.

- Remove the (ا, أ, آ, إ) characters from the beginning of the word if found, because they added more confusion.
- Ignore the first character handling: in English language, it is important to handle the first character, but in Arabic, there are many words with the same sound but with different first characters.
- Update the character sound categories by removing or adding some characters.

3.3 Drawbacks of the Present Arabic Soundex algorithms

Most phonetic algorithms were developed for use with the English language; consequently, applying the same rules to words in other languages might not give a meaningful result. Soundex Algorithms proposed in [19], [20], [21] and even [22] for Arabic Soundex are based in some cases on suggestion to aggregate the Arabic characters (such as "م", "ن") that equivalent to similar Soundex characters in English (which are "m", "n"). But this rule may not get a good result for Arabic language in such a way that, "m" & "n" characters may resemble each other in Sound for English language but "م" & "ن" don't give the same sound in Arabic language. Also other aggregated characters such as "د، ذ", "خ, ج, ز" and "ح, ع, غ, ش, و، ي" are completely differ in sound in Arabic language. Other rules used in [19],[20],[21] and [22], that lead to incorrect results, include:

- Double letters may produce a different sound than that for the single letter such as "اكتتاب" & "اكتاب". So that handling double letters as one letter may produce error.

- Handling only the first four characters of Arabic word is not sufficient.
- Ignoring the first character in Arabic word is a big error that leads to generating a completely different sound word.

3.4 The Proposed Arabic Soundex Algorithm

Due to the above drawbacks for the present Arabic Soundex algorithms the author concludes that, the enhanced algorithm in [22] is also not effective for Arabic language. And after long search for the similar sound characters in Arabic language in courses provided by some academic institutes that teach the rules for Arabic language such as [23] and [24], the author suggested the following algorithm for Arabic Soundex. The proposed algorithm achieved less error rates than the previous algorithms as will be explained in the next section.

1. The first preprocessing step, before beginning to get the equivalent Soundex code for the word, is to stem the Arabic word (removing "ال" from the word ,if found,).
2. The second step is to use table 3 for Arabic Soundex codes instead of table 2 for coding the word. And we must include all word's characters in coding even if there are double letters or two consecutive letters with the same sound.
3. In some cases, some characters can be deleted without affecting the sound such as "ى" character when come as a second character in the word. Such as "فيزياء" which has the same sound as "فزياء" and "كيمياء" which also has the same sound as "كمياء".
4. "و" character followed by "ء" character can be treated as one character "ؤ" and take one code "N" as shown in table3. The same rule can be used for "ى ء" & "ئ" and "ايـ"&"إ".

3.5 Experimental Results and Comparative Study for the Proposed Arabic Soundex

Experiment done on about 100 Arabic words with their similar or un-similar sound words to evaluate the proposed algorithm and comparing it with the current enhanced algorithm in [22] as shown in table 4. Implementation for the proposed algorithm to gather statistics is shown in Figure 1. Two error rates are calculated for each algorithm, False Positive (FP) rate and False Negative (FN) rate which can be defined as follows.

$$FP = \frac{\text{No. of correct sound words that recognized as incorrect}}{\text{Total number of words}}$$

$$FN = \frac{\text{No. of incorrect sound words that recognized as correct}}{\text{Total number of words}}$$

Results are concluded in table 5 and represented in figure 2.

False recognition error in our algorithm is due to some Arabic rules that aren't handled such as:

1. Same spelling words may differ in sound due to using the diacritics in the Arabic language. This makes the word as "فرقان", with the "Dama ضمة" diacritic mark on the first character, has the same sound as the word "فورقان".
2. Rule 3 in the proposed algorithm doesn't valid for all words such as "أيمن" & "أمن". This is due to; the first character of the word "أيمن" has "Fatha فتحة" diacritic mark not " Kasra كسرة".

Thus the effect of the diacritics on the sound of the Arabic characters is an important issue that must be considered to produce an efficient Soundex algorithm for the Arabic language.

Experimental results in Table 5 show that, the proposed algorithm achieves law error rates, especially for FN rate, which reflect the higher discrimination power of the proposed algorithm than any others algorithms.

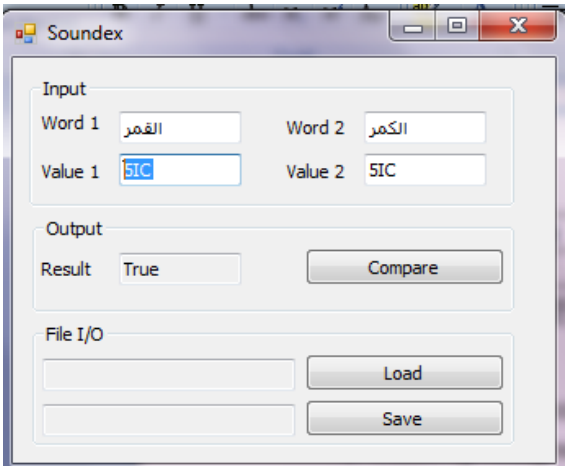

Figure 1. Implementation for the Proposed Arabic Soundex Algorithm

Table 3. The Proposed Soundex Codes for Arabic Language

Soundex Code	Arabic Characters	Soundex Code	Arabic Characters
1	ت – ط	C	ر
2	د - ض	D	ش
3	ذ – ز - ظ	E	ع
4	ث – س - ص	F	غ
5	ق - ك	G	ف
6	ا ى (at the end of the word only)	H	ل
7	هـ - ة ا (at the end of the word)	I	م
8	ب	J	ن
9	ج	K	و
A	ح	L	ى (at the beginning or middle of the word)
B	خ	M	ء – ئ - أ - آ
q	إ or (ا + يـ)	N	ؤ or (و + ء)

Table 4. Experiment analysis

Two words	Equality of Sound	[22]	Prop. algo.	Two words	Equality of Sound	[22]	Prop. algo.
سارق - صارق	T	T	T	جلال - هلال	F	T	F
رانى - هاني	F	T	F	كلال - هلال	F	T	F
قول - فول	F	T	F	فلول - هلال	F	T	F
سوب - ثوب	T	T	T	ردى - رضا	T	T	T
زيادة - ذيادة	T	T	T	هدى - رضا	F	T	F
غاده - غادة	T	T	T	ئمرية - كثبة	T	T	T
غادة - زيادة	F	T	F	كدبة - كذبة	F	T	F
فوءاد - فؤاد	T	T	T	مقر - مفر	F	F	F
كمر - قمر	T	T	T	مبرة - مفر	F	T	F
سمر - قمر	F	T	F	كفر - مفر	F	T	F
سنر - قمر	F	T	F	مقر - هكر	F	T	F
همر - قمر	F	T	F	جرن - قرن	F	T	F
ممر - قمر	F	T	F	فرن - قرن	F	T	F
فورقان - فرقان	T	T	F	مملياء - مومياء	F	T	F
أمن - أيمن	F	T	T	لحام - لحوم	F	T	F
اكتاب - اكتتاب	F	T	F	فز - فظ	T	T	T
مزان - ميزان	F	T	T	مثاثة - مصاصة	T	F	T
مثمار - مسمار	T	F	T	ثافره - صافره	T	T	T
فزياء - فيزياء	T	T	T	سآل - سؤال	F	T	F
رئوس - رؤوس	T	T	F	فرد - فرض	T	T	T
ميهنة - مهنه	T	T	T	احلام - احرام	F	F	F
مكينة - ماكينة	T	T	F	كروسين - كيروسين	T	T	T
قيث - قيس	T	F	T	تارك - طارق	T	T	T
شمر- سمر	F	T	F	فاءز - فائز	T	T	T
ضهر - دهر	T	T	T	فئر - فأر	T	T	T
كطيبه - كتيبة	T	T	T	بئر - بار	F	T	F
كدبة - كتيبة	F	T	F	عطوش - رطوش	F	T	F
مدبة - كتيبة	F	T	F	غمار - عمار	F	T	F
ثرثار - صرصار	T	F	T	ممر - منار	F	T	F
قوث - قوس	T	F	T	راضة - رياضة	F	T	T
فاءدة - فائده	T	T	T	تنين - كمين	F	T	F
موكف - موقف	T	T	T	وتوات - وطواط	T	T	T
مدينة - مضينه	T	T	T	كف - كهف	F	T	F
ضياء - ضاء	F	T	T	رؤية - رؤيا	T	T	T
ايستمرار - إستمرار	T	F	T	فنضك - فندق	T	T	T
إجمرار - إستمرار	F	T	F	ماخضع - مخادع	F	T	F
إحمرار - إستمرار	F	T	F	لاءيم - لئيم	T	T	F
مئذون - مأذون	T	T	T	فوزى - فوزي	F	T	F
توئم - توأم	T	T	T	مهدوم - مهضوم	T	T	T
توائم - توأم	F	T	F	مسارع - مصارع	T	T	T
فثل - فصل	T	F	T	اظضاض - ازداد	T	T	T
حاظم - حازم	T	T	T	عمل - عامل	F	T	F
حاذم - حازم	T	F	T	اخط - اخت	T	T	T
رووءية - روؤية	T	T	T	كفاح - صباح	F	T	F
سهد - صهد	T	T	T	سفاح - كفاح	F	T	F
نهى - نها	T	T	T	ماأراب - مآرب	T	T	F
قراأه - قراءه	T	T	T	باظلاء - بازلاء	T	T	T
آمجاد - أمجاد	T	T	T	فرصة - بورصة	F	T	F
عناد - عماد	F	T	F	برص - بورصة	F	T	F

Table 5. Experiment Results

Algorithm	FP	FN
[22] or others	0.08	0.46
Proposed algorithm	0.04	0.03

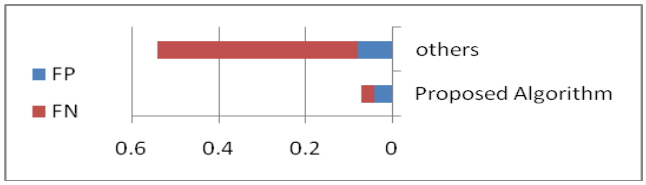

Figure 2. Graphic Representation for the Experimental Results

4. APPLYING THE SOUNDEX ALGORITHM FOR ASSESSMENT IN E-TEST SYSTEM

Using the Soundex algorithm enables us to facilitate an intelligent assessing methodology for the student's short answer for the "Complete" type question in e-test with English or Arabic languages. This methodology is based on applying the Soundex phonetic algorithm on the correct answer's word (or words if the question has more than one correct answer word).

4.1 Tables Structures and the Proposed Assessment Methodology

The structure for the main table for questions is as follows.

Table name: Questions

Table structure:

- **Question Code:** question instant code**.**
- **Question type :** type of question; true/false, Complete, MCQ, …etc.
- **Difficulty :** level of difficulty for the question.
- **Feedback(Yes/No):** Applying the feedback (select yes) means that, we feedback the student with the correct answer if he submit a wrong answer or incorrect spelling.
- **Attempts:** allowable no of attempts
- **Discrimination:** Discrimination value for this question
- **Guessing** : probability of guessing the answer for this question.
- **Answer code**: code for the answer instant
- **Answer text** : the correct spelling answer word.
- **Correct answer points**: total points awarded for the correct spelling answer.
- **Soundex match answer points**: total points awarded for the correct Sounding but not correct spelling answer word.

Discrimination, guessing and difficulty parameters are the used parameters for selecting the next suitable item (question) in case of "adaptive" type test (not "Fixed" type test). In adaptive type test the system selects the next question from the question bank according to the current student's response, his reached level of knowledge and the item (question) parameters [25]. But in fixed type test, the test is composed from fixed questions to all students' levels.

The attributes for the proposed file structure for the "Complete" type question are as follows.

Table name: Complete Questions

Table structure:

- **Question Code:** question instant code**.**
- **Question text:** The head text of the question
- **Answer code**: code for the answer instant
- **Answer text** : the correct spelling answer word.
- **Correct answer points**: total points awarded for the correct spelling answer.
- **Soundex match answer points**: total points awarded for the correct Sounding but not correct spelling answer word.

Thus the question can have more than one correct answer and the synonyms for the correct answer word must also be considered. The instructor must specify the total points awarded for the correct spelling answer and the points awarded for the correct sounding but not correct spelling answer. But logically, the later must be less than or equal to the former. Soundex then enables the e-test system to match the student's answer word with the similar sounding word to the correct answer to facilitate the computer based intelligent marking method.

Marking method may be as follows: if the student responds with the correct spelling answer word(s), then he/she takes the total points of the question. The student which responds with the correct sounding but not the correct spelling word(s) may take points less than or equal to the total points according to the considered subject and the instructor's opinion. The points awarded for the correct sounding word is assigned by the instructor while the question is being created (the value assigned for the "Soundex match answer points" attribute). This feature facilitates an intelligent marking method that can be used for subjects that do not require correct spelling answer such as Science, Humanities and other subject rather than the "languages" subjects.

For language subjects, the instructor must decide if he can accept a student's response with correct sounding, but give him a small degree less than the total points, or he doesn't allow incorrect spelling answer. In this latter case the score will be binary (1 for correct or 0 for incorrect).

5. IMPLEMENTING THE SOUNDEX ALGORITHM IN E-TEST

This section explains the implementation of the English Soundex algorithm and the author's proposed algorithm for Arabic Soundex in assessing the student's answer for the "Complete" type question in e-test maker tool.

Figure 3 explains how the instructor can use the English Soundex in developing the "Complete" type question. As shown in Figure 3, the instructor prompted to enter the question text, the acceptable correct answers, if there are more than one correct answer, and the remaining parameters for developing the

question such as points (correct answer points), attempts, difficulty, feedback, Discrimination and guessing. The "Apply Phonetic Assessment" check box is checked if the instructor wants to apply the Soundex algorithm in assessing the student's answer to this question. In this case the instructor must specify the language for the Soundex from the "Language" list box and then enters the number of points (Soundex match answer points) that give to the student if he/she responses with a correct sounding word but not correct spelling. Soundex points must be less than or equal to the total points for the question.In "language" subject the instructor may assign a Soundex points that may be less than the total points. But in other subjects that focus on the scientific concepts not on the spelling, the instructor may consider the correct sound word is a correct answer and give the student the total points. As example: in figure 3 the instructor gives 5 points only out of 10 to the correct sound answer.

Figure 4&5 display the student responses for the questions in the e-test and how the system applies the Soundex algorithm in English language. Figure 6 explains the developing of the "Complete" Type question in a general subject that learned in "Arabic" language and figures 7&8 display the application of the proposed Soundex algorithm in the assessment of the student's answer.

In figure 7 the student responded with correct spelling answers, then he got the total points which is 10 points for every question as specified before when the question created. But in figure 8 the student responded with the correct sounding but not correct spelling answers, then he got the "Soundex" marks only which specified before in figure 5 as 5 points only. Then the total points awarded for the student in the three questions test is 15 points out of 30.

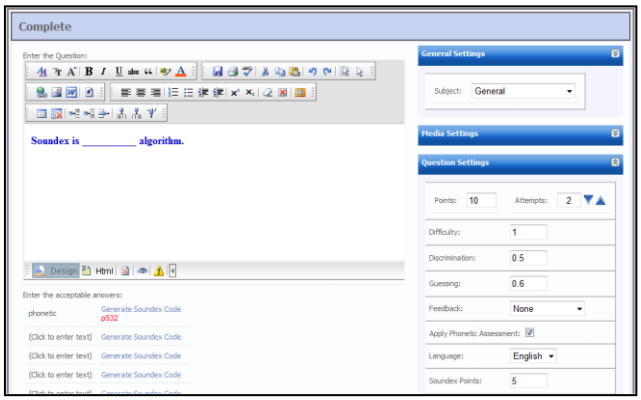

Figure 3. Applying the English Soundex in Developing the "Complete" Type Question

6. CONCLUSIONS AND FUTURE WORK

This paper presented an innovative method, and its implementation, for intelligent Computer based assessment of student's short-answer for "Complete" type question in e-test. This method is based on applying the Soundex phonetic algorithm on the answer's word. The author also proposed a new Soundex algorithm for Arabic language that achieved less error rates than the previous algorithms as shown in the experimental results.

There are many commercial tools and Learning Management Systems (LMSs) that used for developing a quiz such as [2], [3], [4], [5] and many others. Unfortunately all of them provide a binary assessment that can be 1 (for completely True) or 0 (for completely false) even if the answer is partially true or partially false. The proposed methodology is based on applying the Soundex phonetic algorithm on the answer's word in English or Arabic language. This feature enables the e-test system to assess the student answer's word against the similar sounding word(s) to the correct answer to facilitate a computer based intelligent marking method.

Future work will be in enhancing the proposed Soundex algorithm for Arabic language. Also algorithms for automated essay scoring especially for Arabic language will be considered in future work.

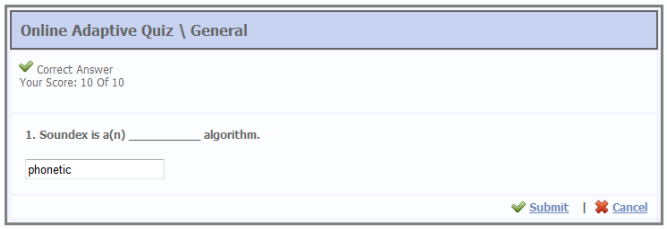

Figure 4. The Student Answers with Correct Spelling (Full match)

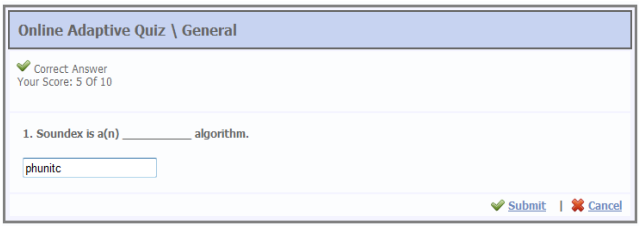

Figure 5. The Student Answers with Incorrect Spelling but Correct Soundex (Soundex Points Only)

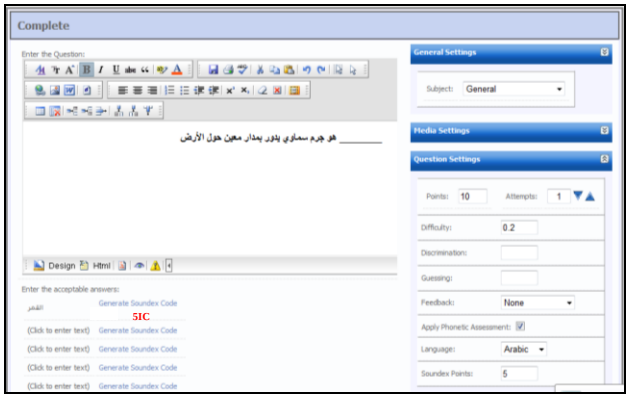

Figure 6. Applying the Arabic Soundex in Developing The "Complete" type Question

Figure 7. The Student answers with the correct spelling words (Total points)

Figure 8. The Student Answers with the Correct Sounding Words but not Correct Spelling (Soundex points only 15/30)

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