Educational Games for Early Childhood
Using Tabletop Surface Computers for Teaching the Arabic Alphabet

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Abstract: This paper presents initial evaluation regarding the use of simple educational games on tabletop surface computers to teach Kindergarten students in Qatar the Arabic alphabet. This effort is part of the "Arabiyyatii" research project, a 3-year endeavor aimed to teach 5-year-olds Modern Standard Arabic (MSA). The paper describes a naturalistic study design, following the activities of 18 students for a period of 9 weeks in the project. All students were native speakers of the Qatari dialect and they were early users of similar surface technologies. The paper presents three of the games available to the students, along with data collected from system log files and class observations. Result analysis suggests that these kinds of games could be useful in (a) enhancing students' engagement in language learning, (b) increasing their exposure to MSA, and (c) developing their vocabulary.

1 INTRODUCTION

Across the Arab world, Classical Arabic (CA), and its derived form, Modern Standard Arabic (MSA), used in all formal contexts, is perceived as the "high" form of language whereas, the local mother tongues (or "dialects") are used in daily contexts and are usually perceived negatively (Ferguson, 1991). The situation in Qatar is no exception, creating confusion to students (e.g., Saiegh-Haddad, 2007). As all diglossic languages, the formal form, MSA is learned in schools and the informal form, the dialect, is the mother tongue spoken at home. Thus, the numbers of geographical dialects are various (Behnstedt, 2006) if counted by all 22 Arab countries.

Our work in the "Advancing Arabic Language Learning in Qatar" project (formerly known as "ALADDIN" for Arabic LAnguage learning through Doing, Discovering, Inquiring, and iNteracting, and recently renamed "Arabiyyatii" for "My Arabic") aims at proposing an updated comprehensive curriculum for the Arabic language – starting from Kindergarten – that would incorporate up-to-date didactical methods (i.e., communicative approaches and collaborative learning) and the use of innovative educational technology (i.e., tabletop surface computers).

This research draws extensively upon the works of Ibrahim (e.g., 2000, 2008, 2009, 2013) pertaining to Arabs language attitudes, the relatedness of the MSA to the dialect and the native speakers awareness, lexical separation as a consequence of diglossia, the use of technologies in Arabic language learning, and language planning and education. For example, in summarizing the current situation of the Arabic language, Ibrahim (2013) noted that there is conflict in Arabs towards their language. Native speakers do not know much about the relationship between the different varieties of Arabic (dialects) and the official MSA and they often have trouble identifying which version is needed from them in formal education. To make matters worse, the language teachers often do not receive appropriate education on how to approach this delicate issue. The end result, as Ibrahim puts it, is "a native speaker who is in a life time dilemma" (ibid., p. 360).

The new curriculum tried to address this issue by applying a holistic approach, offering a rich learning experience that includes listening, discussing, writing, storyboarding, and gaming activities. For 9

weeks during the Fall semester 2013, we tested the new curriculum in a private Kindergarten of the Qatar Academy in Doha, Qatar. The instructional goal during this study period was to teach a class of 5-6 year-olds the Arabic alphabet and enrich their vocabulary in MSA. The paper focuses on the use of the educational games, specifically designed and developed for the project.

2 BACKGROUND

2.1 The Arabic Language

The Arabic alphabet consists of 28 consonants, 3 long vowels, and 3 short vowels. Short vowels are not written within the word, but either above or below the letter. Arabic writing has four major characteristics that distinguish it from other languages: (a) writing is from right to left, (b) most letters are connected in both print and handwriting, (c) letters have slightly different forms depending on where they occur in a word (isolated, initial, medial, and final form), and (d) Arabic script consists of two separate "layers" or writing: the first is the basic skeleton made up of consonants and long vowels, and the second is the short vowels and other pronunciation and grammatical markers.

As far as pronunciation is concerned, Arabic has one-to-one correspondence between sound and letter, while the writing system is regularly phonetic meaning that words are generally written as they are pronounced.

While teaching the Arabic alphabet, we focused on two major issues: recognition and production of the letters. Production means that the students should be able to write and pronounce clearly the letters of the alphabet, while recognition means audio and visual recognition. The students should be able to recognize a specific letter in a spoken or written word. Production in the project was covered by writing activities and discussion sessions led by the school teacher (result analysis on the writing activities can be found in Papadopoulos, Ibrahim, and Karatsolis, 2014). On the contrary, the educational games presented here were focused on recognition.

2.2 Computer Games in Early Childhood

The use of computer games in educational contexts has attracted the interest of many researchers resulting in a very rich literature. Kebritchi and

Hirumi (2008) provide an overview on the pedagogical foundations of modern educational computer games. The use of computer games has yielded encouraging results in motivation, engagement, knowledge acquisition, collaboration, and problem-solving in primary (e.g., Meluso, Zheng, Spires, and Lester, 2012), secondary (e.g., Papastergiou, 2009), and tertiary education (e.g., Hainey, Connolly, Stansfield, and Boyle, 2011). Although there are studies focusing in younger ages (e.g., Vangsnes, Økland, and Krumsvik, 2012), little can be found regarding the use of computer games at Kindergarten. Especially when it comes to the Arabic context of the project, the use of educational software or computer games in formal education is rare, if any.

2.3 Innovative Technologies and Surface Computers

Tabletop surface computers are a new approach in learning environments, with research reporting encouraging results so far. Kerne et al. (2006) discuss the roles for interactive systems enabled by touch screen devices in supporting creative processes and aiding in idea formation. Morris et al. (2005) examined the educational benefits of using a digital table to facilitate foreign language learning. As documented in Piper (2008), the use of multimodal tabletop displays, as a rich medium for facilitating cooperative learning scenarios, is just emerging.

The tabletop surface computers (http://www.samsung.com/us/business/displays/digital-signage/LH40SFWTGC/ZA) we use in the project allowed us to design learning activities using touch technologies and shared interfaces. The system (also "table" for the rest) has a 40" touch screen that can recognize more than 50 simultaneous touch points, making it possible for several students to interact and participate in the same activity. The size of the screen is large enough to support 4 5-year-olds per table. This was essential in the project, since breaking apart the traditional setting of a classroom (i.e., strictly defined by desks and whiteboards) and allowing students to gather around the tables increased peer interaction and student participation.

The use of touch technology was essential, since kindergartners usually lack the ability to use a computer. On the contrary, the students had already been exposed to other touch systems, such as smartphones and tablets both at home (parents' devices) and at school (each student receives a tablet pc from the school in the beginning of the year).

3 METHOD

3.1 Participants

One of the classes enrolled in the "Arabic Studies" course was assigned to the study by school administration. The class had 18 Qatari students (9 boys and 9 girls), natives of the Qatari dialect. All students were between 5 and 6 years old. Although students were native speakers of the dialect, they were novices in MSA. The learning goal of the course was to teach students fundamental linguistic skills in MSA such as vocabulary development, letter production and recognition, and proper pronunciation.

The total population of the class was available only 8 days during the course of 9 weeks for various reasons (e.g., illness). Usually, the actual number of students in the classroom ranged from 16 to 17.

3.2 Design

The study followed students' activity in the new curriculum for a period of 9 weeks (Sep 29 – Dec 4) and the instructional goal during that period was to teach students the isolated form of the first 12 Arabic letters (from [ﺍ] to [ﺯ], considering 'alif' and 'alif with hamza' two different "letters"). The design applied in the study followed an naturalistic study approach.

Usually, a new letter was introduced by the teacher during the listening and discussion sessions, followed by writing activities. The games were used at the end of the class repeatedly, in order to (a) keep students' engagement and enthusiasm high, and (b) enhance retention. To analyze students' performance and attitudes, we utilized observations and the system log files.

3.3 Material

The main instructional goal behind the design of the educational games was to support students in letter recognition. In this section, we describe the three most played games we used in the classroom.

3.3.1 Soundboard

The Soundboard was not a game per se, but we consider it part of the gaming sessions, since it was usually preceding the other games. The purpose of the Soundboard was to mimic the basic function of the soundboard toy, i.e., teach students how different objects are pronounced and support them in building their vocabulary. The interface was compiled by three main components: (a) the letter bar, showing 34 buttons with all the letters of the Arabic alphabet, (b) the gallery, containing up to 15 (clip art) images of objects starting with a specific letter, and (c) the current item, showing the currently selected image. Each time a letter was selected, the gallery was randomly compiled by retrieving images from a larger pool of images. Spending time in the Soundboard allowed students to get familiar with the
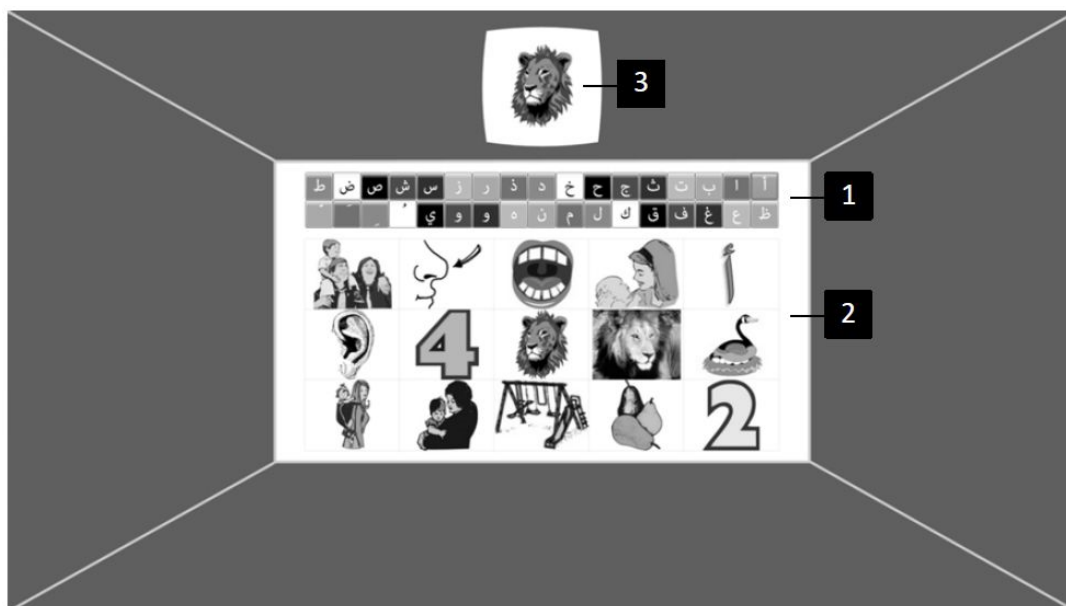

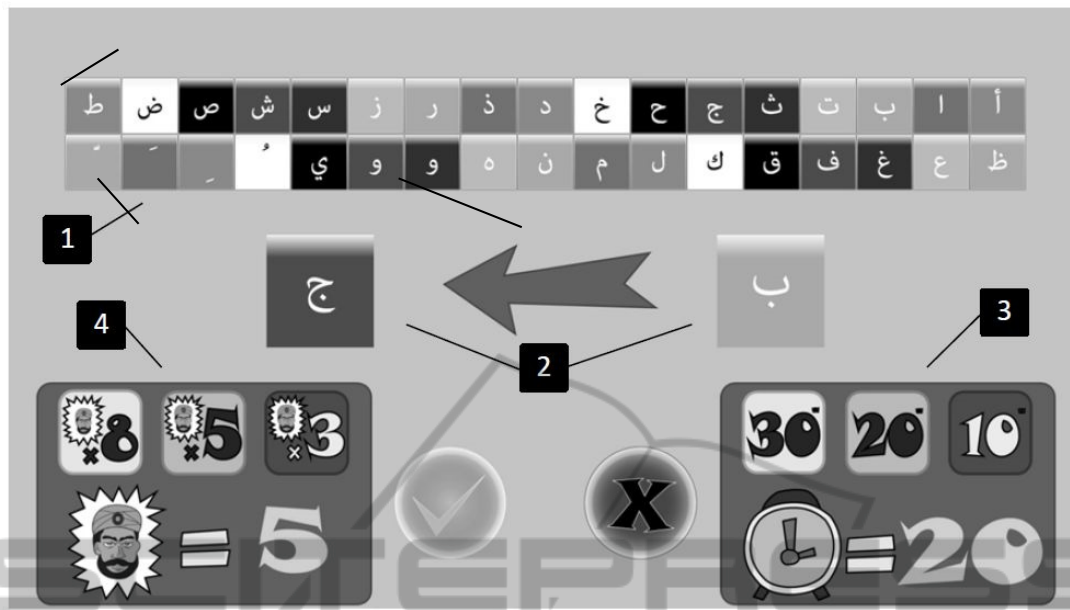Figure 1: Soundboard game. 1: Letter bar; 2: Gallery; 3: Current image.

Figure 2: Bingo game start page. 1: Letter bar; 2: Selected range of letters; 3: Seconds per round; 4: Allowed mistakes per round.

vocabulary and the images they were going to see in the games to follow.

The idea behind Soundboard is really simple: the player selects a letter and a gallery of objects that start with this letter appears. Each time the player touches an image in the gallery, the system plays an audio file representing the correct pronunciation of the word in MSA. The early version of the Soundboard was designed to accommodate 4 players per table (i.e., the screen was divided into four equal parts). However, the number of simultaneous words played, and the fact that the classroom proved to be smaller than needed for the number of tables used in the project created a noise. Because of this, a new version was developed with only one player per table (Fig. 1). To make sure that the sound would be clear for all students to hear, we added an additional set of speakers. Finally, the activity was eventually used only on one table operated by the teacher. The students were surrounding the table, while the teacher was standing in front of it leading the first few rounds. After that, the students were taking turns in touching images and hearing the pronunciation in MSA.

3.3.2 Bingo

Bingo was the most played game in the study. It was introduced first to the students and they preferred it over the other games we introduced later. The idea is based on the well-known bingo game, modified for content and instructional goals. Two teams of students (typically two dyads) per table play against each other trying to finish first in order to win. In the beginning of the game, the teacher chooses the range of letters that are going to appear in the game, along with the duration of each round and the number of allowed mistakes per round (Fig. 2).

When the game starts, the screen is divided in half with a gallery of 40 clip art images in each side (Fig. 3). The system randomly populates the two galleries, drawing images from the pools of the selected letters. Each round, the system selects a letter from the selected range and displays it in the middle of the screen, along with the remaining time. The round time and selected letter are common for the two teams. The students have to touch the images that start with the round letter. If a touched image is correct, it is replaced with Aladdin's face and remains like that for the rest of the game. In case of a mistake, the face of the Magician (i.e., Aladdin's nemesis) appears, and the object image reappears in the next round. A round ends, either when time runs out, or when both teams reach the allowed number of mistakes. The game ends, when one of the teams fills the gallery with Aladdin's face.

In terms of pedagogy, the students need to act in three levels, first identify the objects depicted, then think (or say out loud) what the pronunciation of the words in MSA should be, and lastly, decide if the words start with the same sound represented by the
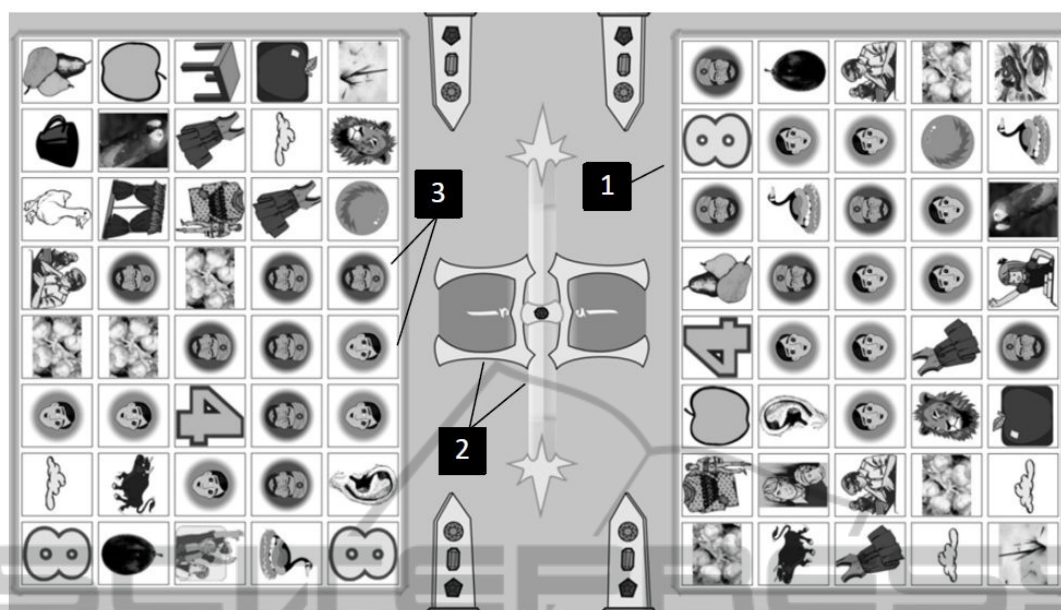
Figure 3: Bingo game. 1: Gallery; 2: Remaining time and round letter; 3: Aladdin's and Magician's faces.

letter. Students' collaboration in teams and the factor of competition were expected to increase interaction and engagement.

At the end of each round, the system was recording the timestamp, the number of total and correct touches made, and the round letter for each team in log files.

3.3.3 Get3

This game is a variation of Bingo described above. The main differences are that Get3 is played individually, and there is no pressure from time limit or competitiveness. We designed this game to complement the data we were expecting from Bingo.

In Bingo, it is not possible to differentiate between the performances of each player, while the time limit in each round makes the game harder for students. Get3, on the other hand, allows the monitoring of individual performances and gives the opportunity to weaker or introvert students to take control of the game and apply their own pace. In addition making the game an individual one eliminates competition, and this also lifts some of the pressure the students might feel while playing.

In term of pedagogy, however, both games follow the same principle for matching a letter to the starting sound of word. The combination of these two games would allow us to better understand student performance in the study.

In the beginning of the game, the teacher, once again, selects the letter range, along with the goal

score (i.e., the number of correct responses needed to end the game). The screen is divided in 4 playing areas (Fig. 4). Each area has a small gallery of 6 images, a round letter, and indications (number and bar) showing the score. These four areas function completely independent from each other. The gallery has always 3 correct and 3 wrong images and it is refreshed in each round. In case of a correct touch, the image is replaced by a diamond, while, in case of a wrong answer, the image is replaced by an "X". After three images are touched, the round ends and the gallery and the selected letter are refreshed by the system. This means that in each round, a student can have 0/3-3/3 success rate. The game ends for a player (but not for the whole table) when the goal score of correct answers is reached.

The system monitors students' activity individually and records the timestamp, the round letter, and the success rate for each round. Both Bingo and Get3 were designed to play sounds on each touch (pronunciation of the words in MSA). However, because of the noise issues noted earlier in Soundboard, the sound was muted.

3.4 Procedure

Students have the Arabic Language class 4 days per week, at different hours. The class typically lasts 40 minutes, however, because students have to switch classrooms and since there is not always a break between classes, the actual duration of the class is usually 30-35 minutes.
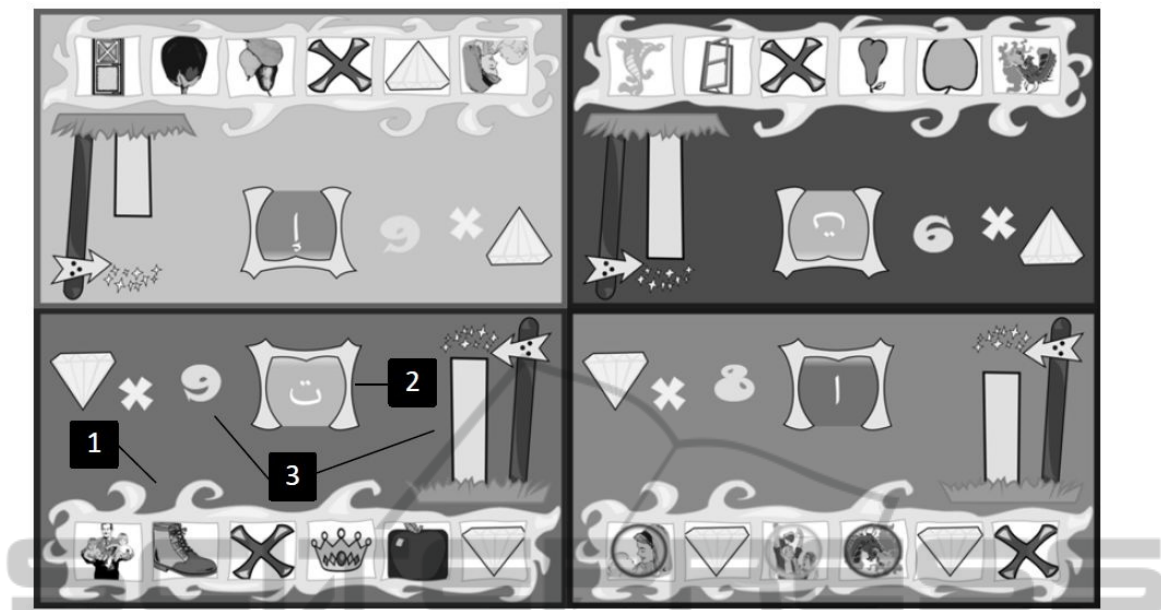
Figure 4: Get3 game. 1: Gallery; 2: Round letter; 3: Total score and score bar.

Gaming sessions were usually taking the last part of the class (~10'), although, there were also sessions covering the whole class. Students played some of the games a few times per week. The class was controlled by the school teacher, with the principal investigator of the project also in the classroom to observe and take notes. The students were distributed to the 5 available tables in the classroom by the teacher. Although organizing students into groups of 3-4 students per table was mostly done randomly, factors such as gender, interpersonal relationships, and general student performance were often taken into account by the teacher, in order to have a balanced distribution. Group formation and students' spots were changing in each class, and, while it was not encouraged, students changing spots during a class was not forbidden either. It is important to note that students' identities were not part of the data collected by the tables or the researchers of the study.

While the number of allowed mistakes (5) and the duration of each round (20'') remained the same for most Bingo games played, the number of letters selected varied significantly to accommodate instructional needs. A higher number of letters means that, respectively, a lower number of images will appear for each letter in the gallery in the beginning of the game. This makes the game more difficult as students have fewer chances to find a correct image. On the other hand, as students proceed successfully, finding correct images and getting the number of remaining available images in the gallery (i.e., not covered by Aladdin's face) much lower, the game gets easier (up to the last round, where the only available image is also a correct one).

In contrast, the number of selected letters did not affect the difficulty level in the Get3, since the number of correct images in the gallery in each round remained constant (3 out of 6).

4 RESULTS

Analysis is based on descriptive statistics, while deeper analysis will be necessary to assess students' behavior through the thousands of touches recorded in the study.

Using the tabletop surface computers was easy for the students. Familiarization phase game was also short, since students were soon able to use the system on their own.

Table I shows the results from the Bingo log files, for each of the 12 total days the game was played. Students' performance varied significantly according to (a) the number of selected letters, (b) the number of letters that were new and had not been played before, and (c) their familiarization with the images of each letter through other games. In addition, there were in-game factors that could affect the success percentage. For example, in the beginning of a game a letter might correspond to 10 correct images in the 40-image gallery, thus giving

Table 1: Bingo success percentages/per letter/per day.

Day	Alif \w h	Alif	Baa	Ta	Thaa	Jiim	Ha	Khaa	Daal	Dhaal	Raa	Zaay	Total
8/10	49.59	41.73	49.54										46.95
23/10	36.90	45.92	43.49	40.63									41.73
30/10	37.86	32.08	32.90	40.83	38.12								36.36
5/11	40.62	31.44	31.04	36.97	35.28	43.58							36.49
6/11						65.91	64.54						65.22
11/11						46.63	43.57	40.57					43.59
13/11						46.39	48.05	50.58	48.96				48.50
18/11							42.49	43.24	46.95	44.69			44.34
25/11								48.45	51.25	50.71	51.41		50.46
2/12	30.23	30.25	48.65	36.08	36.21	47.46	50.16	41.83	32.36	43.91	45.53	47.98	40.89
3/12	42.33	24.74	52.18	42.58	27.74	55.02	69.69	40.56	33.03	21.53	29.45	33.75	39.38
4/12	28.31	32.20	43.92	42.90	31.62	40.53	43.92	27.43	35.66	37.74	56.96	51.39	39.38
Avg. %	37.98	34.05	43.10	40.00	39.15	49.16	49.65	41.81	41.37	39.72	45.84	44.37	42.18
Touches	984	1001	831	754	1156	1547	928	1356	1138	786	495	156	11132
Images	362	341	327	269	580	771	391	582	491	334	224	56	4728

students a 25% chance of success. In this case the selection of a correct image by the students might indicate that the students were indeed aware of the correct answer. As the game progresses, both the number of available correct images and the number of remaining available images in the gallery change randomly (e.g., the sequence in which the system selects the letters and the number of correct responses from the students in each round cannot be predicted). As such, the values presented in Table I cannot be analyzed as absolute values (in which case a 40% success rate would mean a mediocre performance), but only by comparing them to each other.

One characteristic example of how the number of selected letters affected students' performance is provided on the statistics on 6/11 (marked grey in the table). When we decided to use only two letters in the gallery, students' scores peaked, exceeding 65% - much more than the total average (42%). Regarding familiarization with the images, it seems that students had trouble differentiate between the letters "Alif with hamza" and "Alif", making more mistakes when "Alif" was selected.

Get3 was played sporadically a little after we introduced Bingo. In the beginning, not all students wanted to switch from Bingo to Get3, because they enjoyed more the collaborative nature of the first one. We asked the teacher to organize a few gaming sessions during the last week of the study, having all students playing the game. During these sessions, we gathered data for the first 8 letters (Fig. 5).

When reading the statistics, one has to have in mind the expected percentage in each occasion. As we mentioned earlier, several factors affect students' performance. Therefore, numbers in the two games should not be directly compared, but correlated. Results showed that students were able to recognize all the letters adequately, scoring once again lower in the letter "Alif" and corroborating the finding we had from analyzing Bingo data.

One more important note regarding the results is that the games used a pool of 600+ clip art images, and these images appeared thousands of times over the course of 9 weeks (e.g., 4728 just in Bingo). This extensive exposure to images and words is very important, especially if we take into account that students considered learning through these games as a reward for successfully completing other tasks, such us writing and discussion.
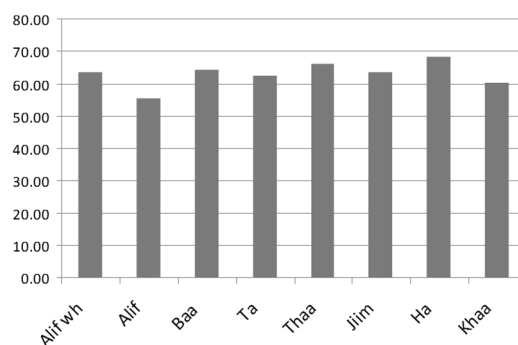

Figure 5: Students' success percentage in Get3 game.

Regarding students' attitudes towards the new curriculum, the positive feedback we received was evident in many forms. For example, many students asked us to develop versions of the games for their tablet computers, "so that they could play at home" as they stated. The students were rushing to the "Arabic Studies" classroom, contrary to what typically happens for other classes, where students are escorted to a classroom following behind a teacher in a single-file line. Parents, teachers, and students of other classes (both from kindergarten and the co-located primary school) expressed a vivid interest in participating in similar activities, while the activities of the project recently attracted attention from Media in the region (e.g., Gulf News, 2014; Gulf Times, 2014).

On the down side, some of the images used in the games were causing confusion to the students regarding the words they were depicting. The use of sound would be enough to clear this issue for the students, however, as we mentioned earlier, sounds had to be muted to avoid noise in the classroom. Finally, the number of the students in the study was easily accommodated by the number of available tables. In case of a larger group, more tables would be necessary to keep every student active. After observing students' activity during 9 weeks, be believe that it would be challenging for the teacher to manage a class in which some of the students need to wait for their turn in the tables.

5 CONCLUSIONS

The papers presented the initial analysis of the data gathered in the gaming activities of the ALADDIN project. Acceptance and engagement was very high and there are strong indications for the effectiveness of the approach. However, improvements are also in order. First and foremost, due to the size of the classroom and the characteristics of the tables, most of the activities were lacking audio feedback. A larger space would allow us to have a better control of the sound. Second, the pool of images (and the words they depict) needs to be revised and expanded. Results showed that the students saw each image numerous times. Using more images would make the games even more interesting and would enhance students' vocabulary.

Indeed, we are already in process of developing additional games, expanding our initial learning goals and including games recognition and production of word and small sentences. In the

meantime, modifications and improvements are also under way for the games we presented here.

Finally, it is already in our intentions to develop tablet versions of the activities. It would be interesting to see whether this approach would increase students' engagement with the material and whether the lack of a shared interface would affect students' performance and attitudes. However, it is certain that the tablet versions would allow for project deliverables to be better disseminated into society.

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