Learning Arabic With Games

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***Abstract*— Our research addresses the design and implementation of a gaming framework that facilitates the acquisition of Arabic linguistic skills for children. Issues that we address revolve around the selection of an appropriate ``sub-language", cognitive structures and knowledge organization (concept map), and the navigation modes through the map (knowledge construction). The implementation of our game-based learning model provides a coherent integration of learning and technology as embodied in electronic games. Our implemented system is deployed on various platforms (e.g.,, laptop, iOS, Android, and HTML5). A major emphasis of our research is to evaluate the effectiveness of game-based learning. Thus, the supporting platform is used to devise experiments to assess the value of our model.**

Keywords-component; learning content; concept map; knowledge organization; game-based learning; Arabic language

I. INTRODUCTION

This is the age of the digital natives who spend the majority of their time interacting with a device ([1], [2], [3], [4]). They play, communicate, collaborate, and learn while connected. Promoting their learning is one of the important activities they carry out. Their preferred and inherent way of learning is through exploration and self-discovery. This process involves the learner and the technology offered by cyberspace. This may be referred to as "cyber-learning" [5]. While current educational methods are adopting new technologies, they have not addressed systematically learning processes, infrastructures, curriculum structures and assessment methods to support cyber-learning. Indeed, completely new models of the learning process are needed to integrate technologies and learning sciences ([6], [7]), and to effectively utilize the powerful tools for representing, visualizing, manipulating, and interacting with the learning content.

A. Background

As confirmed by recent statistics [1], the use of and interest in Information and Communication Technologies (ICT) permeates all segments of society. The use of ICT in learning in general, and specifically in Language Learning, Computer Assisted Language Learning, Computer Enhanced Language Learning, ICT-Based Learning, Technology-Enhanced Language Learning, and Web-Based Learning, are some of the technology-based approaches of language learning commonly found in the literature.

Besides owning a variety of mobile devices, young students spend a considerable amount of time playing games ([1], [6], [4]). Consequently, game proponents have been advocating digital games as effective toolkits to promote learning ([8], [9], [10]). Unlike games that are just played for fun, games intended for learning are now labeled *serious*. The emphasis underlines a shift in the attitude and treatment of educational games within the research communities (cognitive scientists, computer scientist, psychologists, educators, etc.). Indeed, the research community at large is converging towards an agreement that learning happens in games, even though the nature and the kind of learning taking place are still debatable.

B. Objectives

1. To develop a framework to support Arabic linguistic skills acquisition for children. We consider K-3 children and how they would learn the Arabic language. Issues that we address revolve around the selection of an appropriate K-3 ``sub-language", cognitive structures and knowledge organization (conceptual map), and the navigation modes through the map (knowledge construction) [11].
2. To design a game-based learning model to promote language learning. The design of our model provides a coherent integration of learning and technology as embodied in electronic games.
3. To implement the resulting model using an available game engine. The game engine provides us with the necessary functionalities to capture authentic learning spaces.
4. To deploy the implemented system on a variety of mobile devices. Existing game engines are now capable of generating executables for various platforms (e.g., iOS, Android, and HTML5). Our task is to migrate these executables onto the desired devices.
5. To assess the effectiveness of the application. A major emphasis of our research is to evaluate game-based learning. Thus, the supporting platform is used to devise experiments to assess the value of game-based learning.

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II. DESIGN PHASES

Our approach consists of the following phases: (1) design and analysis of surveys about games; (2) K-3 curriculum survey and synthesis; (3) concept map development; and (4) design and implementation of game for learning Arabic. Our major concerns throughout these stages were to identify and integrate the learning content, gameplay, knowledge structure, learning strategy, and learning progress. We elaborate our approach in the following sections.

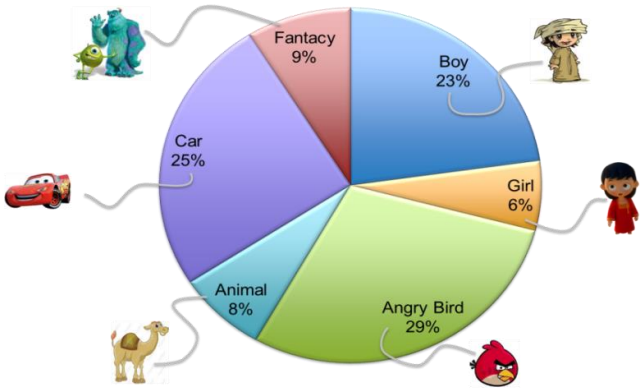

Figure 1: Favorite Characters

A. *Surveys*

We performed two surveys to identify how students felt about games as learning vehicles and which features in a game are more attractive. In survey 1, we polled one hundred female University students about their attitudes towards games. The overall perception is that games are useful instruments in learning. Additionally, research on games suggests that they can be an effective instructional medium and a major component of the school curriculum [2].

The second survey was targeted towards identifying game types, characters, and environments which children prefer. One major feature of these games is the support for interaction with and manipulation of objects. Such a feature is an effective way to support children learning. This survey was administered to fifty K-1 students. The first question was to assess which characters were most popular among pupils. They were given pictures of various characters and were asked to rank them. Figure 1 shows the results. Another question was to assess the type of environment they enjoy the most. Figures 2 and show the results. Unlike the wealth of data found in the U.S.A. (e.g., [1]), locally, data characterizing children's habits with regards to games are not available. We plan to further refine our surveys to account for the local cultural context. Additionally, we surveyed several successful educational games for children to extract their essential features [12].

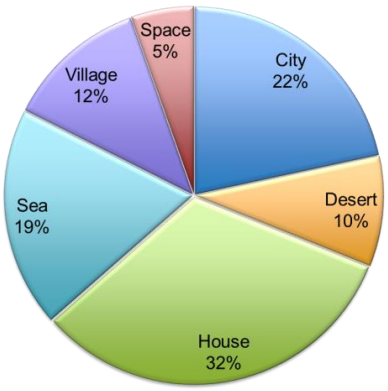

Figure 2: Favorite Environments

B. *Curriculum*

Because of our emphasis on K-3 children and how they would learn the Arabic (or any) language, we investigated issues revolving around the selection of an appropriate K-3 "sub-language". Thus, our task involved the survey and comparison of school curricula from Japan, Egypt, United Kingdom, and United States and the selection of frequent concepts and skills to synthesize a core curriculum for an appropriate language arts curriculum. From these curricula, we selected some of the fundamental recurring features that are prerequisites the children need to acquire linguistic skills. This core served as a basis for building a curriculum for teaching the Arabic language in our educational game. Based on this core, we constructed a conceptual map to structure linguistic knowledge exploration. We summarize our synthesis for KG in Table I from the selected countries.

TABLE I. KG CORE CURRICULUM

Listening	Stories and songs
Writing	Alphabet and common words
Reading	Words and short sentences
Speaking	Simple descriptions and short sentences

C. *Children Vocabulary*

We analyzed primary school Arabic language textbooks in order to identify some of the issues associated with the development of children vocabulary based on school corpora ([13], [14]). The analysis covered sounds, words, and expressions. Figure 3 summarizes the distributions of the parts of speech in three different curricula. Taking into account the frequencies and distributions allows us to generate learning content that is authentic and at the appropriate level [15]. Thus, rather than being incidental, the learning content is structured on a relevant knowledge base (words, images, environments, sounds, and activities).

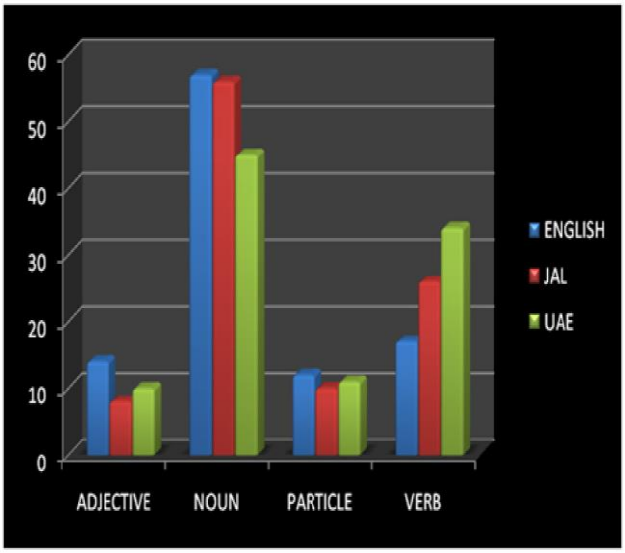

Figure 3: Parts of Speech Distribution [13]

D. A Child-Centered Concept Map

The organization of learning content along themes provides a concept map that is proven to be an effective pedagogical strategy. With the advent of computers and the proliferation of data, various approaches to organizing knowledge have been advocated. An example is conceptual mapping [16] which has been shown to model the students' cognitive structures. Viewed as small-scale ontologies, concept maps help children organize their knowledge and their thinking, and stimulate their cognitive skills [17]. In our approach, we developed a concept map based on the child's universe and vocabulary. In the game, overlaying this map is a scene that starts with the universe and zooms in on the smaller components of the child's world, such as home, toys, parents, schools, and other interesting elements surrounding the child. The structure of the scene transparently captures linguistic, visual, and relational information about a given theme. Dynamically exploring moving scenes allows the child to construct a rich story and build his/her knowledge. Even though the underlying representation is highly structured, the child's exploratory activities are spontaneous and guided by his/her actions and decisions. As reported in [18], interaction and exploration are processes that contribute significantly to the children intellectual development.

Figure 4 captures the organization of knowledge to be explored and learned in three levels, such as:

- **Level 1:** the concept of letters of the alphabet is introduced through its grapheme, its writing, and its pronunciation. This is the lowest level concept. Once a sufficient number of letters is learned and mastered, the next level can be explored. That is, progress from level to level is possible by fulfilling minimum prerequisites.
- **Level 2:** the concept of word is introduced through spelling, pronunciation, image, and animation. This rich combination associates and reinforces the meaning of the word.
- [**Level 3:** the concept of a simple sentence is introduced through complete sentences, their utterances, and their associated animations.

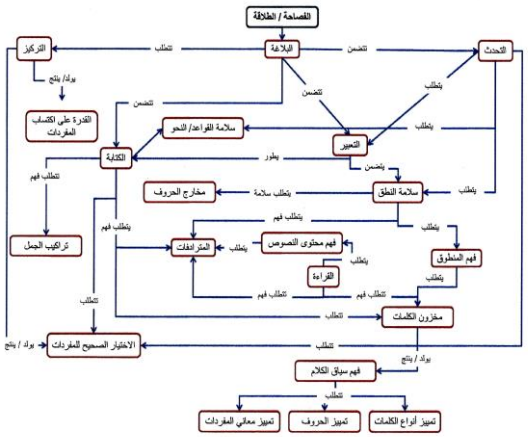

Figure 4: Arabic Concept Map

This gradual organization and flexible player-defined method of exploration provide a multitude of learning paths that the player can generate in order to construct additional knowledge. The explored network defines the knowledge level the player has acquired. One can also view the complete network as the set of all potential cognitive structures the player will acquire. As shown in Figure 5, the construction of these structures starts from the bottom level, and as they progress upwards, they become more and more elaborate, i.e., complex knowledge is constructed [19].

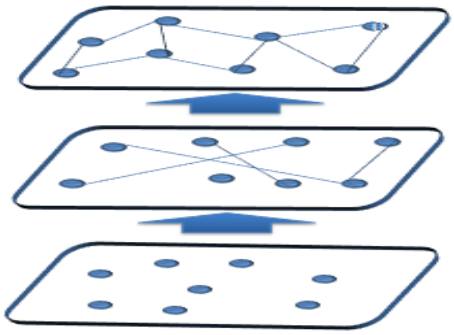

Figure 5: Cognitive Structures

Tied to each concept map is an authentic environment, i.e., which is an environment that captures the individual experience, the tangible objects, and the appropriate practice ([17], [18]). Authenticity has been shown to be an effective component of meaningful learning ([20], [21]). Some characteristics of authenticity are: the content represents real-life faithfully; it represents relevant information; it represents accessible meaning. The learning process is then viewed as generating associations to build up the meaning function. The gradual exploration of this environment is structured according to a set of concepts that captures the child's universe. Based on our preliminary work, we characterize the notion of an authentic and rich environment that can be freely explored as an environment in which entities, animate and inanimate, whether real or imaginary, can interact with the child and define relations between vocabulary/picture/sound. The game mechanics to support this kind of exploration has to support the integration of gameplay, learning, and assessment. Despite the extensive research in serious games, this integration is still problematic. Our assumptions about the concrete nature of the learning content and the young age of the learners provide us with a more concrete level of learning. Such a level is more amenable to doing and manipulating, making it closer to what adventure and shooter games embody.

As shown in Figure 4, the learning content is structured as a concept map. Each level of expertise is defined by its own concept map. We identify the following levels to support learning: (1) learning through a tutor (supervised learning) to allow scaffolding; (2) personalized knowledge construction (learning through exploration and discovery); (3) acquiring expertise (gaining deeper and solid knowledge); and (4) validating one's knowledge (assessment). Each of these stages is supported by the gameplay.

Figure 6: Authentic Environment

Figure 6 shows an example of what we think is an authentic learning environment. Not only it is familiar, but conceptually and concretely, the playroom is very rich. Thus, environments are built based on culture, familiarity and richness. Typically, the player is allowed to roam in his/her "universe" zooming in and out and interacting with entities that come into her contact. The interactions are couched in typical gameplay actions such as challenges, puzzles, physical prowess, etc. The zooming feature allows for a highly rich structuring of the concept map. We can visualize such a map as multi-dimensional, unlike the typical concept map. Each dimension defines a semantic feature that is associated with a given entity.

III. Implementation Model

Development stages consisted of requirements specification, use case, structural, and behavioral designs.

Figure 7: Use-case Diagram

The use-case diagram in Figure 7 identifies the major functions defining the behavior of the system. Our implementation model is shown in Figure 8. The game structure consists of three major components: (1) the user interface; (2) the game engine; and (3) the object model.

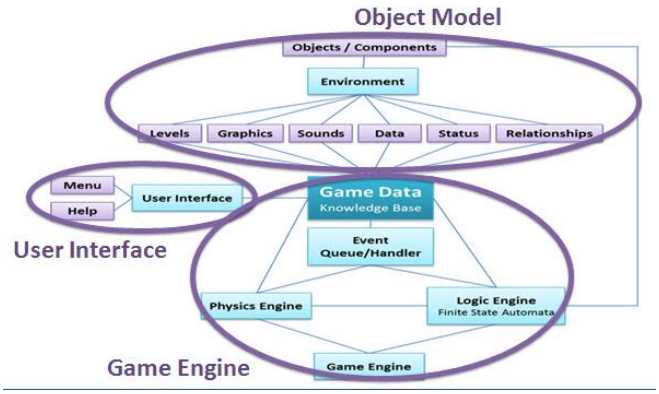

Figure 8: Game Structure

We implemented the learning game using the Game Maker Studio game engine [22]. This engine supports the construction of elaborate environments, the definition of objects and their behaviors, the integration of sound and music, rendering, and numerous special effects.

Figure 9: Major Game Components

Another way of depicting the object model is shown in Figure 9. The major components in the game consist of objects, sprites, sounds, and rooms. The objects are the actors capable of complex behaviors. The sprites are the external manifestations (physical appearance) of the objects. Sounds cover music, speech, noises, and any aural effects. Rooms are used to delimit environments in which activities take place. The user interface is a typical game interface for keyboard and touch-screen devices.

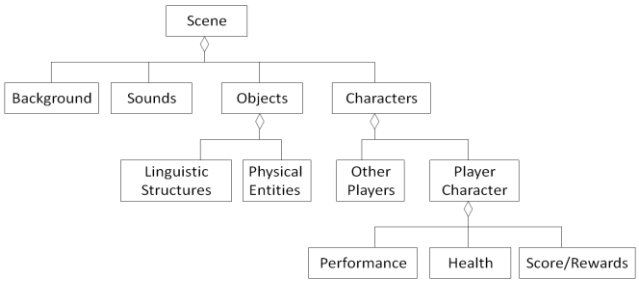

Figure 10: Game Scene

Figure 10 shows a draft of an object-oriented design of a game scene, which is an abstraction of the actual scene as shown in Figures 6 and 11. A game can be viewed as just a sequence of scenes. For example, in Figure 11, we can identify the environment as the background and its boundaries, the objects, such as the child, the monkey, the falling Arabic letters, the word, the fruits, the monsters, and in general any object. With each object is associated a behavior. The capability of programming objects at will to exhibit complex behaviors with some simple actions gives the game developer a powerful toolbox for constructing all sorts of virtual worlds. In our example, the letters perform the action of falling, and when caught, express themselves. The child moves in all directions and tries to catch the letters. There is also music background and sounds (pronunciation of the word and of the falling letters). This part of the game is the first level of learning with minimal challenge. The major difficulty lies in identifying a single letter at a time, a simple pattern recognition task. The purpose of this phase is to give the player a knowledge basis upon he/she can advance. Further levels introduce more noise in the patterns to sharpen the discrimination process and increase the player's knowledge. Examples of noises contributing to the complexity of pattern recognition are:

- Similarly shaped letters
- Variations in script writing
- Ambiguous shapes
- Combinations

A. Challenges

The game implements several types of challenges to keep the player highly motivated, among them are physical, visual, mental, and aural challenges. Keeping learners motivated for a long time in a game requires the integration of challenges, control, fantasy, and curiosity in the gameplay [23]. The major challenges a player faces in our game are four different types:

1. Physical challenges require coordination, speed, and fast reflexes. For example, when collecting letters, the player faces a gradual increase in the number and speed of the invading letters and variation in their appearances and orientation. The variety and the randomness of these factors define a wide range in the complexity of the challenges that keep the player's attention heightened.
2. Visual challenges involve visual identification of concepts, images, and their associations. It allows the player to link concepts to their representations, and thus, construct new meanings.
3. Aural challenges involve identification of utterances (e.g., pronunciation) with their corresponding images and lexical/syntactic expressions. Again, this is another facet of meaning construction.
4. Mental challenges involve applying the linguistic skills just learning by gradually reconstructing lexical and sentential fragments based on puzzles and missing components.

Figure 11: Game Scene

The other types of challenges deal with pattern recognition. Thus, the game generates a series of patterns containing an increasing level of noise. The combination of noise and the previous factors diversify and complicate the aural, mental and visual challenges. Overcoming these challenges provides a measure of how successful the player is in learning and is used as a form of feedback and assessment.

IV. CONCLUSION

We identified and integrated four major components that directly contribute to game-based learning. Among these components are learning content (curriculum), knowledge structure (concept map), learning strategy (gameplay), and learning progress (assessment). Each of these components was explicitly defined based on the notion of authentic learning. A game to demonstrate the feasibility of integration of these components was developed. This game allows children to gradually acquire linguistic skills ranging from the letters of the alphabet to simple sentences. Players acquire competence in reading, writing, and listening.

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