EMPLOYING DESIGN AND DEVELOPMENT RESEARCH (DDR) APPROACHES IN THE DESIGN AND DEVELOPMENT OF ONLINE ARABIC VOCABULARY LEARNING GAMES PROTOTYPE

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ABSTRACT
The design and development research, first proposed by Brown and Collins in the 1990s, is currently among the well-known methods in educational research to test theory and validate its practicality. The method is also known as developmental research, design research, design-based research, formative research and design-cased and possesses conceptual underpinning and practical aspects of the 'what' and 'how' of 'doing'. This paper describes the design and development of a web-based Arabic vocabulary learning games prototype incorporating the methods and approaches of DDR for elementary learners in Centre for Foundation Studies (CFS), International Islamic University Malaysia (IIUM). The effort in generating this learning prototype attempts to design, develop and integrate a game-based learning application in an online platform. It is meant to provide an interactive learning experience for learners who have been through traditional non-computer based Arabic teaching and learning methods. Their feedbacks and responses are then gathered and analysed as the formative evaluation for the design and development principles. The exploration of the potential of use for the game-based learning prototype in teaching and learning in real setting by various experts, learners and teachers was also among the steps taken to evaluate the usability and practicality of the prototype during the design and development phases.
Keywords: Design and development research, online games, Arabic vocabulary learning, formative evaluation, web-based games

INTRODUCTION

Nowadays, online digital educational games are described as the new model of e-learning (Squire, 2005) and have attracted researchers' attention from around the world and perceived as an integrated tool within the teaching and learning process (Prensky, 2001; Pivec, Koubek & Dondi, 2004; Whitton, 2010; Roslina et. al., 2011). The term 'game-based learning' or GBL describes the teaching and learning process via computer games similar to terms such as 'digital game-based learning' (Prensky, 2001), 'edutainment' and 'serious games' (Tsai F.H., et. al, 2008). 'Serious games', however, differ from edutainment games in terms of more advanced design consideration, latest hardware and software and rules of simulation (Michael & Chen, 2006). The differences between games and simulations are also viewed as fulfilling a particular psychological situation for the player in games and participants in simulations (Gredler, 1992). Simulations are also found potentially helpful in assisting the students to learn by construction in a simulated embodied experience and problem solving skills (Liu, Chen & Huang, 2011) and is also capable of evoking flow experiences and positive effects (Chiang, et. al., 2011).

The computer games characteristics are also among the main factors that differentiate them from any other instructional media and technology. Malone and Lepper (1987), for instance, identify motivational factors in games such as challenge, fantasy, curiosity and control. Other researchers have expanded the potential characteristics of games in designing game-based learning framework in terms of fun, entertainment, constraints,

goals achieving, acquiring knowledge and skills (Gredler, 1992), experiential learning and challenging (Gredler, 2004), competitiveness, enjoyable, creativity (Akilli, 2007), played on various platforms or game consoles (Roslina & Azizah, 2008), motivating (Tuzun, 2004; Alessi & Trollips, 2001) and experienced-based storyline (Zarina & Hanafizan, 2005).

Design and Development Methodology in Educational Games

The design and development of games proves to be a not so easy process requiring an extensive programming project from the development of game engine, middleware, interface programming and audio programming. Despite the difficulties, a number of tools such as functional authoring tools and drag and drop interface have been recently developed to ease the complexities (Roslina & Azizah, 2008). Several frameworks and models have been proposed by researchers in the field of game design such as The Design Framework for Edutainment Environment by Embi (2005), Adopted Interaction Cycle for Games by Barendregt and Bekker (2004), Game Object Model by Amory (2001) and The Engaging Multimedia Design Model for Children by Said (2004), as cited in Tan, Ling and Ting (2007).

The design and development principles of the online Arabic vocabulary games in study were based on the 5 level of games learning which Prensky (2001) refers to as: "**"How," "What,""Why," "Where," and "When/ Whether"** levels at which learning occurs in video and computer games (Pivec, Koubek & Dondi, 2004, p. 42). The design and development process of the Arabic vocabulary games prototype in this paper involves the integration of Arabic learning contents from the traditional text book and the Raptivity ® e-learning authoring software supplying many and various games templates. The selection of this software is due to reasons of its supportive features to the correct display of Arabic fonts and the right to left Arabic writing system. It is also a tool that can be easily navigated through by educators without requiring high level of computer skills, which is among the identified shortcomings of the Arabic language teachers (Mohd Feham & Isarji, 2006; Mohd Feham, 2006; Zawawi, 2008).

The online mode is selected as the games platform for this prototype because it allows learners, regardless of their geographic location, to independently participate in the learning environment (Connolly & Stansfield, 2006). It is played on a computer platform with the internet connection; the games are stored and played directly from the server (Roslina & Azizah, 2008). An online platform is also chosen for the games prototype to facilitate the usability and ensure easy-access to this application for the Arabic language learners.

Design and Development Research (DDR) Method as Employed Approaches

The employment of design and development research (DDR) methodology as the selected approach is justified in this study by its pragmatism in testing the theory and validating the practicality. Besides, it is described as a way to establish new procedures, techniques and tools based on specific needs analysis (Richey & Klein, 2007). This methodology is also formerly known as developmental research (Richey, Klein & Nelson, 2004), designed case (Reigeluth & Frick, 1999), design-based research (Reeves, 2006 & Herrington, et. al, 2007), formative research (Nieveen, 2007), and design research (Bannan-Ritland, 2003; Van der Akker, 2007).

Although many terms have been introduced to explain and describe this research method within its similarities and differences, it was first proposed by Brown and Collins in 1992 as an extension to other educational research methods (Wang & Hannafin, 2005, Markauskaite & Reimann, 2008) and to test theory and validate its practices (Richey & Klein, 2007). It is also employed to design and develop an intervention (such as programs, teaching-learning strategies and materials, products and systems) with the aim to solve a complex educational problem and to advance our knowledge on the characteristics of these interventions and the processes to design and develop them (Plomp, 2007, p.12). Wang and Hannafin (2005) define it "as a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (p. 6). Table 1.0 illustrates the pragmatic elements of a design and development research that have been adapted in this study:

Table 1.0 : Elements of a design and development research

Goals	Dual goals – theory and practice
Theory development	Multidisciplinary and interdisciplinary
Method	Mixed modes
Process	Cyclical, iterative, teamwork
Resources	Extensive literature, collaboration, partnership, various research technologies
Outcomes	Improved theory, product, design principles

Adapted from Nor Aziah (2007)

A Pragmatic Model of Design and Development of Online Arabic Vocabulary Learning Games Prototype
The employment of pragmatic elements of a design and development research (DDR) in this paper is described as the followings :

a) Multidisciplinary and interdisciplinary theory development: The design and development of the online Arabic vocabulary learning games involved various multidisciplinary and interdisciplinary analyses of needs for the design and development of games addressing numerous aspects of Arabic vocabulary learning problems among learners, teachers and experts. The design and development aspects from other fields of knowledge were also considered prior to the games' design and development process.
b) Mixed modes methods :
The mixed modes methods were implemented in the formative evaluation of the online Arabic games. The evaluation is meant to *judge the strengths and weaknesses of its instruction in its developing stages, for purposes of revising the instruction to improve its effectiveness and appeal* (Tessmer, 1993, p. 11). The evaluation was divided into 2 phases of game prototype 1 and game prototype 2 implementing both quantitative and qualitative mix-method instrumentations. The validation of the instruments for the formative evaluation was conducted by an expert in instructional design and game-based learning from the University of South Dakota, United States of America (USA).

The process of consultation, discussion and validation were communicated through the researcher's email at sabriqld2003@gmail.com. The formative evaluation for pre-prototype 1 went through several try-out sessions with a limited number of the user groups such as teachers and learners who will eventually use the materials and expert appraisal or review from a group of experts consisting of subject matter experts, instructional design experts, and teachers review of the materials (Nieveen, 2007). Prototype 1 and prototype 2 have been evaluated via four (4) types of formative evaluation which are expert review, one-to-one evaluation, small group test and field test which were adapted from Tessmer (1993, p. 15). The process of formative evaluations for the design and development principles were conducted in the following phases as shown in Table 2.0 below:

Table 2.0 : Phases of Formative Evaluations for the Games Prototype

GAMES PRE-PROTOTYPE (ANALYSIS, DESIGN AND DEVELOPMENT)	
Participants and Methods	**Instruments**
- 115 out of 133 learners in semester 3, 2008/2009 - 13 lecturers teaching in semester 3, 2008/2009 - 2 senior IT officers at CFSIIUM - (consultation in IT facilities) - 2 programmers from Raptivity ® - (consultation in using Raptivity's authoring tool) - 3 experts in digital game-based learning (DGBL) – consultation in survey design	• Needs analysis • Open-ended questionnaires • Interviews • Think-Aloud protocols • Content Analysis
GAMES PROTOTYPE 1 (DESIGN AND DEVELOPMENT)	
Participants and Methods	**Instruments**
- 2 programmers from Raptivity ® - (consultation in using Raptivity's authoring tool) - 1 subject matter expert in Arabic language - 3 experts in validating the survey design - 2 experts' review in instructional designs, English language and Arabic language.	• Open-ended questionnaires • Interviews • Think-Aloud protocols • Content Analysis
GAMES PROTOTYPE 2 (FORMATIVE EVALUATION)	
Participants and Methods	**Instruments**
a) Pre-Formative Evaluation - Peer reviews (2 lecturers) - SME in Arabic language (1 expert) **b) Formative Evaluation 1** - Experts' review (6 experts) - Learners' review (2 learners) - Evaluator's review (1 peer lecturer/asst. coordinator) **c) Formative Evaluation 2** - small group testing (16 learners) - field testing 1 (33 learners) - field testing 2 (49 learners)	• Survey • Open-ended questionnaires • Interviews • Think-Aloud Methods • Class observations • Testimonials

c) Cyclical, iterative, teamwork :
The iterative cycles of the five (5) phases of analysis, design, development, implementation and evaluation used in this project are in accordance to the ADDIE Model as shown in Figure 1.0 :

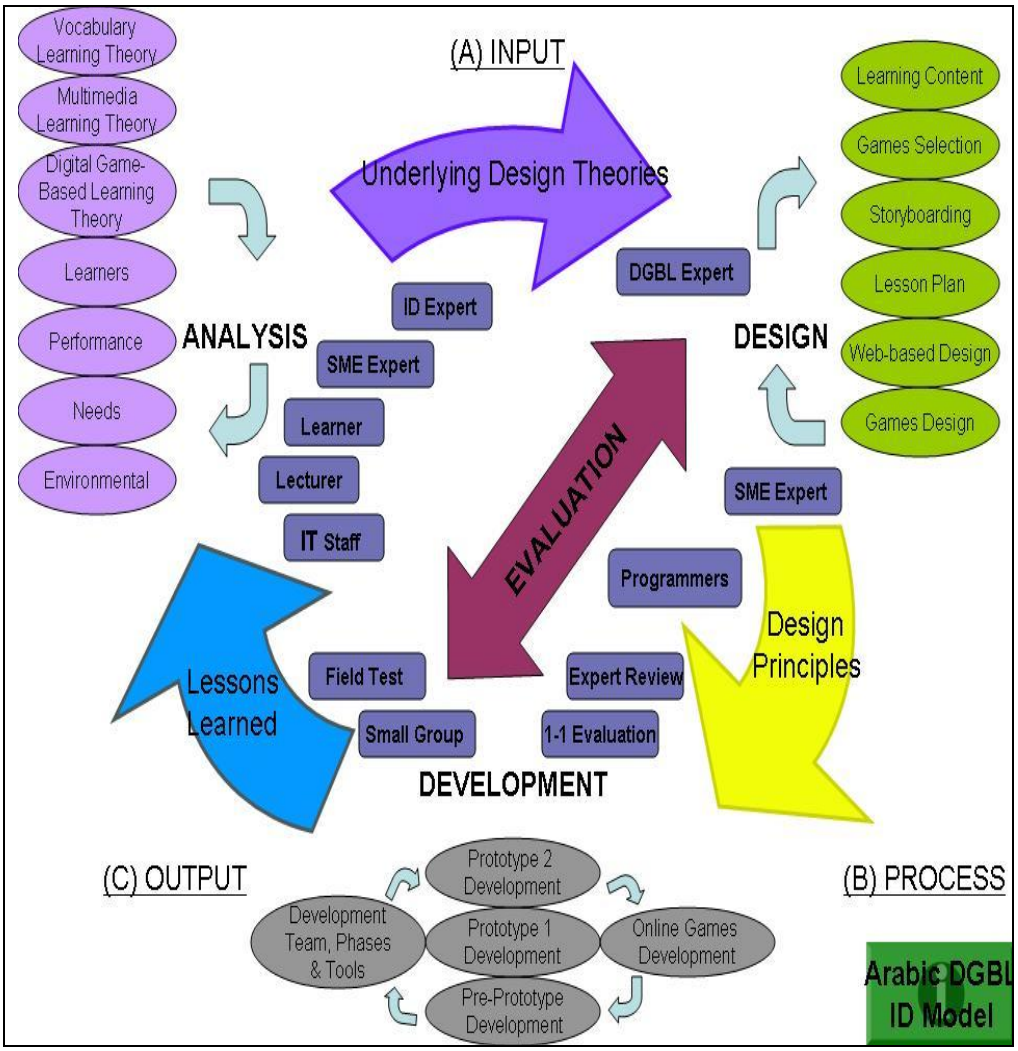

Figure 1.0 : Iterative cycles of adapted ADDIE's model

The front-end analysis for the learning needs of the prototype's design and development was then conducted based on the design and development of product and tool research (Richey & Klein, 2007) or previously known as Type 1 of developmental research (Richey, Klein, & Nelson, 2004). The differences between TYPE 1 and TYPE 2 developmental research are shown in Table 3.0 below :

Table 3.0 : A Summary of the 2 Types of Developmental Research

	Product and Tool Research Or Type 1 of DR	**Model Research Or Type 2 of DR**
Emphasis	Study of specific product or program design, development, &/or evaluation project	Study of design, development, or evaluation processes, tools, or models (can focus only on ONE phase)
Product	Lessons learned from developing specific products and analyzing the conditions that facilitate their use	New design, development, and evaluation procedures &/or models and conditions that facilitate their use
	CONTEXT-SPECIFIC CONCLUSION	*GENERALIZED CONCLUSIONS*

This research has embraced the product and tool research method (Richey & Klein, 2007) or previously known as Type 1 of developmental research (Richey, Klein, & Nelson, 2004). The product for this study is an online Arabic vocabulary learning games prototype, which was conceptualized, designed and developed based on both

theoretical and practical aspects. The development of the online Arabic vocabulary learning games prototype as a final educational product is a combination of the design and development principles with vocabulary games templates from Raptivity ® e-learning authoring tools in an online learning environment. The researcher is the main designer and developer of this learning prototype module. It is however, the nature of developmental research that the researcher collaborates with a development team. Relevant tools of development are employed and the development process is documented in work logs as illustrated in Table 4.0 :

Table 4.0 : Work Logs of Development Process and Stages

Stage	Work Log	Descriptions
Stage 1	Designing the online games storyboards.	Designing the storyboards based on 'Design Principles'.
Stage 2	Designing the webpage.	Designing the webpage for the online vocabulary games learning.
Stage 3	Developing the vocabulary games.	Developing the games by integrating the learning contents into the games design templates of Raptivity.
Stage 4	Uploading and publishing the games website.	Uploading and publishing the website in the internet server and testing the application.
Stage 5	Conducting pre-formative evaluation	Conducting pre-formative evaluation with subject-matter expert (SME) and lecturers as future users.
Stage 6	Revision of design and development	Revising and modifying the development process based on the feedbacks and responses.
Stage 7	Conducting formativeevaluation 1.	Conducting formative evaluation 1 of the online Arabic vocabulary games with expert reviewers, lecturers and learners as actual users.
Phase 8	Revision of design and development	Revising and modifying the development process based on the feedbacks and responses.
Stage 9	Conducting formative evaluation 2.	Conducting formative evaluation 2 of the online Arabic vocabulary games with students and teachers as the actual users.
Phase 10	Data analysis and report	Conducting the data analysis and report of the design and development process

d) Extensive literature, collaboration, partnership and various research technologies : The design and development of the online Arabic vocabulary learning games prototype have not been simply conducted as in designing and evaluating the games formatively or summatively. It has been scrutinized through the analysis of extensive literature, collaboration and partnership between different learners, lecturers, experts and instructional designers and integrated various research technologies and tools. In order to construct the framework for the online Arabic vocabulary learning games prototype, as shown in Figure 2.0, analyses of theories from literature such as of Nation's (2003), digital game-based learning (Prensky, 2001) and multimedia learning (Mayer, 2001) were conducted. The analyses of extensive literature were combined with a 9-year personal teaching experience of the researcher and the reasons for failures in Arabic subjects among learners in 4 consecutive semesters of 2005/2006 until 2008/2009 (TEMU Report, 2005-2009). Based on the researcher's initial analysis and observation, the lack of instructional technologies in current teaching and learning of Arabic has led to the problem of memorizing the content of Arabic lessons taught in the classroom, as echoed by Mohd Feham (2006) and Zawawi (2008). Concurrently, the reports on students' failures revealed that among the main and obvious factors were poor attendance in the classroom, weaknesses in memorizing Arabic vocabularies and their minimal effort to improve and pay attention in Arabic language learning. These factors are mainly related to students' learning attitude and motivation in learning Arabic.

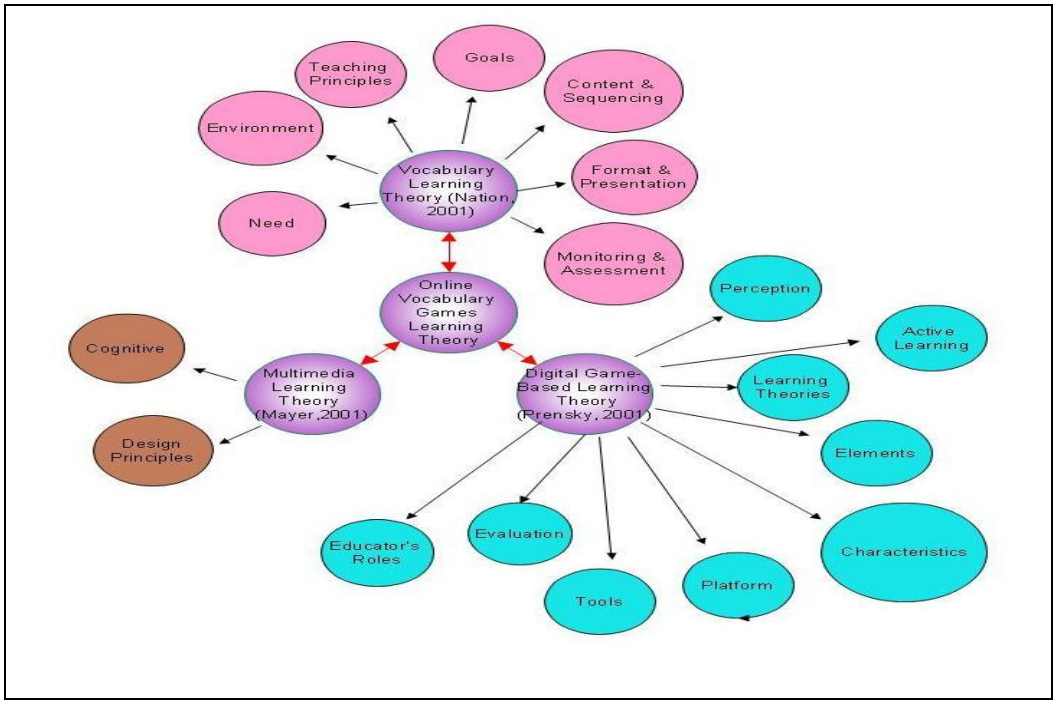

Figure 2.0 : Design theories of online vocabulary learning games from extensive review of related literature

In addition, the ADDIE's adapted model is chosen as the instructional design model for the research as it fits the design and development methods, objectives and approaches to portray a complete picture and understanding, theoretically and practically, of an online vocabulary learning module. Walter Dick and Lou Carey are widely viewed as the torchbearers of the ADDIE methodology, through their book *The Systematic Design of Instruction* (Dick & Carey, 1996). Akilli (2004) has proposed the FID^{2}GE model, also consisting of four phases of design; analysis, design, development and evaluation, which stands for "**F**uzzified **I**nstructional **D**esign **D**evelopment of **G**ame-like **E**nvironments" for learning in which the name was derived from the dynamism, non- linearity and the fuzziness of games (p. 139-142) as shown in Figure 3.0 :

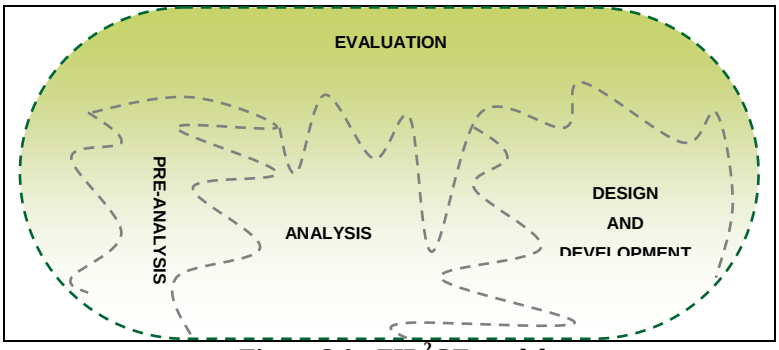

Figure 3.0 : FID^{2}GE model

The researcher, however, opted to use the adapted ADDIE's model (Figure 1.0) instead of FID^{2}GE due to the uncertainty of the implementation phase in FID^{2}GE and the existence of five (5) main phases in ADDIE to facilitate the research. The argument of whether ADDIE is a model or just a process is not the objective of discussion in this paper. To reiterate, the ADDIE model is chosen for its systematic generic approach in instructional design, which clarifies the instructional framework to the designers or researchers in order to ensure the effectiveness of instructional products with creative processes (College Station, 2001).

e) Improved theory, product and design principles based outcome :

The refinement of theories from the literature in the *iterative cycles of testing and refinement of solutions in practice* (Reeves, 2006 & Herrington, 2007) begun at the front-end analysis phase directed at analysing four (4) components of needs analysis which was adapted by Dabbagh (2006) and as shown in Figure 4.0. The participants involved were 113 out of 133 students studied Arabic language in semester 3, 2008/2009 as well as

the lecturers and were required to answer the needs and pre-design survey of an online Arabic vocabulary games in CFSIIUM (Muhammad Sabri and Nor Aziah, 2011). The validation of the instrument was completed by a lecturer, from the Institute of Education (INSTED, IIUM), teaching the subject of Research Methodology in IIUM.

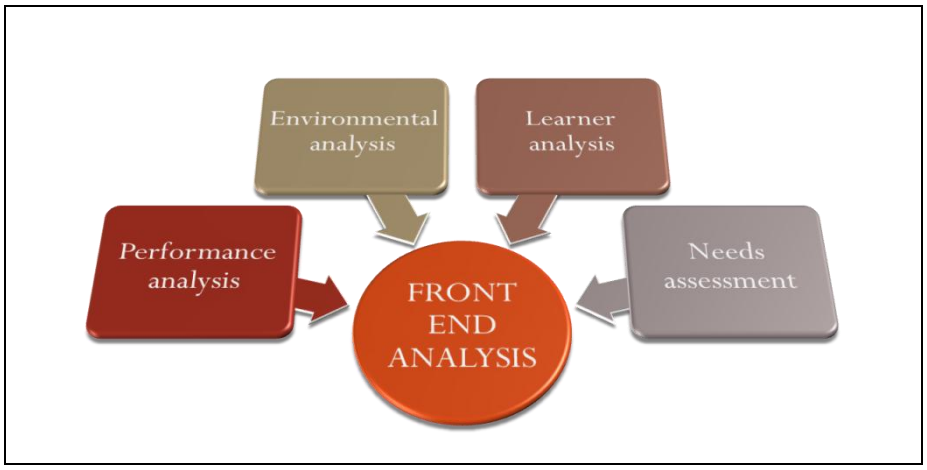

Figure 4.0 : The Analysis Procedure in Developmental Research

The initial design from the analysis phase was then validated by an expert who is an Arabic language lecturer from the Centre for Language and Pre-University Academic Development (CELPAD) of IIUM in order to refine the contents of Arabic language integrated in the online games. The theories were also refined by an expert from the Centre for Professional Development (CPD) of IIUM who specializes in instructional design and teaching using technology. At the end of this phase, the design and development principles were established to guide the development process. The details of procedures conducted were previously explained in Table 2.0.

Design and Development of Online Arabic Vocabulary Learning Games Prototype

The online vocabulary learning games was designed as a final research product of additional teaching and learning aid in Arabic vocabulary learning and was hosted in a web-based environment. The general outlines of design and development of this online Arabic vocabulary games prototype are as the followings:

a) Constructing general research framework
b) Conducting front-end analysis procedures
c) Validations from various experts (ID & SME)
d) Consultations from various experts (ID & SME)
e) Constructing 'Initial design principles'
f) Revising and validating 'design principles'
g) Development of initial pre-prototype
h) Revisions of prototype 1 and prototype 2 in iterative and cyclic and process – meant for changes and improvement of final games prototype
i) Conducting formative evaluation of design and development among various experts, lecturers, and learners
j) Final product is ready for use

The samples of website screenshots are as shown below in Figure 5.0 and Figure 6.0 :

Figure 5.0 : Main Page of Online Arabic Vocabulary Learning Website

Figure 6.0 : Screenshot of Online Arabic Vocabulary Learning Website

Main Characteristics of Online Arabic Vocabulary Learning Games Prototype

a) It is designed mainly for Arabic learners in CFSIIUM.

b) It has a compendium of 34 varieties of games and distributed into 7 levels of vocabulary difficulties.
c) It is supported by online learning tools such as instructions to play, learning objectives for every game, online translator, online dictionary, games glossary in English to Arabic and 2 vocabulary test games.
d) It is functioning as a supportive teaching and learning tool for Arabic language in the classroom and multimedia laboratory as the followings:.

i) The lecturer facilitates (facilitator)
ii) Learners collaborate (collaborative learning)
iii) Has the potential for self-instruction (synchronous and asynchronous modes)
iv) Supportive learning tool for blended/hybrid learning
v) Can be used between 14 weeks of semester (flexibility)

Challenges and Obstacles

Design and development research (DDR) provides an alternative to conduct rigorous and systematic design research based on solid theoretical foundations. It possesses the necessary approaches to design and develop the principles of the games prototype with the flexibility of revision in iterative cycles of user testing sessions in real and authentic setting. However, each endeavor is not without its own challenges and barriers. The challenges and obstacles mentioned in this paper were established from the experience of researcher during the design and development of this online games prototype and are as the followings:

a) The limitation of technical support in Raptivity ® software in Arabic writing systems and fonts exists, and has caused some restrictions in using Arabic conveniently, especially in the display of Arabic fonts with the vowel sounds.
b) The limitation of games design templates in this software also restricted the design of language games with advanced features such as in displaying overall scores for all players for the purpose of competition, more choices of attractive games templates, colours, and buttons.
c) This study is specifically designed for elementary level Arabic learners only based on the selection of vocabulary games and may not be suitable for higher level of learning.
d) The financial implication is one of the restrictions to producing a high technology games for this study which has resulted in the researcher in using the Raptivity ® software as a platform to develop Arabic vocabulary games.
e) This software can be used by all educators with proper training and briefing without the need for a high level of computer competency skills such asin using advanced authoring software to develop games such as the Adobe Flash, and SwishMax ®. Thus, this software could not be used to develop the advanced features of language games.

SUGGESTIONS FOR EDUCATORS AND INSTRUCTIONAL DESIGNERS

a) The technical limitation of this software in Arabic writing systems and fonts should be improved and enhanced in order to make it more compatible, convenient and user-friendly to Arabic learning application.
b) The limitation of games design templates in the Raptivity ® software can also be upgraded and enhanced with advanced features such as in displaying overall scores for all players for the purpose of competition, more choices of attractive games templates, colours, and buttons.
c) The future research and study of using game-based learning in Arabic language could attempt to design and develop the games that use different learning platforms compared to this study such as the arcade, console, CD-based and handheld or mobile learning games.
d) The educational institutions that offer Arabic language learning should play more active role in producing attractive and interactive teaching and learning aids in order to enhance students' motivation and attitude in learning process and improving their achievement and performance.
e) The Arabic language teachers and practitioners should be more aware of and knowledgeable with the latest teaching technology and computer skills. Some groups with high computer skills in every educational institution can be trained periodically in a cluster training in order to help them producing new teaching and learning aids in Arabic language.
f) There should be sessions of cooperative work and research activities between language teachers such as the Arabic, English or other languages with the instructional designers and computer experts to design and develop advance and effective games for teachers and learners.
g) Other ID models may be used in the design and development of games based on the objectives, structures, expected outcome, technology or others issues based on the suitability and purpose of games design and development.

SUMMARY
This paper has described an effort to design and develop an online Arabic vocabulary learning games prototype in IIUM using the design and development research (DDR) methodology and approach. This Arabic educational DGBL is now in function and linked to several learning and research institutions such as My-Arabic at CELPAD, IIUM (Link: http://myarabic.e-celpad.com/), Malaysian Foundation of Innovation (Link : http://www.yim.my/databank/index.cfm?menuid=5&action=show&ib=128&), and educational blog in Arabic learning such as http://mari-belajar-bahasa-arab.blogspot.com/. The outcome of this project will hopefully enhance the process of teaching and learning Arabic language in IIUM as well as in other institutions. This research is hoped to trigger more in-depth research methodologies and approaches in the design and development on online educational games based on real needs in the real settings of learning environment and institutions, This prototype has reflected a set of design and development principles for an online Arabic vocabulary learning games in the Malaysian context specifically and for non-native Arab speakers in general.

NOTES ON CONTRIBUTOR

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