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Identifying Elements for Applying Learning Instructional in Game Base Design

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ABSTRACT

Background

Instructional systems are increasingly being used mainly in learning, expanding the idea of learning instructional through game approach providing experiences with the purpose of improving the system of learning. Therefore, it is necessary to establish mechanisms for instruction as a learning usability in the game-based interface design that make appropriate basis of interaction. This is to achieve a balance between functionality and knowledge retention.

Objective -This study aims to present the results of a systematic analysis focused on identifying appropriate learning instructional for a game-based system. Considering devices with instructional capability, the usability methods, the common interface issues, and the elements were adopted to propose a good game-based learning interface framework.

Methods - In the context of this study, the methodology that allows the iteration processes is adopted. It encompasses two parts; theoretical; identifying the elements and Evaluation; expert review. The research was centered on some electronic database both national and international: from 2015 to 2018. Within 47 studies evaluated, 10 matched the eligibility criteria of a good game-based learning instructional interface. As a requirement, the study considered applying game learning as theoretical section and the use of expert review to evaluate the identified instructional elements.

Results - In the 10 studies found, there was no standardization in the methods, because of the diversed analysis variables. Heterogeneously; authors used different approaches to design game-based interfaces and no default instructional learning elements were proposed. Questionnaires were the most used instruments 6/10 (60%), followed by interviews 3/10 (30%), and observation method 1/10 (10%). Moreover, 60% (6/10) of the studies used gesture-based serious games to evaluate the performance of elderly participants in rehabilitation tasks. This highlights the need for identifying instructional elements to guide developers for designing learning instructional game based that provides a user-friendly interface according to the user's age and limitations.

Conclusions - Through this study, it is concluded that there is need for an instructional design for game based learning, especially games for educational adults, which may offer the user more comfort, retention, and confidence.

Keywords: Interface, Computer games, Retention, Learning instructional, Game-based design

1. INTRODUCTION

Many researchers have investigated the use of Internet and Multimedia Presentation for enhance learning instructional. It has been realized that visualizations and animations are appropriate in learning environment (Ebner & Holzinger, 2003). Animations are generally more effective than 2-D graphics in describing objects for real time knowledge in time and space (Tversky, Morrison, & Betrancourt, 2002, Aneja, et al., 2018). Research supports the hypothesis that animation facilitates learning when it presents, while static graphic does not present the concept (Thompson & Riding, 1990). However, animations are often too complex or too fast to be accurately perceived; continuous events are also often conceived as sequences of individual steps.

Careful use of interactivity game can overcome these limitations (Schnotz & Grzondziel, 1999; Biard, Cojean, & Jamet, 2018). Game learning approach is an active process on the part of the learner and knowledge, as well as understanding can only be constructed by the learners themselves (Clark, 1994; Shanbari & Issa, 2019). However, enjoyable experiences should not only be enriching but also memorable educational transformation (Shneiderman, 1998; Petner, 2018; Gentry et al., 2019). In addition, an important factor is the retention of the students in using any designed learning application through the use of learning interface design (Logan & Gordon, 1981; Holzinger, Pichler, Almer, & Maurer, 2001; Abdulrauf, Ariffin & Sobihatun, 2016). This was founded to assist students during their learning process by using game learning system to retain their intention for knowledge acquisition (Ebner & Holzinger, 2007). The students considered interactivity extremely important (Kettenanurak, Ramamurthy, & Haseman, 2001; Abdulrauf, Ariffin & Sobihatun, 2015) in learning instruction. Consequently, this research proposed elements of Game Learning System (IGLS's), which require that any game developer must consider it when designing this kind of learning interaction using a construct cognitive schema. This cognitive concept accords with the four components of instructional design model for Complex Learning (Van Merriënboer & Kester, 2005; Van Merriënboer & Kirschner, 2017) that have been realized the idea of building a Game Based Learning (GBL).

This research is presenting instructional elements of game interface that is positioned at all levels, namely, the four-component instructional design model; van Merriënboer, 1997; Van Merriënboer, Clark, & de Croock, 2002; Van Merriënboer & Kirschner, 2017), and to discuss how this theory can be used to derive instructional elements for complex learning. Such complex learning explicitly aims at the integration of knowledge, skills and attitudes, the ability to coordinate qualitatively different constituent skills, and the application of what is learned to real life system. The cognitive approach towards game based system views authentic learning tasks that are based on real-life tasks as the motivating factor for learning retention in a well-designed interface for complex learning. The three interface design components are procedural information, instructional information, and part-task retention.

Learning from game requires cognitive procedural information (for instance, interaction of relevant learning levels, the psychological understanding that relate with formal knowledge) and strategy procedural (for example, the tactic to employ is the engaging effort to the cognitive procedures). Concerning the cognitive procedural, the cognitive theory of multimedia learning (Mayer & Moreno, 2003) and cognitive load theory (Plass, Moreno & Brunken, 2010) were part of theories that determined the genuine learning forces, which will assist learners to explore in proper cognitive processing in learning (i.e., selecting, integrating, and interacting) in a human data processing system that has restricted processing capacity. Cognitive load alludes to the degree of processing the needing of task, for example, gaining knowledge from a game application. There are three important instructional information in each learner's processing capacity: (1) lessen irrelevant information (i.e., cognitive processing which does not aimed at learning objective and this resulted from poor interface design), (2) manage the important information (i.e., cognitive processing which is intended to show the presented course material and results from the contents inbuilt complexity), and (3) promote generative information (i.e. cognitive processing which is intended at making a logical presented course material and resulted from the strategies to enhance learner's in learning and retention).

Appropriate design of instructional interface can limit the irrelevant procedure for game learning users (thus lessening cognitive load) by assisting users to maintain the cognitive resources that consequently result to missing and disorienting. In a nutshell, the issue of cognitive reduces the irrelevant procedure and unblocks the cognitive capacity that could be utilized for fundamental and generative procedures (for example, encoding the important parts of information relating to game learning and psychologically linking them with one another and with appropriate previous learning).

Furthermore, instructional strategies that enhance learning processes during game should easy to use and satisfying appropriate interface design. This could enhance users to utilize what is obtainable in the cognitive capacity for proper cognitive procedure in the learning activities. In the review of Schiefele (2009) on part-task retention focused on interest, the study projected on learning instructional strategies that will build interest which represented an achievable antecedent of motivation. Also, it noted that in respect of several other motivational constructs, interest is constantly identified with a particular strategy, object, subject area or activity. Studies by Hidi, (2001), Silvia (2006), and Renninger, Hidi and Krapp (2014) have identified situational interest that involves a limited period of psychological condition that engages: focused mind, determination, incentive or affective involvement, increased cognitive functioning, and curiosity. A general theme in conversations of situational interest can encourage a feeling that supports cognitive engagement.

In the strategic context of interface design of game learning, Norman (2004) suggests common idea that properly designed learning instruction can generate helpful emotional situation for the interface, and frequently affect the influence cognition. In the game based design, the study extend this idea by proposing that appropriate learning instructional elements that can help users feel more satisfied with the game learning system is considered necessary while designing game based learning. When users are motivated through appropriate instructional strategies, it is possible to involve them in fundamental and generative procedures during implementation.

2. METHODOLOGY

In other words, this study stresses on the analyzing of existing game learning systems to identify instructional elements for game based learning system, and implementing expert's walkthrough in order to determine the efficiency and effective elements of learning instructional, rather than the usefulness of the existing game-based system. Therefore, based on the rational of using Iterative Processing Methodology approach, this study decides to apply comparison of instructional elements in the previous studies as the theoretical methods of gathering data for the framework. This technique provides richer data on top of the empirical data.

2.1 Game-based Studies Analyses

This subsection listed all game learning that were selectively compared in seeking for generic elements of instructional design to be integrated as part of game-based learning design. They were selected as samples based on certain justifications in Table 1 that work for not only gaming interface development components but also for learning instructional components. For making the elements to be generic, samples were selected from various targeted and by publishers from various countries, both from local and international.

Those selected game based with learning instructional were analyzed in detail which include their concepts and limitations, in order to seek the research gap.

Table1: Justifications for Selecting Game Learning

S/No	Studies	Justifications
1.	Development and Evaluation of Game-Based Learning System Using the Microsoft Kinect Sensor (Tsai, Kuo, Chu, & Yen, 2015)	It clarifies the implementation of usability evaluation design for game-based learning system
2.	User Experience Design for Inexperienced Gamers: GAP – Game Approachability Principles (Desurvire & Wiberg, 2015)	It highlights the details of User Experience in aspects of flow, and as well as a narrower concept specifically for use in gaming with approachability principles
3.	Teaching clinical reasoning and decision-making skills to nursing students: Design, development, and usability evaluation of a serious game (Johnsen, *et al.,* 2016).	It stresses on the learning activities for decision making skills and the details the design, development, and instructional design of a Serious Game.
4.	Usability Evaluation Methods for Gesture-Based Games: A Systematic Review (Simor, *et al.,* 2016).	It described the usability methods for common interface issues, and the strategies adopted to build good gesture-based games.
5.	Guidelines of brain-based learning through serious game for slow students. (Abidin, Noor, & Ashaari, 2017).	It recommends specific guidelines to be considered in designing game-based learning interface, which is good for this study.

Table 1: Unique reasons why all selected studies are significant

S/No	Studies	Justifications
6.	The Effects of Game Design Experience on Teachers' Attitudes and Perception regarding the Use of Digital Games in the Classroom (An & Cao, 2017).	It describes the design approaches in terms of content arrangement (layout design) and it considers teachers' attitudes and perception that are useful for this study.
7.	Playing Well with Others: Applying Board Game Design to Tabletop Display Interfaces (Whalen, 2003)	This study provides some design elements in the interface design which is appropriate to adopt in this study.
8.	Gamification: a methodology to motivate engagement and participation in a higher education environment (Ribeiro,. da Silva & Mussi, 2018)	It focuses on accessibility of the learning materials. The design factors that were considered pedagogical issue, information architecture, and delivery issues.
9.	Unpacking effective learning through game analytics (Habgood, 2018)	It describes the learner model in terms of content layout and it considers knowledge acquisition by children that are useful for this study.
10.	ChillFish: a Respiration Game for Children with ADHD (Sonne, & Jensen, 2016)	It comprises of multimedia digital content strategies to improve the retention of learning. The concept of chillfish was combined to deliver learning contents. Also, Multiple Intelligence is mapped into the development of learning material and the multimedia elements combine animation, imagery, text, and voiceover that enable the students to stimulate for reading activity.

Table 1 listed a number of unique reasons why all selected studies are significant to be considered in this study. Some of the studies are considered based on their learning approaches, design guidelines, game content basis, some with theories and some with game components. It is emphasized again that this comparative analysis was done in order to discover generic elements for instructional as part of game-based learning design guideline. This shows that the suggestion of learning instructional element is to improve the interface of the existing game-based system and also consider the suggestions from experts and actual users. For such purpose, the element of instructional for game-based learning design has been gathered through user center design approach. Consequently, the identified elements of instructional design are described separately in terms of used elements of game-based interface design and the process in the integration of the identified instructional design elements for determining learning retention strategies.

2.2 Identify Instructional Elements

The Game-Based Learning (GBL) is described as instructional strategy that is associated with applications that has defined learning outcomes. As an emergent learning process, GBL is designed to balance subject matter with game play and to help players retain and apply the subject matter to the real world (Prensky, 2001). GBL typically uses game technology, interactive interfaces, scoring strategies, flexibility courses, and real-time feedback to engage learners in learning. GBL not only makes learning meaningful, but also creates a mental model that retains what the participants have learnt (Chumbley & Griffiths, 2006).

Game-based learning instructional has been defined as organization of learning content that contains procedural information (introduction), instructional information (learning content) and part-task retention (i.e closing section) (Clark & Mayer, 2016). Maintaining multimedia features such as the use of images, video, voice, animation, learning by using interactive supports is significant in increasing the level of learning rates and found as decreasing mental cognitive load (Marcu, 2005; Moreno & Mayer, 2007; Abdulrauf, 2015). To seek for the instructional elements of game interface design, two methods were used for the study; the literature study and comparative analysis. However, this study made use of working applications for the analysis. Hence, the three sections as described as follow.

1. Procedural information: It contains information about the learning objectives in the game. It contains the following items:
   a. Title: - described the title and objective of the game.
   b. Instruction: - the guideline from the beginning to the end of the game to achieve in the learning objective such as steps description, keyboard, justification, duration and requirement.
   c. Verso: - Meta information about the game.
   d. Development team: - the list of individuals and organizations that involved in the game design and development.

2. Instructional information: It contains the general content.
   a. Learning objective: - the objective to be achieved at the end of the game learning.
   b. Learning content: - the content and the pedagogical approach in the game
   c. Learning presentation: - the learning style of the game.
   d. Learning delivery: - the actual learning to be experienced and expected in the game
   e. Learning flow style: - the various levels in the game, such as level 1, 2, 3, …, n, Beginner level, Intermediate level, and Expert or Hard level.
   f. Learning Support: - the various users support of the learning such as assistive tool, feedback, error recovery and action reversal.

3. Part-task retention: this is a sign of approaching the end of game learning.
   a. Summary: - it contains the summary of the levels or stages.
   b. Assessment: - it contains interactive assessments such as scores.
   c. Debriefing: - it shows the signal of approaching the end of the game such as time spent.
   d. Acknowledgement: - acknowledging the learning contributors whom their effort are used in the game design.

This study agrees with all these elements, and hence they are considered to be adopted in it. Furthermore, the summary elements of instructional for game-based learning design are stated in Table 2.

Table 2: Proposed Elements of Instructional for Game-Based Learning Design

Components	Elements	Proposed
Procedural information	Title	C
	Instruction	C
	Verso	C
	Development team	C
Instructional information	Learning objective	C
	Learning content	C
	Learning presentation	C
	Learning delivery	C
	Learning flow style	C
	Learning Support	C
Part-task retention	Summary	C
	Assessment	C
	Debriefing	C
	Acknowledgement	R

Legend
C: Compulsory
R: Recommended

This study describes the proposed elements in Table 2 as fitting the condition to be applied in the element of instructional for game-based learning design. Accordingly, Figure 1 illustrates the proposed framework of element of instructional for game-based learning design that adheres to multimedia interactive element.

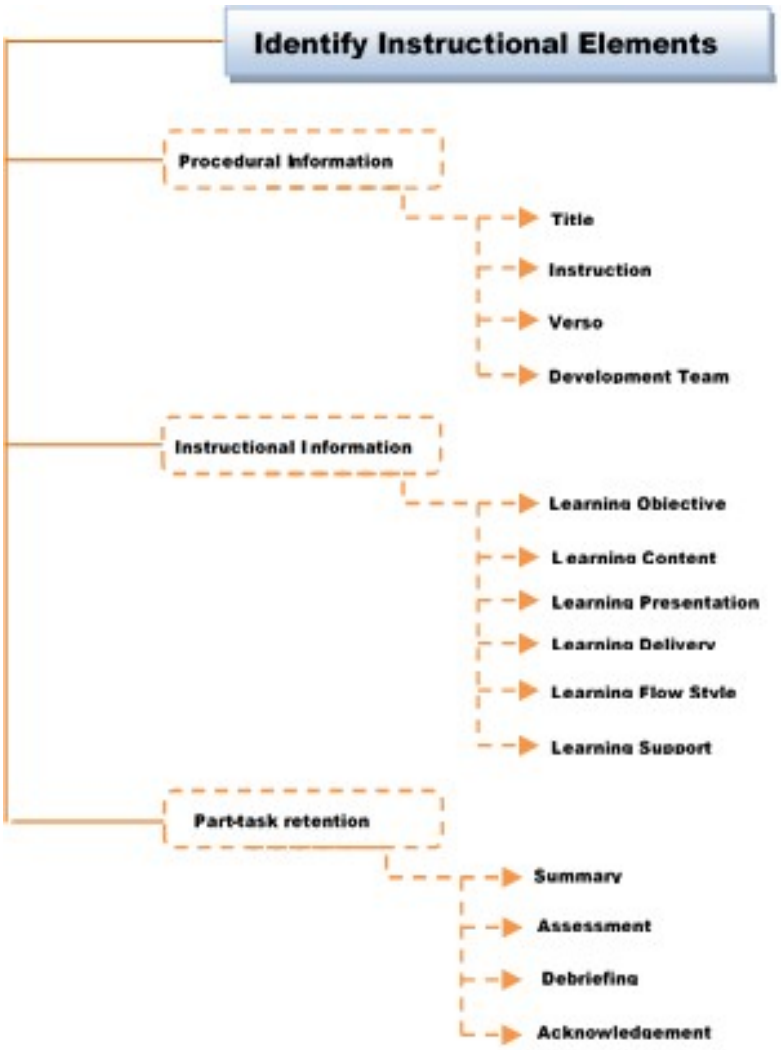

Figure1. Framework for Applying Learning Instructional in Game-Based Design

The framework for applying learning instructional in game-based design is not specifically developed for the design of multimedia environments for learning, it has important implications for the selection of a combine suitable educational concept as well as the presentation of information and arrangement of practice and feedback through this game-based. The procedural information will first present a general description of how people learn complex skills in environments that are built from the four components, how instructional control can be organized in these environments, and how different media can be used to implement each component and instructional control. Secondly, the relationship between the four components and the assumed cognitive architecture is explained. This section describes a limited working memory and a virtually unlimited long term memory as the main memory systems, schema construction and schema automation as the processes that lay the foundation for meaningful learning and monitoring.

2.2 Evaluation

Data gathered from the expert review are tabulated in Table 3. The data were documented as in frequency of responses of the expert review to the questions asked in the instrument.

Table 3: Frequency of Responses from Expert Review Focus Group

	Question	Strongly Agree	Agree	Disagree	Strongly Disagree
Q2.	I found the connections and flows of all elements are logically appropriate.	4	5	1	0
Q3.	I found that identified elements are easy to guide game-based designers.	3	7	0	0
Q4.	Generally, I found that the proposed framework will demonstrate a high usability in enhancing instructional learning system	3	6	1	0

As shown in Table 3, majority of the experts agreed that the game-based framework contains relevant elements, exhibit logical flows, usable to the development of game learning system and the elements are readable. In addition, 90% agreed that the proposed framework will demonstrate a high usability in enhancing instructional learning system. Further comments from the experts were also documented during the reviews.

Table 4: Further Comments from The Expert Reviews

Table 5 listed the comments from all of the experts. Some of the comments were rephrased in the original versions to express clearer meaning.

Q1.	The Prototype	Frequency (n=10)		
		Is easy to understand	Need some explanation	Not relevant
	a) Structural Components	10	0	0
	b) layout Components	6	1	3
	c) Structural Instructional Elements	10	0	0
	d) Layout Instructional Elements	7	3	0
	e) Procedural information	10	0	0
	f) Instructional information	10	0	0
	g) Part-task retention	10	0	0

Table 5: Comments from all of the experts.	
Experts	**Comments**
Expert 1	1. Overall, the items are easily understood but need to demonstrate with prototype.
Expert 2	1. Appropriate learning approach should be well considered as usability strategies 2. The proposed elements design should be user's friendly as much as possible 3. The e-mail and phone number of instruction in charge of the game could be included in the development team section.
Expert 3	1. The proposed items for instructional interface are essential for improving game-based design 2. The element may incorporate some features of adaptive and intelligent web-based systems to make the game-based design to be more adaptive.
Expert 4	No comment
Expert 5	No comment
Expert 6	1. The supportive guidance should cater for all strategies 2. The framework should be consistent in terms of terminologies used 3. The title of the framework should be consistent with terminology of usability strategies and instructional interface.
Expert 7	No comment
Expert 8	1. Adding semantic features to engage multiple players to enhance the degree of game-based relevance
Expert 9	1. The proposed item should review as strategy enhancement for game-based learning system
Expert 10	No comment

In summary, improving the learning instructional in game-based interface design can influence how well learners are retaining learning content. In essence, it can motivate their willingness to involve in learning activities that produce strong learning goals. The idea of this study is to determine the common design issues, and the elements adopted to propose a good game-based learning instructional framework.

3. CONCLUSION AND FUTURE WORKS

Overall, this study reports a research regarding the development of Framework for Applying Learning Instructional in Game-Based Design. UCD approach and comparative analysis have been carried out in identifying the appropriate elements, content composition and design process of the proposed framework. The determined instructional elements in this study addressed the needs of learners by enhancing the content acquisition through the game-based system, and designed towards learning instructional. Learning Instructional in Game-Based incorporates strategies by considering both practice and feedback as part of retention strategies in Learning. The game interface supports users, while the supportive learning instructional enhances the accessibility of learning contents. This is inline with the study of Norman (2004) and Abdulrauf, Ariffin and Sobihantun (2016) that suggests common idea of strategies and principles which are properly designed that can generate emotional situation for the interface and frequently affect the influence cognitive. Future works of this study is to empirically validate the proposed framework through experimental approach with prototyping.

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