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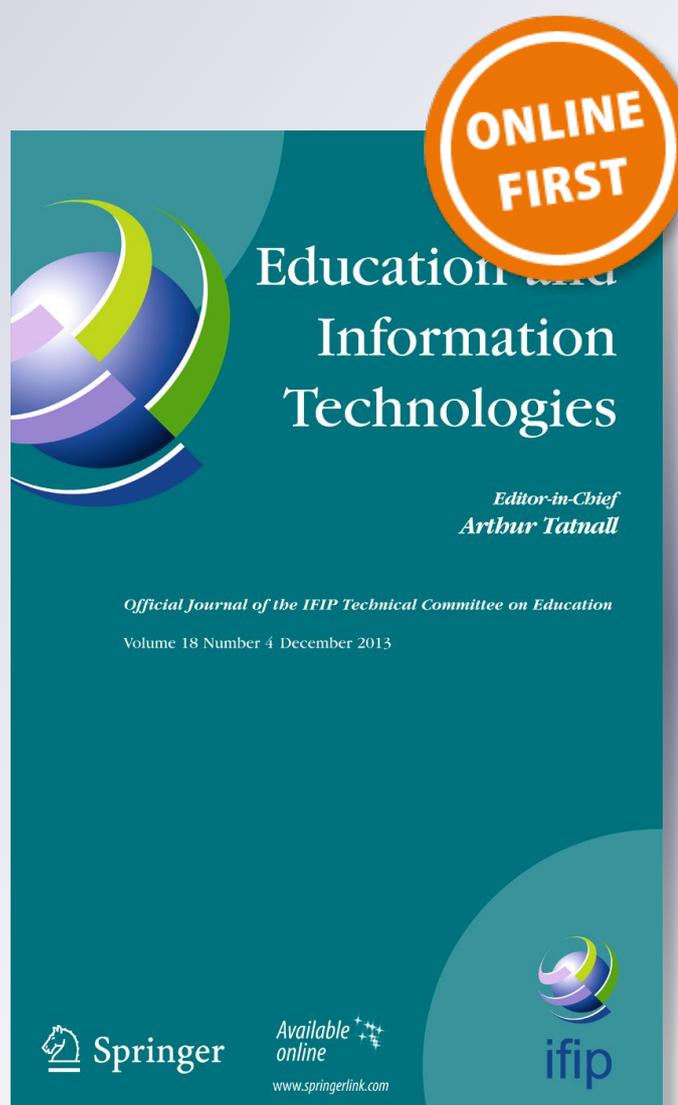
## **Education and Information Technologies**

The Official Journal of the IFIP Technical Committee on Education

ISSN 1360-2357

Educ Inf Technol

DOI 10.1007/s10639-017-9610-5



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# A survey of educational games as interaction design tools for affective learning: Thematic analysis taxonomy

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Received: 19 January 2017 / Accepted: 24 April 2017  
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**Abstract** A Computer game is the new platform in generating learning experiences for educational purposes. There are many educational games that have been used as an interaction design tool in a learning environment to enhance students learning outcomes. However, research also claims that playing video games can have a negative impact on student behavior, cognition and emotion. The aim of the study is to review the related articles in educational games and the function of games as interaction design tools, which affect student's cognition, emotion and social skills interaction when playing games. We use thematic analysis to classify the papers including the following: (a) data familiarization (b) initial code generation (c) review themes (d) themes search (e) Define & Name Themes. The articles were found from four databases: web of science, IEEE, ACM, and Springer. All the articles were analyzed based on three main

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research questions (1) what are the issues of survey papers in educational games? (2) What are the trends of research models in educational game? (3) What is the technology used in educational games? The results show that educational games are affective interaction design tools for learning outcomes.

**Keywords** Educational game · Taxonomy of interaction design · Affective learning · Cognitive · And behavior

## 1 Introduction

Educational Games can be an alternative approach to generate learner's understanding besides of traditional books in conveying learning objectives. The pedagogical foundations in educational games though can be effective tools for learning outcome because it can create individual motivation and satisfaction, facilitate a variety learning styles, reinforce the master skills and provide interactive platform. Kebritchi and Hirumi (2008) stated that the impacts of educational games in learning are can construct the pedagogical foundations such as learning by doing (experiential learning), discovery learning, situated learning in communities of practice (situated cognition), and it can generate declarative and procedural knowledge which stimulate learners to perform task through playing games.

The progress of technology embarked on an evolution from educational games to terms of serious games. The embedding of a serious purpose will give a strong impact to players especially on their cognition, emotion and social skills interaction.

Serious Game (SG) is an interactive media technology, which combines animation and narration to improve player performance based on a games rule system (Sorden 2005). The emergence of SG in the late of 1970s changed the traditional concepts of education. It started when persuasive technology was embedded in various computer platforms to persuade learner motivation for achieving learning outcomes when playing games (Fogg 2003). Games are used for educational context has called as educational games such as game based learning and serious game for learning.

Connolly et al. (2012) suggest that playing computer games and serious games will give a positive effect on student learning and behavioral outcomes based on fives variables in a game such as the primary purpose of game, digital or non-digital, genre of game, platform of delivery and subject discipline. Their research proves that game can increase knowledge acquisition, perceptual and cognitive skills, motor skills, behavior change, soft skills and social skills, and affective outcomes based on more than 70 articles reviewed. Nowadays, computer games have been applied in many areas such as medical, corporate training, and education. Starting from a Video Game, it was changed into Game based Learning and into serious game because of the new integration of gaming hardware and software. Current games have been integrated with technology enhancement in which a player needs to engage with full emotion, cognition and social skills interaction when playing the games.

According to Rogers, Sharp and Preece (2002), interaction design can be defined as designing interactive products to support the way people communicate and interact in their working lives. It consists of three main elements: cognition, emotion and social skill interaction to support the people interaction with artifacts. In our contexts, we define

cognition is how games can transfer the knowledge to store in learner memory. While emotion is the augmentation of learner feelings when completing the game level and social skill interaction is a behavior or learner attitude affecting by their response when playing the games.

Interaction design is an important element to support each of product features regarding user needs and requirements. (Onventions and Norman 1999) extended a cognitive aids model of artifact to include a cognitive element that was termed a cognitive artifact. Much of the research in games focused on negative impacts of playing games. It is because of the aggression in playing violent entertainment games. Regarding this issue, a Meta-analysis from (C. A. Anderson 2004) has proven that playing video games can have negative effects such as aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, low empathy and lack of pro social behavior.

### 1.1 Games as interaction tool for learning

In this paper, we consider an educational game as an artifact that solves the learning problem through the interaction design elements. As mentioned earlier, games have a potential as a component to blended learning proposed by (Clarke et al. 2012). This provides a solution in games through development of a framework which is called PR:EPARe (Positive Relationship: Eliminating Coercion and Pressure in Adolescent Relationship) based on blended learning theory. Games also have a big potential to be implemented as a formal or informal learning environment, either for individual or collaborative learning environments (De Freitas et al. 2012). (Robertson and Howells 2008) has made analysis that focuses on the development of aspects in successful learning. Robertson has highlighted two factors for successful learning such as enthusiasm and motivation by measuring high standards of achievement, with applying learning in new situations. Learning is the process whereby knowledge is created through the transformation of experience during the learning process. Serious Games (SG) is one example of the knowledge transformation, which is based on interactive learning process.

Michael (2011) defines SG as a platform that must be played with a computer in accordance with specific rules, using the entertainment elements. The research presented a concept of cognitive as mental contest in games to test players. Besides that, (Meyer and Sørensen 2009) has defined SG as a digital game and combines with entertainment through educational design and beyond entertainment. It is the first important attempt to match the design of the games and cognitive aspects. In designing games, one must engage with pedagogy in order to generate the learning experiences.

Wouters et al. (2011) proposed a successful Serious Game (SG) through a Cognitive Aspect in which one measures the knowledge acquisition and construction based on three aspects: learning, cognitive load and enjoyment factors. Two types of learning that embedded in SG design are deep learning and surface learning. The function of deep learning is to construct the aspect of mental model and to prove the structural of knowledge assessment. For surface learning, it combines the two types of knowledge: declarative and procedural knowledge in constructing the mental model attributes (Wouters et al. 2010; Wouters et al. 2011).

In this paper, we review published research articles in educational games and we propose a taxonomy of interaction design such as cognition, emotion and social interaction. Our findings show that games are effective learning tools based on interaction design concept.

This paper is divided into five main sections. Section 1 provides a brief introduction of this paper and the concept of learning and the proposed model between research issues and the interaction design element in games. Section 2 presents a methodology to conduct this review, and section 3 explains the results of this review. Section 4 discusses the findings from this review. Section 5 presents the conclusions and future direction of study.

## 2 Method

The aim of this paper is to report a review that analyzes the issues of games as a part of interaction design tools and classifies them into respective categories using thematic analysis (Braun and Clarke 2006; Tseklevs et al. 2016). The study was based on 41 articles, which met the inclusion criteria. The ways of how we conducted this study is derived from (Tseklevs et al. 2016), where we started with the research question, the literature review, and the proposed interaction design element. A thematic process has been implemented in order to define the names and themes and it is followed by recommendations guidelines as stated in Fig. 1.

Figure 1 presents the methodology employed. After researching the literature, we proposed the interaction design elements (cognition, emotion, social skills interaction) which originate from (Preece et al. 2002; Kebritchi and Hirumi 2008; Connolly et al. 2012). We derived a number of themes to categorize the 41 articles found in articles included. These themes were derived for the guidelines recommendations and proposed Taxonomy of Educational Game as Interaction Design Tools for affective learning. We also included some additional references in order to support the guidelines recommendations.

### 2.1 Research question (RQ)

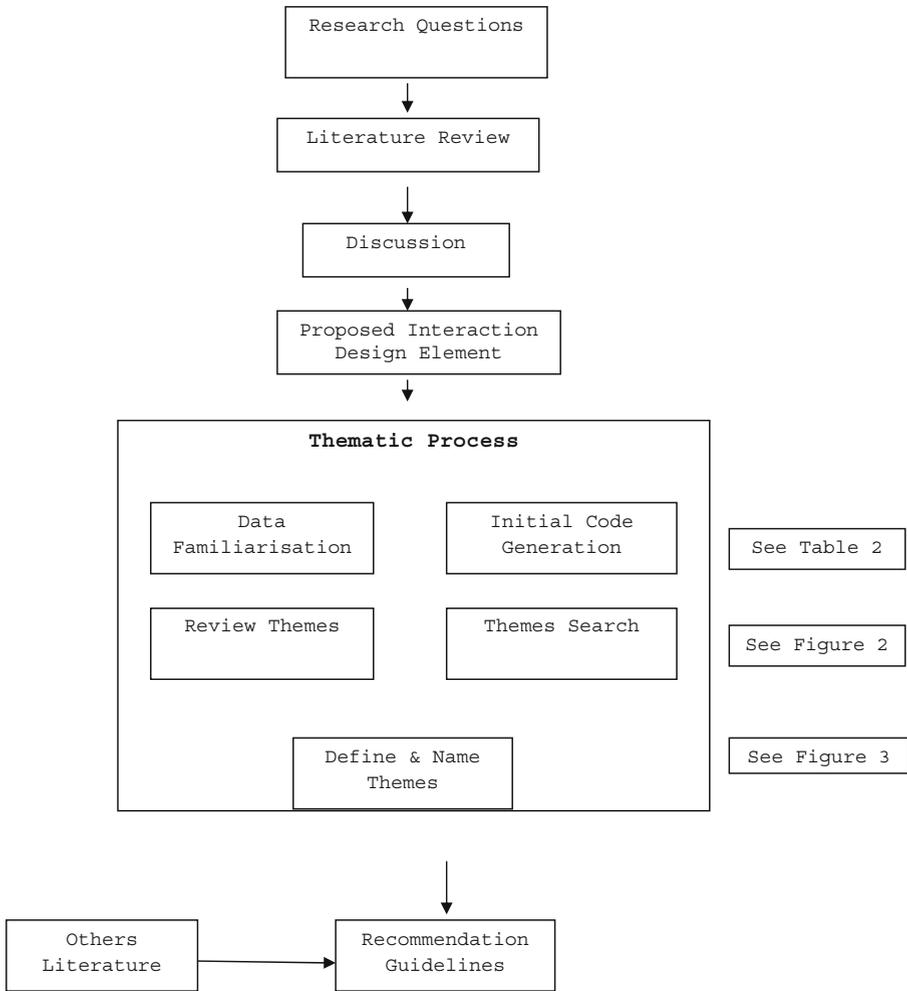
The literature review was guided by the following three research questions:

- (1) What are the issues of survey papers in educational games as interaction design tools for affective learning?
- (2) What are the trends of research model in educational games as interaction design tools for affective learning?
- (3) What are the technologies embedded in educational games as interaction design tools for affective learning?

### 2.2 Search terms

The search terms for the literature review were derived from a previous research carried out by (Connolly et al. 2012) who conducted the systematic literature review on playing computer games and serious games will affect on student learning and behavioral outcomes. While we were primarily interested in games, we used the search terms to clarify our study as follows:

- ((A Survey) OR (A Trends OR Issues)) papers in games for learning
- OR (Research Model) in games for learning OR
- (Embedding Technology) in games based learning



**Fig. 1** Literature review methodology

### 2.3 Database searched

The databases searched included those identified as relevant to computer, education & information technology.

{Web of Sciences; IEEE Explore; ACM Digital Library, Springer Link, Google Scholar}.

#### 2.3.1 Selected criteria for inclusion of papers in the current review

This study aimed to find previous research, which used computer games, or serious games as interaction design tools for affective learning outcomes. A number of additional criteria were specified to select appropriate studies to be included in the review. The papers had to:

- (a) Describe the term of “games” in the title for learning purpose
- (b) Date from 2000 to 2015
- (c) Include an abstract and keywords which contain terms such as game, or game based learning or serious game, or learning theory in games
- (d) Relate with the user cognitive, emotion and social skills interaction

### 3 Results

#### 3.1 Papers identified

Table 1 presents the number of papers, which were identified from each database along with the number of papers, which were included in the reviews.

#### 3.2 Papers excluded

The titles and abstracts of the 41 papers identified were reviewed to select papers, which were possibly relevant. Some of the papers did not meet the criteria. Papers were excluded for the following reasons:

- (a) A number of papers which reported the use of games in learning purpose, but were excluded from this review if they were not published between January 2000 until March 2015
- (b) Similarity, several papers identified by the search terms described the wide variety of educational games, but these were excluded from the review if they did not include any empirical research, which did not give effects of learning outcome based on cognition, emotion or social interactions to learners.
- (c) Not in a peer reviewed

In this study, our initial search of 4959 articles. After applying the inclusion criteria just presented, 4800 papers were excluded, leaving 159 articles for further scrutiny. Of the 159 papers fully screened, 41 addressed directly the research questions and were selected to be included in the review.

##### 3.2.1 Themes identified

Our study selected review articles produced a number of themes based on the thematic analysis as illustrated in Fig. 2. The themes were identified from the objectives study in 41 including articles, which underpinned and support the element for interaction design tools for affective learning. Starting from bottom until top, a total of 18 main individual themes have been identified. These are following:

- Experiences. These refer to how game can impress user understanding and perception and interest them in playing again.
- Effectiveness. These elements will determine the influence factors when playing educational games.

**Table 1** Number of selected articles with selected database

	Identified from database	Included in the review
Web of Science	781	<b>20</b>
- Journal of Computer & Education	✓	
- Journal of Computers in Human Behavior	✓	
- Procedia in Computer Science	✓	
- Educational Research Review	✓	
- Journal of Cultural Heritage	✓	
- Journal of Adolescence	✓	
- Review of Educational Research	✓	
- Electronic Journal of E-Learning	✓	
- Journal of Computer Assisted Learning	✓	
IEEE Explore	144	<b>1</b>
- Conference proceeding		
ACM Digital Library	3109	<b>6</b>
- ACM Journal of Computing & Cultural Heritage	✓	
- Conference proceeding	✓	
Springer Link	233	<b>5</b>
- Serious Game in Edutainment Application	✓	
- Lectures Note in Computer Science	✓	
- International Series on Intelligent, Control, and Automation: Science & Engineering	✓	
- Educational Technology Research	✓	
- Journal of Virtual Reality	✓	
Others journals		<b>9</b>
- International Journal of Computer Games & Technology	✓	
- International Journal of Serious Game	✓	
- Journal of Applied Educational Technology	✓	
- Information Journal of Information and Education Technology	✓	
- Journal of Advanced Distributed Learning Technology	✓	
<b>TOTAL</b>		<b>41</b>

- **Motivation.** This refers to intrinsic and extrinsic factors from users themselves in playing educational games.
- **Attention.** This refers to what a learner focuses on when playing a game until moving to the next level in games.
- **Memory.** This refers to how information is encoded, stored and retrieved individually.
- **Learning.** This refers to how knowledge can be transferred from playing games to players after completing the games.
- **Problem Solving.** This refers to how players using games solve their problem in order to complete the entire game task.
- **Reasoning.** This refers to how educational games can enhance player-thinking level to complete the task.

- Happy. This indicates that games can interpret user emotion through the content.
- Engagement. This indicates the retention and involvement of a user as a player and a learner in the games activities.
- Fun. This refers to the amusing of game elements in attracting user attention.
- Satisfaction. This refers to how a user can interact with games and feel wanting to play again.
- Enjoyment. This refers to how the learner as a player can feel ownership and authenticity through the concept of game mechanics and aesthetics.
- Immersion. This indicates how powerful are the graphics, narration and content of games in attracting learner attention.
- Interaction. This refers to the issues of how a user can interact with games, such as gesture, body movement or using any new software and hardware.
- Communication. This refers to how games can improve player communication based on a multimodal approach.
- Behavior. This relates to issues of how a game can change player habitual actions, and bring about good behavior and have positive impacts.
- Attitudes. This refers to how playing games can bring new values and ideas for each player and affect their attitudes.

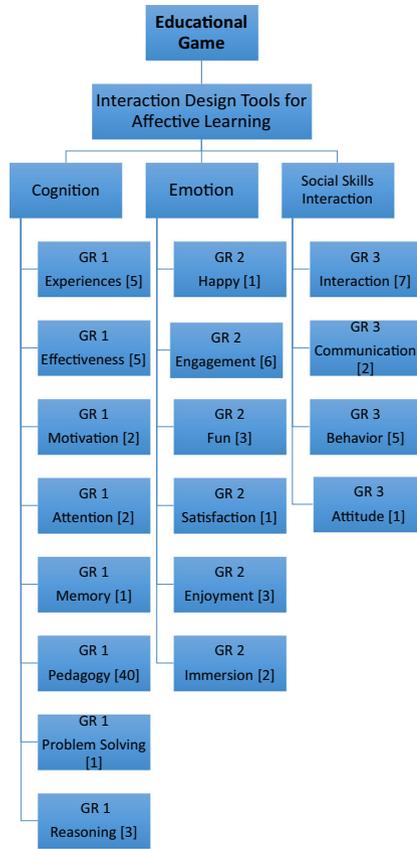
We have classified the themes into three main categories, cognition, emotion and social skills interactions to produce more individual themes among selected papers. After that, we classified the guideline recommendations (GR) for designing educational games for primary schools students into three groups (GR1→GR3) as follows in Fig. 2.

Figure 3 indicates the defined names and themes of individual themes in (Table 2) by visualizing the different size of word. The word size represents how frequently the themes were found in the articles. We choose at least one theme that has been used in the articles to define it.

Table 2 lists all themes and indicates in which article they had been discussed by the literature and hence were seen as more critical. For instance, it indicates that pedagogy as a main element in educational game as an interaction design tools for support affective learning with frequency 40 (Table 3), is followed by engagement, fun and effectiveness elements which should be emphasized in designing educational game. Besides that, the elements of enjoyment, behavior, interaction, reasoning, experience and communication as an others factors to support the interaction design aspects.

More precisely, Fig. 2 depicts how we extract the themes from the literature review led to formulation of each of the proposed recommendation guidelines. As it can be seen in Fig. 2, the elements of experiences, effectiveness, motivation and attention grouped under guideline recommendation 1 (GR1) because all of the elements are the same criteria of positive learning outcome including memory, pedagogy, problem solving and reasoning are in the same group because this entire element is a criteria of pedagogical approach in learning environment.

We grouped the entire element (happy, engagement, fun, satisfaction, enjoyment and immersion) under emotion sub themes as GR2 because it is the same criterion regarding learner or user feeling when interacting and playing with the games. For guideline recommendation 3 (GR3), interaction, communication and behavior are in the same group under social skills interaction. Mostly, pedagogy has a highest frequency,



**GR: Guideline Recommendations**

**Fig. 2** Literature Review theme classification and link into guideline recommendations (GR) for game as affective learning tools

whereas 40 from 41 articles reviewed mostly discussed learning embedded with pedagogical issues and learning theory. These reflect the purpose of educational games, which represents the affective learning concepts. In the emotion sub theme, engagement is a highest frequency (6) because of how long user or player keep playing with the game. Interaction and behavior have the same frequency (under the sub theme social skills) because of the relationship among player interaction will affect their own behavior.

### 3.3 Papers selected

Based on the inclusion criteria described in 2.4, 41 papers met the inclusion criteria and were identified as relevant to the current review. The papers describe the uses of computer games for educational purposes.



**Fig. 3** Word cloud

### **3.4 Categorization of articles**

Based on our review, we have classified the papers into three categories as follows:

## **4 Discussion on research questions:**

### **4.1 Papers on issues of survey papers in educational games**

In this section, we discuss the answer to each research question, which are listed in section 2.1.

We identified 16 articles that reported on surveys or reviews on games for educational purposes.

Search terms in the current review for survey or issues in games for learning purposes are mostly related to the cognition aspect. We identified 16 articles that can be classified under surveys or issues in games. (Vargas et al. 2014) found 1236 related articles in his survey and 112 (of them) from that article meet the quality characteristics of serious games. Their findings discovered some issues on quality initiatives, identifying gaps that merit future investigation based on a time-period of 10 years up to April 2013. Based on the results, quality characteristics of serious games can be divided into two categories: quality in use and product quality. Effectiveness, efficiency, satisfaction, usefulness and pleasure are the elements that were found for quality in use, while the product quality, eight elements should be considered in measuring your game functionality. The eight elements are functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability should be embedded inside the game to meet the quality.

**Table 2** Summary of emerging themes per author as revealed by the literature review analysis

Interaction Design		Cognitive Experience	Effectiveness	Motivation	Attention	Memory	Pedagogy	Problem Solving	Reasoning	Emotion Happy
Sub theme	Individual Themes									
Authors		√								
1.	Anderson (2004)						√		√	
2.	Dondlinger (2007)						√		√	
3.	Anderson et al. (2010)						√		√	
4.	Wei and Li (2010)			√			√			
5.	Catalano et al. (2014)		√				√			
6.	Connolly et al. (2012)						√			
7.	Vargas et al. (2014)		√				√			
8.	Wu and Wang (2012)						√			
9.	Meyer (2012)						√			
10.	Young et al. (2012)						√			
11.	Proctor and Marks (2013)						√			
12.	Obikwelu et al. (2013)						√			
13.	Boyle et al. (2014)					√		√		
14.	Caroux et al. (2015)						√			
15.	Perreira et al. (2012)						√			
16.	Bahreimi et al. (2012)						√			
17.	Zain et al. (2012)						√			√
18.	Stuttle et al. (2012)						√			
19.	De Freitas et al. (2012)						√			
20.	Amory (2007)						√			
21.	Kiili et al. (2014)						√			
22.	Obikwelu and Read (2012)						√			
23.	Westera et al. (2008)		√				√			
24.	Barbosa et al. (2014)						√			



**Table 2** (continued)

Interaction Design	
4. Wei and Li (2010)	
5. Catalano et al. (2014)	
6. Connolly et al. (2012)	√
7. Vargas et al. (2014)	
8. Wu and Wang (2012)	
9. Meyer (2012)	
10. Young et al. (2012)	
11. Proctor and Marks (2013)	
12. Obikwelu et al. (2013)	
13. Boyle et al. (2014)	√
14. Caroux et al. (2015)	√
15. Pereira et al. (2012)	
16. Bahreini et al. (2012)	√
17. Zain et al. (2012)	√
18. Suttie et al. (2012)	
19. De Freitas et al. (2012)	
20. Amory (2007)	
21. Kiihi et al. (2014)	
22. Obikwelu and Read (2012)	
23. Westera et al. (2008)	
24. Barbosa et al. (2014)	√
25. Mäkiälä et al. (2009)	
26. Bellotti et al. (2012)	
27. Antoniou et al. (2013)	
28. Huang and Huang (2013)	√
29. Gentile et al. (2014)	
30. Karouzaki and Savidis (2012)	√

**Table 2** (continued)

	6	3	1	3	2	7	2	5	1
Interaction Design									
31. Zarzuela et al. (2013)						√			
32. Meyer and Sørensen (2009)						√			
33. Paolis et al. (2011)						√			
34. Hendrix et al. (2013)									
35. Coenen et al. (2013)	√								
36. Pereira et al. (2012)	√								
37. Marzo and Ardaiz (2012)		√							
38. George and Sema (2011)					√				
39. Mortara et al. (2014)					√				
40. Derbali and Fransson (2012)						√	√		
41. Liljedahl and Örgqvist (2010)									
Total (Individual Themes)	6	3	1	3	2	7	2	5	1
Total (Sub-themes)	15					12			

Catalano et al. (2014) identified the factors that influence the effectiveness of serious games in the learning impact and discussed the current efforts made to evaluate games. Catalano et al. (2014) identified some of pedagogical theory to be considered in game design such as; Bloom taxonomy (to establish the pedagogical interchange through four types of cognitive: factual knowledge, conceptual knowledge, procedural knowledge, metacognitive knowledge), Kirkpatrick's four level training evaluation models (evaluate the effectiveness of games through four levels: reaction of user, learning process, behavior change and results), experiential theory of learning, (process learning through experience) and SECI (socialization, externalization, combination internalization) model which is used as a knowledge creation model that provides how tacit and explicit knowledge are converted in organization. The theoretical underpinnings of game design and learning outcomes are also the strong element in video game research that support the cognition based games.

Dondlinger (2007) reviewed the literature on video games research in analyzing game design elements to produce a conducive learning environment. The research identified five effective elements in video games: edutainment vs education, motivation, narrative context, goals and rules, interactivity and multisensory cues. He also stated that three learning theories to support the learning outcome: constructivism, constructionism and situated cognition in playing games. Obikwelu et al. (2013) proposed Fine Tuning System (FTS) that incorporates the relationship between fading, games progress and gaining knowledge. He addresses the issues in the design and implementation of a FTS for Serious Games based on the fading concept to facilitate the fine-tuning of the learning stimulators to the changing needs of learners. In actualizing the fading concept, some factors to be considered in the implementation are: fading decisions, fading and learning rates, optimal scaffolding distance, and the concept collaboration learning among students and teachers. All the factors affect the learner's memory because they need to do many activities to facilitate the fine tuning of the learning simulators.

Boyle et al. (2014) showed games as an interaction medium among a player and a video game with conducted literature review and categorized the types of games into four types: entertainment games, serious games, animation or simulation, e-learning based application and games as modeling tools to teaching research methods and statistics.

Caroux et al. (2015) showed a narrative literature review to investigate the concept of game interaction between player aspects and video game aspects through five factors; engagement, enjoyment, input/output information, contents and multiplayer based interaction. Caroux et al. (2015) proposed a model of player – video game interaction that consists of two main aspects with five elements of interaction such as engagement, enjoyment, and input/output information, contents and multiplayer aspects.

Besides the cognitive issues, behavioral is the important element in capturing the affective learning outcome. Regarding the behavior of the learner, Connolly et al. (2012) examined the positive impact of a gamification approach for users' aged 14 years or above. The surveys discovered four main positive impacts in playing games based on user's perception, cognitive behavior, affective and motivational aspects which can lead to learning, skills enhancement and engagement. In contrast, Anderson (2004) reviewed issues on games based on negative impact. The findings showed that violent video games can significantly increase aggressive behavior, aggressive cognition, aggressive affect, and cardiovascular arousal and they can decrease in helping behavior.

The review also showed the impact on behavior effects on violent games. To extend his research, Anderson et al. (2010) explored the state of the art of games incorporating

**Table 3** Criteria in categorization of papers

Categorization of Papers	Criteria	Included in Review
RQ1.Papers of survey in educational game	Identified papers that analyze, and reviews any issues regarding computer games that related in learning outcome.	16
RQ2.Papers of research model in developing educational games	Identified papers that explain a model, framework or method in developing or designing games in education.	15
RQ3.Papers of current technology in developing educational games	Identified papers that proposed any new emerging technology in games including augmented reality, virtual reality, new software and hardware with games in education.	10

theories, methods, and technologies used in serious heritage games. This research was implemented to test the strength and weakness of the described research methodology through three ways: prototypes or demonstration, virtual museum and commercial historical games. This paper discovered the potential of games in history context by using or combining real time computer graphics application such as virtual reality, augmented reality and artificial intelligence techniques.

In developing games, methodology is an important factor to guide the implementation of games in learning environment in achieving their goals. Implementation can be defined as a step in conducting the research from start until end. Regarding implementation of educational games, Wu and Wang (2012) conducted a survey on issues to be considered in game based learning using game development framework. The implementation has been done through approach: pedagogical context and teaching process.

The authors also proposed the selection of Game Development frameworks and evaluation of game development based learning methods. Besides that, Proctor and Marks (2013) reported a survey on teachers' perception, use, and access of computer based games and technology for classroom instruction among 259 respondents using retrospective surveys. Games can be used to enhance the level of knowledge in a particular topic. (Meyer 2012) investigated the uses of SG on sustainable development to facilitate a knowledge understanding in issues around sustainability, opportunities and development strategies. In other similar work, Chan (2010) discussed the evolution of a game design to stimulate a learning process based on three concepts: energy conservation, deforestation and carbon footprints.

Interactive learning has applied games as a platform in new digital culture through the social based interaction. It can be done when the gamification approach was given the intention to people in gaining their knowledge and skills using games Landers et al. (2011). Wei and Li (2010) reviewed requirements for educational game design, the details of development stage including design theories, design approaches and the balance concept of integration between educational character and playfulness in educational game.

Six aspects which were discovered by Wei will generate the social skills interaction among learner's behavior such as: providing the virtual environment for learners to test their creative ideas, and forcing learner to change their behavior habits through some

setting in game. Besides that, he also suggests additional of effective interaction and communication to perform a collaboration concept, which provides a learner support and helping automatically based on a set of discussion platform to engage learners, which have different roles. Young et al. (2012) reviewed more than 300 articles in games based learning for educational purposes based on several subjects: language learning, history and physical education. The survey highlights six features of game: rule based formal system, variable and quantifiable outcome, different assigned values for different outcomes, and outcomes influenced by the players.

#### 4.2 Papers on trends of research model in educational games

The current trends of research methodologies in games are based on the framework development from the various components of previous research. We found 15 articles that explain the research models or frameworks in developing games for educational purposes.

There are many frameworks proposed by previous researchers to evaluate the effectiveness of SG in improving learning outcome. We finalized 18 related articles that met the criteria on focusing of methodology in developing in SG. Most of related articles highlight a cognition element as interaction design for learning purpose. Bahreini et al. (2012) proposed FILTWAM (Framework to Learning through webcam and microphones) to improve learning through the use of webcams and microphones. The combination of conceptual and technical concept has produced this framework to enhance the online communication skills of lifelong learners. Besides that, motor impact user (MIU) is an important factor that must be considered when playing games. Zain et al. (2012) has proposed a framework based on Game Flow model to contribute MIU experiences enjoyment when playing serious game. Regarding the concept of enjoyment, Suttie et al. (2012) discovered the relationship between games mechanics and pedagogical element for game designers in making game fun and effective. The mapping process among game mechanics and pedagogy are through five level of thinking skills: creating, evaluating, analyzing, understanding, and retention based on different element of game mechanics (game design) and learning mechanics (pedagogy).

De Freitas et al. (2012) proposed four-dimensional frameworks that combine four main elements: learner specific, pedagogy, representation and context to measure the effectiveness of game. Amory (2007) proposed a Game Object Model (GOM) Version 2 which inherited from Game Object Model Version 1. The content of the model integrated the learning element into game object element. GOM version 2 was developed to provide the mechanism for the use of computer games in classroom in addition to supporting the development of educational computer game through computer-mediated communication as a network and tools in games.

Most of the previous research methodology in games considered two elements to ensure the games as interaction design tools in affective learning. Regarding those issues, Kiili et al. (2014) extended his research by using the eye tracking method to identify the user perception when exploring the games. Eye tracking method is a useful technique in measuring player's attention while playing the game. The method is based on attentive user interface (AUIs), which uses visual attention in order to attract players. The technique will track user's physical proximity, body orientation and eye fixations, which are turned through signal processing using the hardware used. While designing the framework in games (Liljedahl and Örtqvist 2010) has underpinned the three

component: immersion, game characteristics and gameplay experience in their contingency framework to test the nature of the relationship between immersion and gameplay experience and investigated contingencies among the relationship.

The focus of most of the previous articles was in designing games which mapped with pedagogical element to produce positive learning outcome such as motivation, engagement and enjoyment (Westera et al. 2008; Obikwelu and Read 2012; Kiili et al. 2014). Mäkilä et al. (2009) has stated three different approaches in conducting a game production course. Firstly, a traditional home assignment model is used where the students take full responsibility of organizing production. Secondly, conduct the research seminars where the teachers act as direct customers for the production and lastly, intensive course is used to allow teachers in the production phase as a coach and mentors. Based on the positive learning outcomes, games are very affordable interactive media system that can be used in teaching and learning.

Previous research of methodology in games development can be divided into three categories Westera et al. (2008): conceptual, technical, and practical levels. The paper showed that in the conceptual level, the basic elements of games must be identified such as state change of the various game components in the course time. System architecture of the game is located in the technical level, which comprises various building tools. In the practical levels, learner can control the game by providing a set of design principles to reduce the complexity of the game system.

In evaluating the serious game, Wouters et al. (2011) has states four effective guidelines in measuring individual knowledge understanding including serious games, Code Red: Triage. The evaluation used Pathfinder as a structural assessment in measuring the learner knowledge organization and compared with a reference structure in knowledge elicitation, knowledge representation, and knowledge evaluation between novices and advanced learners.

As an interactive system, a model in games must have a concrete spatial organization, which is a virtual world of the game where the knowledge is distributed, and the task through the concept of metaphors and game rhetorical when exploring the games Bellotti et al. (2012). Bellotti et al. (2012) also identified the methodology in games for Cultural heritage for 3D model based on ontology which includes in three steps: the 3d model is completely geo-referenced, in each covered areas, a few point of interest (POIs) are implemented and textures for all the places are built through statistically ontology based algorithm. Besides that, Antoniou et al. (2013) initiated three parts of model to design games for cultural heritage. The descriptive model used to classify method for games of different characteristics for Cultural heritage. The model is used for the creation of different Cultural Heritage games and implementing a detail case study for developed game and user testing process. Huang and Huang (2013) developed a cultural game for Taiwan's Indigenous people. Huang et al. developed a comprehensive framework which integrates historical and cultural theories, and combines them with educational framework to produce a robust game design.

In constructing the research issues in game methodology, Gentile et al. (2014) used an agent based approach to guide the design process of serious game. This approach allows designers to bring forward the assessment of educational effectiveness in a design phase. It is to ensure that the right equilibrium between educational effectiveness and entertainment aspects. Methodology for developing game has to be aligned with the current technology requirements. Meyer and Sørensen (2009) presented a specific

approach to multiplayer mobile game, which makes interaction between players and learners. Meyer and Sørensen (2009) showed that the selected technology that is often used by mobile users, it rarely supported in mobile game. In designing game, emotion has emerged as an important factor to be considered by designer and developer. Karouzaki and Savidis (2012) have described a framework that is supported by emotional facial expressions to allow user convey their emotions to be more expressive than the current commentary system based today.

### 4.3 Papers on emerging technologies embedded in educational games

The various components of technology have been embedded in games to fulfill user requirements. The integration of software and hardware has enabled the actualization of computer games as a technology tools embarking on learning purposes. Ten previously published papers, listed below, have stated the games as a technology for interaction tools.

There is a long tradition to merge technological elements in developing games to attract learners' attention. We found 10 articles that highlight the technology as a key issue in contributing game performances. Most of the articles explained the uses of computer graphics tools to integrate the graphic software library with game environment. Zarzuela et al. (2013) used Augmented Reality (AR) games to attract children and handicapped people to gain knowledge about animals through mobile-based interaction. Three characteristics of AR are interactive in a real time, combines virtual object in real environment and registering 3D object has created an immersive environment to player while interact with the games (Yusoff et al. 2014; Yusoff et al. 2015).

Besides that, Starner (2000) proposed architecture for AR and which called WARPING (Wearable Augmented Reality for Personal, Intelligent, and Networked Gaming) and it was combines two gaming systems. The architecture has included a concept of natural user interaction to enables user interact with the mobile platform through gestures, voice, head movement, location and physical object based. It has also used computer vision techniques for user to interact with mobile and stationary platform through multimodal interactions, which include gestures, voice, head movement, location and physical objects. Paolis et al. (2011) developed a Virtual Reality games among middle Ages in reconstruction town of Otranto through peripherals and software applications through data collection. Virtual Reality (VR) has been identified as an effective way to learn students about ancient cultures through immersion and shared social spaces in virtual environment. Wiimote and Balance Board were used to increase the sense of immersion in virtual environment through interaction with Media Evo game interfaces.

TrackFX which developed by Ryokai et al. (2013) is a multi-object tracking game (MOT) for young children as 30 until 50 months which evaluated among 31 children. This game trying to contribute in the disciplines of development and cognitive psychology with a valid tool for generating knowledge regarding on the changes in object tracking performance based on age and practical. However, the results of the study shown that TrackFX is just a fun game which they wanted to catch as many ladybugs as possible and was not a cognitive game which the function to assess the object tracking performances.

To support an effective learning technology, game also has been integrated with e-learning platform like Moodles to explore the standardization of integration of this two platform (Hendrix et al. 2013). Coenen et al. (2013) implemented the concept of

pervasive games by combining the virtual playing field of traditional e-games with physical and social aspects. Coenen et al. (2013) explained three elements to emphasize the concept of pervasive games in the museum: narratives (user generated narrative), social learning (Social activity and group interaction) and critical thinking through questioning. Social learning is the famous phenomena nowadays. In constructing the e-learning tools to apply in games, Pereira et al. (2012) proposed a personal and social learning (PSLE) with detailed taxonomy to be embed in game, while Marzo and Ardaiz (2012) used a social networking site to connect with his contact and fetching data about the player. He also proposed a new game mechanic which called game entity social mapping (GESM) to train, teach, or persuade user in increasing necessary to use realistic context with the game.

Game mechanic is the most important platform, which embedded in game instruction to player. George and Serna (2011) George used the mobile as a gaming platform in promoting the learning of knowledge and building skills. The potential of mobile technologies are to favor situated learning and to promote interaction and collaboration between learners in a classroom. The term of collaboration requires a technological element to support the interaction process between devices or people. Mortara et al. (2014) gave player experiences with engagement concept in game for cultural sector, through storyboard, graphics, usability, collaboration, competition mechanism and interaction devices. To ascertain the experiences, a pedagogical approach has been embedded to structuring the educational content and organizing the presentation.

There has been a growing interest recently to use electroencephalogram (EEG) as devices in controlling game. (Derbali and Frasson 2012) contributed theoretical model of motivation to evaluate 6 motivational strategies selected from a game called Food-Force. 33 participants took part in the testing phase. The study was measured based on Instructional Material Motivational Surveys (IMM) where it derives from Keller ARCS Model which involving the elements of attention, relevance, confident and satisfaction. They conducted the experiment through three sensors; EEG, galvanic skin resistance, and blood volume pulse. Results indicated that attention and confidence deserve a relevant result through EEG as devices in measuring the motivational element using Keller ARCS Motivation Model.

## 5 Findings and proposed game design goals

This study was conducted to review the trends and issues of educational games in learning environment, which underpinned by three research questions. The results allows us to propose some goals for designing educational games with affective learning. Based on the findings, the interaction design elements, which are represented by cognition, emotion and social interactions (sub-themes), were identified as important elements to achieve an affective learning outcome.

**Proposed game design goal 1** A common point of game design could be established for adoption of some of cognitive criteria embedded with a pedagogical approach in order to transfer the knowledge from interactive system to user and enable students to understand and build their interest to play the games.

Interaction with technology needs a cognitive process, which consists of combination theories, modeling tools, guidance and methods to answer the question how and

why people interact with the games. Based on the findings, cognition has a strong relationship with mental models in which it develops understanding of a system through learning process. We identified some of learning theories, which can support the cognitive, emotion and social skills interaction process.

There have been a few steps of cognition process, which include human attention, perception, memory, learning, the combination of reading, speaking and listening and the problem solving. The elements were constructed based on the two definitions of cognition by Onventions and Norman (1999) Norman, highlighting that cognition consists of experiential and reflective cognition. Playing a game is the example of experiential which involves the level of expertise and engagement. The examples activities of reflective cognition are thinking, comparing and make a decision-making.

Based on the proposed taxonomy, we can summarize that cognition is the main factor in designing computer games to initiate learner experience, effectiveness, motivation, attention, memory, learning, problem solving and reasoning. Findings show that pedagogy and learning theories are two factors used in constructing the cognition element for creating the interaction (Dondlinger 2007; E. F. Anderson et al. 2010; Connolly et al. 2012; T. Meyer 2012; Obikwelu and Read 2012; Vargas et al. 2014; Wu and Wang 2012; Young et al. 2012; Catalano et al. 2014).

**Proposed game design goal 2** In order to generate student pedagogy, we need to engage their emotion naturally besides the game mechanics and aesthetics.

Emotion is the second factor that supports affective learning outcomes in educational games. Player's emotion can be detected through their facial expression when playing the games. It is because, playing educational games can stimulate learner emotion such as happy, engage, fun, satisfaction, enjoyment and immersion. Findings from the review show that researchers have to know the gamers characteristics first before designing and developing educational games to map with their emotions (Bahreini et al. 2012). Besides that, technology also is a great challenge in generating learner emotion (Mortara et al. 2014). However, the keys of affective learning through emotion are experiences which can generate learners happy, engagement (Bahreini et al. 2012; Boyle et al. 2014; Barbosa et al. 2014; Caroux et al. 2015), fun (Bahreini et al. 2012; Marzo and Ardaiz 2012; Barbosa et al. 2014), satisfaction (Lanyi et al. 2012), enjoyment (Bahreini et al. 2012; Pereira et al. 2012; Caroux et al. 2015) and immersion (Liljedahl and Örtqvist 2010; Derbali and Frasson 2012; Mortara et al. 2014).

**Proposed game design goal 3** Encouragement from what student feels can affect their action.

A good social skill interaction is the action that is represented by learners when they have an effective learning when playing game. In this article, we categorized the social skills into four categories, interaction (Karouzaki and Savidis 2012; Zarzuela et al. 2013; Paolis et al. 2011; Meyer and Sørensen 2009) communication, behavior (C. A. Anderson 2004; Wei and Li 2010) and attitudes (Huang and Huang 2013). Findings from our review also show that it is a challenge in determining the good social behavior such as gender differences. We found and identified the game characteristics that are embedded into learning theory and each of phase of game development are the most important success factors to stimulate effective learning outcome.

## 5.1 Proposed taxonomy

Figure 4 shows the support elements of interaction design for generating affective learning outcome in educational game context.

Based on the findings, this research categorized all the related articles in the three-research questions into the elements in interaction design using thematic analysis. We extend the elements of interaction design in educational game context in Fig. 2. This figure demonstrates the taxonomy of the study, which was classified into three main elements of interaction design. There are three main conditions to engage students in games: through cognition, emotion and social skills interaction.

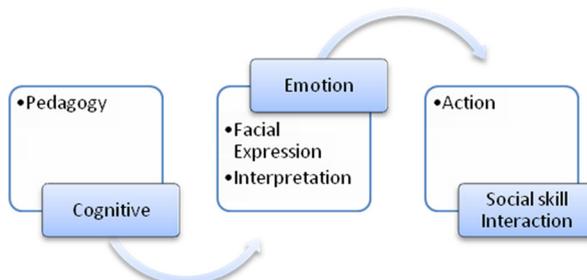
Interaction design in educational games context needs the aspect of gamification. Gamification can be defined as the uses of games in non-gaming contexts, which can consist of any user who is not expert in games, trying to use games to enhance their life.

Cognition and emotion are the important elements used in games. It is because cognition needs some processes to produce the affective learning outcomes. Dormann and Biddle (2008) stated that affective responses refer to learner's feelings, motivations and self-perceptions that they represent the responses through human behavior and self-reporting. Expressing learner emotions when playing games can demonstrate a behavior change that fulfills the social skill interaction among game players. This research found that interaction, communication, behavior and attitudes are elements that construct the social concept in games as interaction design tools.

As a part of contributing on the knowledge, educational games facilitate in producing two types of knowledge, which are declarative and procedural knowledge. Declarative knowledge can be derived from providing games with a components matching or answering question based primarily on learning facts. Besides that, declarative knowledge is derived when game requires learners to understand concepts and apply those strategies and concept in limited situations. It also generates declarative knowledge if the learner need to move a piece around a board or to answer questions when provided some type of stimulus. These types of knowledge acquire a cognition and emotion as an interaction design tools to do something as a part in supporting the social skill interaction.

## 6 Conclusion and future directions

The current review revealed that there are many benefits of games in helping users to solve their learning problem and decrease their negative perception regarding impacts of



**Fig. 4** Taxonomy of Educational Game as Interaction Design Tools for affective learning

research in games. The high number of studies published in the field of educational games is extra evidence that it is becoming an increasingly important research of games for educational purposes. The proposed taxonomy of interaction design such as cognition, emotion and social interaction skill shows that games have a big potential as tools to educate people in learning environment based on concept interaction design. Findings show that games are effective learning tools based on interaction design concept.

The limitation of surveyed articles is that it focused on the function of educational games based on three main categories of cognitive, behavior and implementation issues. For cognitive, game as one medium to transfer knowledge through the cognitive process and this paper revealed that majority research papers found that playing games give positive impact in term of player behavior, emotion and cognitive activity. This paper does not emphasize the negative impact of playing games among learners. Instead, this review shows that game is new media that can increase learner cognition, emotion and social skill in generating positive learning outcomes. Besides that, the papers on research framework articles consider general issues in the game development purposes. The technical game development phase was excluded because of the scope of research objectives in this article just to reveal on how games design is based on the learning and pedagogical conceptual research.

Regarding the evaluation issues, this paper focused on traditional methods such as qualitative and quantitative research methodology to evaluate the usability of games in educational context. A lot of learning theories and research variables were undertaken but there still has the limitation. This paper does not study artificial intelligence or computational methods in games. A limited impact of technology in games can occur when damage in their core component occurs. Core components are considered to be software and hardware requirements, which can cause game, malfunction properly. This can have a negative impact on learning outcomes. Besides that, it is difficult to map the learning theories into game design because of lack of support technology and lack of people skills. Both of these issues need a further study to enhance the current limitations.

**Acknowledgements** We would like to thank University of Malaya Research Grant (UMRG) for sponsoring this project under (RP006A-14HNE), Usability of Serious Game Application for History Education.

**Compliance with ethical standards** The authors declare that there is no conflict of interest and there are no other ethical standards that are involved in the manuscript.

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