**Bulletin of Electrical Engineering and Informatics**
Vol. 8, No. 4, December 2019, pp. 1411~1417
ISSN: 2302-9285, DOI: 10.11591/eei.v8i4.1622 

# Review on gamification in children computer interaction (CCI) for persona modelling

**Nor Haniza binti Mohd Khir, Marina Ismail**
Department of Computer and Mathematical Sciences, Universiti Teknologi Mara (UiTM),
Shah Alam, Selangor, Malaysia

**Article Info**

***Article history:***

Received Apr 30, 2019
Revised Jun 24, 2019
Accepted Jul 6, 2019

***Keywords:***

Children computer interaction
Game elements
Gamification
Human computer interaction
Persona

**ABSTRACT**

Human Computer Interaction (HCI) plays an important role in connecting humans and computers. Many studies conducted to find better alternatives to improve communication between humans and computers. Various frameworks, catalogue and models revised to complement the lack of existing ideas. The growing technology is increasingly being used by not only adults but also children. However, many applications developed do not fully emphasize the use of HCI suitable for children. Thus, Children Computer Interaction (CCI) created to meet the specific needs of children. Yet, there are still many CCI weaknesses being improved to overcome various problems from time to time. One of the ideas presented is through gamification, which is fun and enjoyable in accordance with the nature of the children. Still, the use of gamification is not as simple as adding some game elements into children's apps, but wider to ensure success in achieving the objectives of the developed application. One way that matter is through the use of user-centered design-persona model. So, this paper reviewed the use of current HCI/CCI, gamification and modified the previously proposed design principles in HCI for children into interview questions for data collection which will be analyzed later to create persona model for future work.



***Corresponding Author:***

Marina Ismail,
Department of Computer and Mathematical Sciences,
Universiti Teknologi Mara (UiTM),
Shah Alam, Selangor, Malaysia.
Email: marina@tmsk.uitm.edu.my

## 1. INTRODUCTION

Technology is growing day by day. Not only adults but children also show interest in technology in everyday life. But the difference is adults use technology more to productivity while children focus on entertainment and education [1] based on their interests and desires. Therefore, it is imperative that children and adult technologies are created with their own needs in order to achieve the proper objectives. Researchers faced many difficulties in understanding the needs of children in producing good communication between them and the computer. Skills and development of children cannot be diminished by the scope of their needs based on an adult's original scope [1]. They are different, their thoughts, interests, development and abilities are different from adults. So many design principles in adult interfaces cannot be used for children. For example, researchers have previously thought improving the existing adult interface with some interesting animations and colors is enough to give children the satisfaction of using technology [1]. This method is not appropriate to motivate children to use technology positively.

Once CCI is introduced, many researchers are working to create a variety of interactive products and applications [2] that are appropriate to the age limit of the child. Various alternatives are introduced and computer game elements are added to stimulate the development of thinking skills and the ability to use

technology practically known as gamification. However, according to [3] gamification will fail to be developed if the way to design the gamification fails to be understood since it is difficult to design. This is because as mention in [3] games are complex and multifaceted source of innovation thus difficult to transfer to other environments, gamification require understanding a host of (motivational) psychology which involve information system design and since gamification affect behavior it will add another layer into the designing scope.

This paper present the review of gamification in children computer interaction for creating persona modelling. User centered design, persona technique being analyzed for future used. Based on gathered information, interview session already started using questions modified from previous available design principle for children's technology. The collected literature shows that persona modelling is a promising technique to enhance the gamification in CCI.

## 2. HCI vs CCI IN CHILDREN TECHNOLOGY

HCI plays an important aspect of life since many daily activities involve the use of computers. Apart from working only to facilitate access to certain tasks, HCI plays a crucial role in shaping high usability interfaces to ensure that the interface is simple, secure and effective for job to be implemented to produce optimum results [4]. HCI concern with the design, construction, study and implementation of human-centric interactive computer systems. According to [5] the important aspect in HCI are functionality and usability. Functionality means that a set of actions or services that are provided to the users and would be important when it can be use efficiently. While for the usability, the objectives are utility, efficiency, learn ability, attitude, robustness, predictability, synthesizability and generalizability. Besides that, there are several principles that can be used for designing good HCI which are knowing the user, understanding the task, reducing memory load, striving for consistency, reminding the uses refresh their memory, preventing errors or reversal of action and naturalness.

From the information that has been collected, some disadvantages for poor interface design in [5] for children listed as lack of HCI based training of people developing interfaces ,a range of knowledge is required to design good interfaces, rapid technological advances is required to design, companies reluctant to commit resources, poor management-where programmers are not thinking and designing as users, lack of interaction and involvement of users. According to [1], there are several design principles can be selected to meet the children's needs. The design principles are suggested for HCI, education and psychology where it been catalogued based on children's development categorized into three section which are cognitive, physical and social/emotional.

CCI is part of HCI component where the word human can be replaced by word children which the important idea of designing and implementation of the interaction focus on the children instead of adult. In previous journal of [2] the term of CCI interpreted as a discipline concerned with the design, evaluation and implementation of interactive computing systems for children's use and with the study of major phenomena surrounding them. This term illustrated based on the statement of HCI from The Association of Computing Machinery since most research on human and CCI is about the design, then evaluation, and next implementation. Here are the ten pillars of child-computer interaction as mention by [6]; work in interdisciplinary teams, deeply engage with stakeholders, evaluate impact over time, design the ecology, not just the technology, make it practical for children's reality, personalize, be mindful of skill hierarchies, support creativity, augment human connections, enable open-ended and physical play.

## 3. GAMIFICATION IN CCI

Gamification is defined as the use of game design elements in non-game contexts [7]. Also, gamification can be translated as the use of video game elements in non-gaming systems to improve user experience and user engagement in non-game services and application [8]. In addition, gamification involve many HCI fields like psychology, crowdsourcing, interface design, logging and tracking technologies and intelligent machine algorithms. Gamification aims at increasing users' positive motivations towards given activities or use technology to increasing the quantity and quality of the output of the given activities [3]. However, as motivation engagement and user experience have become important to public policy goals in health, education, and civic engagement, gameful experience are becoming the crucial outcomes of gamification [9].

Gamification has been used for many different purposes like fitness and context-aware applications, still lack in research with younger age groups. Rewards is one of the element in gamification. It can drive participation increase motivation while doing routine tasks. However the practice of gamification has far overtook researcher understanding of its process and methods. Besides the source of innovation; games are

complicated, multifarious thus hard to directly use in other environments. Gamification consist of motivational system design which involves understanding a host of (motivational) psychology. The goal of gamification is normally also to affect behaviour which adds yet another layer into the scope of gamification design [3]. Gamification primarily aims at increase user's positive motivation towards given activities, or use of technology and thereby increasing the quantity and quality of the output of the given activities. Gamification promotes enjoyment [10, 11] and motivation to the target users [10].

### 3.1. Games elements

The game elements are needed in order to create the game experience environment. But not all are necessary for the game [12]. It follow the need of the design proposed. Stated in [13], based on previous researcher, Caillois defined game as an activity that must have the following characteristics:

a. Fun: the activity is chosen for its light-hearted character
b. Separate: it is circumscribed in time and place
c. Uncertain: the outcome of the activity is unforeseeable
d. Non-productive: participation does not accomplish anything useful
e. Governed by rules: the activity has rules that are different from everyday life
f. Fictitious: it is accompanied by the awareness of different reality

Besides that, according to [11] there are six elements from non-reward-based game design that can be explored more for gamification purposes. They are known as RECIPE which are

a. Play- the ability to have freedom to explore and fail
b. Exposition- creating stories for participants and allowing them to have their own
c. Choice- put the power in the hands of the user
d. Information- using game design and game display concepts to allow user to learn more about real-world context
e. Engagement- encouraging user to learn others in the real-world setting
f. Reflection-assisting user to find other interests and past experience that can strengthen engagement and learning

While, in [14] based on the concept that theory is the key idea to explain the user experience towards playing computer game, they list out the principle elements that can deeply investigate. They are concentration, challenge, skills, control, feedback, immersion, and social engagement. According to [1], there are three disciplines for designing for children which are HCI, education and psychology. In this paper, we are going to design the appropriate gamification interview questions so that it can be analyzed to create the persona model. Many available research used gamification for education/learning application. Thus, with the limited sources and some available paper reviewed, based on suitable game elements mentioned, we found that the catalogue created by [1] is suitable as the guideline for the interviewed question. The catalogue will be modified for this project. It illustrates the principle descriptions used in the interview question during the data collection phase. The question is in the form of proposition statements. It is divided into three categories. First, cognitive development that examines the development of the mind and intelligence of children. In this category there are four sub section namely literacy is to study the content of interfaces whether appropriate to the ability of children or not. Next, feedback and guidance where it is concern on whether there is any appropriate help for children in every phase of technology use or not. Furthermore, mental development which examines the understanding of children in understanding, recognizing, using every element of the designed interface. While, in imagination part, children are observing by their ability to understand the interface they are using. In the second category, physical development, motor skills are studied. Where this study was conducted to understand the ability of children to use various hardware and designated elements such as mouse and buttons. Also, tangibility assesses the satisfaction of children when it can manipulate the situation. Whereas in the third category, research is conducted to identify social/emotional development of the children. This is to identify the user experiences they have been positive and to stimulate mental development in using technology. While social interaction was studied to determine the effectiveness of interactions between children and computers. Besides that, [15] use three different components to measure the selected game in their project which are effectiveness, efficiency and satisfaction. This tally to the ISO 9241-11 usability definition; "the product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in specified context of use"

## 4. USER-CENTERED DESIGN (UCD)

Various techniques or methods are used for designing children technology in CCI. Some involve children and some do not involve them. From time to time many researchers believe that the involvement of children in developing their technology is very helpful [16] in producing products that suit their needs [5].

This is called user-centered design. This UCD aims to produce user-friendly products instead of users adapting to the product [17, 18]. It is the technique that describe the design process for and involve the target users [19] Other than that, participatory design and experience design involve target users as partners in the designing phase. With this child can act as informants and co-designers through the feedback given to the product prototype [20]. This suggests that researchers agree that in producing effective child technology, their involvement is directly or indirectly helpful. The designing process in human HCI/CCI normally design accordingly by many previous researcher is diagrammed as below. According to [21] there are four categories of user modelling techniques that can be used which are user segments, user profile, user role, extreme characters and personas. The list is as below:

a. User role: collection of attributes that characterize certain user population and their intentional interaction
b. User segment: user relationship to the systems key needs system should meet to distinguish one another
c. User profile: understanding user individual characteristic such as experience, age, gender, skills, education, cultural level
d. Personas: based on user research mapping user archetypes and represents a few important classes
e. Extreme characters: modelling of radical personalities cover all kind of users

### 4.1. Modelling technique using persona

A variety of methods have been used in CCI research such as user-centered design (UCD) methods where it involves user into the designing process. UCD aims to improve the usability of the design by making the system understand the will of the user rather than letting the user to adapt with the system requirements [13]. UCD is known as the approach that optimizes a computer systems usability by fulfill the requirements and capabilities of the users [5]. Other than that, methods such as participatory design and experience design focus on how target users can be engaged as partners in the design process because it is important for understanding interaction within the user's context. There are several idea for user modelling but there is no fundamental model that evaluate on other aspects of the user such as cognitive, motor and psychological [17]. The understanding on the significance of involving children in the process of designing their technology is growing [22].

Personas are discover to be the strongest method. It is possible to intergrate from other modelling techniques into persona even though there are many other models that can work as tools for the interaction designer like workflow models and physical models. Persona is known as the artificial character based representations of user goals, attitudes, motivations and abilities which enable designers to focus their design efforts on key targeted users [23]. There are some reason why persona is better for design.There are the logistic issues where working with actual children impossible, insufficient time, financial issues, and university/workplace regulations policy: restriction to work with children. Thus it leads to drawbacks such as lack of interaction with children, seeing children through the adult eyes [20], designers being self-referential and emotional in thinking of the child for whom they are designing. Personas can be describe as the actual explanation of user's characteristics and also what they want to attain, furthermore it must be based on sound field research in addition should or could be conferred in text and/or image. It help designers to understand, interpret, focus and analyse user's objectives and behaviour patterns.

The idea of persona is to help a designer focus on the main users his/her behaviour patterns and needs [16]. Persona must be based on real-world observation. Appropriate accuracy and skills need to be applied to the process of identifying important and meaningful patterns in user behavior to be an effective tool in order to be translated into archetypes that represent a broad cross-section of users. Methods of creating persona can be qualitative or quantitative [24, 25] or qualitative personas with quantitative validation [25]. Since there are many cases where the technology designer is not necessarily the technology user thus it is crucial to involve the user in the design process to achieve the predetermined goal [26].

## 5. METHOD AND MATERIALS

The research method used in this data collection phase is interview. Since target users for this research are in the range of 7 to 11 years, we prefer to use interviews rather than questionnaire. The interview session is divided into two sections where the first part of the questions regarding the child's personal information. Please refer to Table 1. While the second part is reserved for usability of the selected available gamification apps. Based on the previously collected literature review, to match this research requirement with game elements for gamification in CCI, the list of propositions to be used in the children's interview session for the data collection phase is as in Table 2, Table 3 and Table 4.

Table 1. Personal information

| Name (Nama): | | |
|---|---|---|
| Gender (Jantina): | | |
| Age (Umur): | | |
| Race (Bangsa): | | |
| Do you know how to use computer? (Kamu tahu menggunakan computer?) | Yes/Ya | No/Tidak |
| Do you like to play computer games? (Kamu suka bermainan permainan computer?) | Yes/Ya | No/Tidak |

Table 2. Propositions statements on literacy,feedback and guidance, mental development and imagination

| Cognitive development | | | | | |
|---|---|---|---|---|---|
| Literacy | | | Scale | | |
| There are too many words than image to read from the page. | Yes | No | 1 | 2 | 3 |
| Terdapat banyak perkataan berbanding gambar untuk dibaca di atas skrin. | Ya | Tidak | | | |
| I prefer more image than words. | Yes | No | 1 | 2 | 3 |
| Saya lebih suka banyak gambar berbanding perkataan. | Ya | Tidak | | | |
| The picture on the screen is telling me the exact story of the game. | Yes | No | 1 | 2 | 3 |
| Gambar di skrin menceritakan apa aktiviti yang dijalankan. | Ya | Tidak | | | |
| I understand what should be done by looking at the picture on the screen. | Yes | No | 1 | 2 | 3 |
| Saya paham apa yang perlu dibuat hanya dengan memandang gambar diskrin. | Ya | Tidak | | | |
| The instruction is easy to remember. I khow how to use the game. | Yes | No | 1 | 2 | 3 |
| Arahan yang diberikan mudah difahami. Saya tahu menggunakan permainan ini | Ya | Tidak | | | |
| Feedback and Guidance | | | Scale | | |
| The game is responding to me. I can understand the next step well. | Yes | No | 1 | 2 | 3 |
| Permainan ini memeberi maklumbalas kepada saya. Saya tahu menggunakannya. | Ya | Tidak | | | |
| Guidance is given. The game guide me step by step. | Yes | No | 1 | 2 | 3 |
| Bantuan diberikan. Permainan ini mengajar saya Lankan demi langkah. | Ya | Tidak | | | |
| Icon provided is interesting and easy. | Yes | No | 1 | 2 | 3 |
| Ikon yang diberikan menarik dan mudah. | Ya | Tidak | | | |
| I understand the icon when I look at them. | Yes | No | 1 | 2 | 3 |
| Saya paham maksud ikon yang dipaparkan apabila melihatnya. | Ya | Tidak | | | |
| I can track my activities. I remember what I did before. | Yes | No | 1 | 2 | 3 |
| Saya boleh menjejaki setiap aktiviti saya. Saya ingat setiap langkah sebelum in. | Ya | Tidak | | | |
| I satisfy with the hints. | Yes | No | 1 | 2 | 3 |
| Saya berpuas hati dengan petunjuk-petunjuk yang diberikan. | Ya | Tidak | | | |
| Mental development | | | Scale | | |
| The menu is easy to use. | Yes | No | 1 | 2 | 3 |
| Menu yang dipaprkan senang digunakan. | Ya | Tidak | | | |
| I can select the menu with one click. | Yes | No | 1 | 2 | 3 |
| Saya boleh memilih menu tersebut dengan sekali klik sahaja. | Ya | Tidak | | | |
| The game is easy to use. | Yes | No | 1 | 2 | 3 |
| Permainan ini sering digunakan, | Ya | Tidak | | | |
| When I first look at the interfaces I can understand how to use it. | Yes | No | 1 | 2 | 3 |
| Saya memahami cara menggunakan permainan ini pertama kali saya melihatnya. | Ya | Tidak | | | |
| Imagination | | | Scale | | |
| I can understand the game by looking at the picture on the screen | Yes | No | 1 | 2 | 3 |
| Saya paham permainan ini dengan melihat gambar-gambar di skrin | Ya | Tidak | | | |
| I can imagine the story behind the image on the screen. | Yes | No | 1 | 2 | 3 |
| Saya boleh bayanagkan apa cerita disebalik gambar-gambar do skrin. | Ya | Tidak | | | |
| I can imagine the next step of the game thorough images on thescreen. | Yes | No | 1 | 2 | 3 |
| Saya boleh bayangkan langkah seterusnya melalui gambar-gambar di skrin. | Ya | Tidak | | | |

Table 3. Propositions statements on motor skills and tangibility

| Physical Development | | | | | |
|---|---|---|---|---|---|
| Motor Skills | | | Scale | | |
| The function of the mouse is simple | Yes | No | 1 | 2 | 3 |
| Fungsi tetikus adalah mudah. | Ya | Tidak | | | |
| I know hiw to use the mouse for clicking. | Yes | No | 1 | 2 | 3 |
| Saya tahu menggunakan tetikus untuk klik. | Ya | Tidak | | | |
| If I want to select the answer I can only click the mouse once. | Yes | No | 1 | 2 | 3 |
| Jika ingin memilih jawapan saya hanya perlu tekan tetikus sekali sahaja. | Ya | Tidak | | | |
| It is enjoyable to use the mouse to select the answer. | Yes | No | 1 | 2 | 3 |
| Ianya sangat mengujakan menggunakan tetikus untuk memilih jawapan. | Ya | Tidak | | | |
| It is easy to select the available answer using the mouse. | Yes | No | 1 | 2 | 3 |
| Mudah memilih jawapan menggunakan tetikus. | Ya | Tidak | | | |
| Tangibility | | | Scale | | |
| I can navigate the game using the mouse easily. | Yes | No | 1 | 2 | 3 |
| Saya boleh menjelajah permainan ini menggunakan tetikus dengan mudah. | Ya | Tidak | | | |
| I can click the button using the mouse easily. | Yes | No | 1 | 2 | 3 |
| Saya boleh klik butang menggunakan tetikus dengan senang. | Ya | Tidak | | | |
| I can insert my name using keyboard easily. | Yes | No | 1 | 2 | 3 |
| Saya boleh memasukkan nama dengan mudah menggunakan papan kekunci. | Ya | Tidak | | | |

The children need to answer each interview question with selection yes or no then to further select the Likert scale with three choices; 1 Disagree, 2-Neutral and 3-Agree. As stated before the guidelines for this proposal are taken from [1] and modified to suit the requirements of this investigation. The usability of the game, can be evaluated while children play freely and expressed their opinion during the observation [27]. Game elements that are aligned to meet the needs of the project include such as agents, timers, rewards, hints and rankings.

Based on the gathered and selected information, interview session has been started with two primary school students. One girl and one boy. They were asked to play five different selected gamification apps and interview question is being asked while they were playing. Each game took about one to two hours. The data collection will be continued with 28 more students, all together fifteen boys and fifteen girls.

Table 4. Propositions statements on user experience and social interaction

| Social Emotional Development | | | | | |
|---|---|---|---|---|---|
| User Experience | Scale | | | | |
| The activity is fun. I love to leartn while playing. | Yes | No | 1 | 2 | 3 |
| Aktiviti yang diberi menyeronokkan. Saya suka belajar sambal bermain. | Ya | Tidak | | | |
| The game is interesting. It is enjoyable to use the game. | Yes | No | 1 | 2 | 3 |
| Permainan ini menarik. Saya suka menggunakan permainan ini. | Ya | Tidak | | | |
| I love to learn new thing. | Yes | No | 1 | 2 | 3 |
| Saya suka belajar benda baru. | Ya | Tidak | | | |
| I learn more when the game is fun to play. | Yes | No | 1 | 2 | 3 |
| Saya belajar lebih apapbila menggunakan permainan ini kerana ia menarik. | Ya | Tidak | | | |
| I love to be rewarded when given the right answer | Yes | No | 1 | 2 | 3 |
| Saya suka apabila diberi ganjaran untuk setiap jawapan yang betul. | Ya | Tidak | | | |
| The activities is interesting and challenging. I love it. | Yes | No | 1 | 2 | 3 |
| Aktiviti yang diberikan menarik. Saya menyukainya. | Ya | Tidak | | | |
| I fell sad when my reward is taken away | Yes | No | 1 | 2 | 3 |
| Saya rasa sedih apabila ganjaran saya diambil semula. | Ya | Tidak | | | |
| Social Interaction | Scale | | | | |
| I can communicate well with the game. | Yes | No | 1 | 2 | 3 |
| Saya boleh berkomunikasi secara baik dengan permainan ini. | Ya | Tidak | | | |
| The game understand what I am doing. | Yes | No | 1 | 2 | 3 |
| Permainan ini boleh memahami tindakan saya. | Ya | Tidak | | | |
| I understand what to achieve. | Yes | No | 1 | 2 | 3 |
| Saya boleh memahami apa yang perlu dilakukan. | Ya | Tidak | | | |

## 6. RESULTS AND DISCUSSION

This section discusses the result and analysis of findings from the review and data collection conducted. So far based on the comments given by the two students during data collection phase, they enjoy playing the game at first but then they feel bored. The given reason is because the game are to long to play and sometimes the requirements cannot be recognized as some elements like button, interfaces and pedagogical agent are difficult to understand.

Besides, the gathered Information showed that the idea of using gamification in children computer interaction can make a change on the usability and attract children towards using the technology more effectively. In order to understand the effectiveness of the gamification apps, the game elements should be used. The usefulness of the elements were interpreted in the interview question. Thus, in this study, the game elements that is selected to be tested its effectiveness in CCI identified such as agents, animation buttons, timers, rewards, hints and rankings. While, for the technique, user centered design, persona model is proposed to be used in the future.

## 7. CONCLUSION AND FUTURE RESEARCH

Many methods and techniques can be used and modified for different need of the children technology. Adding gamification into CCI will increase the interest and usability of the product thus create an enjoyable and fun environment for the children. There are many different game elements used in different study based on the need of the study and also the age range of the children. Many studies concern about gamification in education/learning application for children. While we focus on the use of game elements in CCI. Thus the need for game elements differ accordingly. According to the pilot study, it can be concluded that children love to deal with interface that understands them instead of which they need to adapt. They also wish to have more feedback and guidance so they are not easily bored and lost while playing. Their mind is simple and the spirit of curiosity is high so in order to successfully design their technology, it cannot be

downsize from adult technology where it is more complicated and extensive. Data collection phase will be continued for more feedback and comment. In the future, all the gathered data will be analyzed for designing the persona model for the project.

## REFERENCES


[1] S. Chiasson and C. Gutwin, "Design Principle for Children's Technology," echnical Report HCI-TR-05-02, Computer Science Department, University of Saskatchewan. 2005.

[2] J. C. Read and M. M. Bekker, "The Nature of Children Computer Interaction," *Proceeding BCS-HCI '11 Proceedings of the 25th BCS Conference on Human-Computer Interaction*. 2007. pp: Pages 163-170.

[3] B. Morschheuser, K. Werder, J. Hamari and J. Abe, "How to Gamify? A Method for Designing Gamification," in *Proceedings of the 50th Hawaii International Conference on System Science*, 2017.

[4] G. J. Kim, "Human Computer Interaction: Fundamentals and Practice", Boca Raton: CRC Press, Taylor and Francis Group, 2015.

[5] I. Begum, "HCI and Its Effective Use in Design and Development of Good User Interface," *International Journal of Research in Engineering and Technology*, vol. 03, no. Special Issue: 03, pp. 176-180, 2014.

[6] J. P. Hourcade, "Child-Computer Interaction", Self, Iowa City, Iowa. 2015.

[7] S. Deterding, D. Dixon, S. Bjork, E. Lawley and L. E. Nacke, "Designing Gamification: Creating Gameful and playful Experiences," *Conference: CHI '13 Extended Abstracts on Human Factors in Computing Systems*. 2013.

[8] R. N. Landers, K. N. Bauer, R. C. Callan and M. B. Armstrong, "Psychological Theory and Gamification of Learning," in *Gamification in Education and Business, Springer International Publishing Switzerland*, 2015, pp. 165-186.

[9] L. E. Nacke, "Games User Research and Gamification in Human Computer Interaction," Magazine XRDS: Crossroads, The ACM Magazine for Students - Incentives and Gamification vol. 24, no. 1, pp. 48-51, 2017.

[10] N. Mohamed Noor, F. H. Yusoff, M. Ismail and R. L. Lob Yussof, "Adaptation of Enjoyment in Learning through Gamification," *Advanced Science Letters.* vol. 4, pp. 400-407, 2016.

[11] S. Nicholson, "A RECIPE for meaningful Gamification," in Gamification in Education and Business, New York, Springer, 2015.

[12] M. Sillaots, "Game Elements," http://htk.tlu.ee/icampus/mod/file/download.php?file_guid=220182. 2015.

[13] K. Erenli, "The Impact of Gamification-Recommending Education Scenarios," *International Journal of Emerging Technologies in Learning (iJET*). vol. 8, no. Special Issue 1, pp. 15-21, 2013.

[14] N. H. Mat Zain, A. Jaafar and F. H. Abdul Razak, "Enjoyable Game Design: Validation of Motor-Impaired User GameFlow Model," *International Journal of Computer Theory and Engineering*, vol. 8, no. 2, pp. 116-121, 2016.

[15] M. Ismail, N. Mat Diah, S. Ahmad, N. A. Mohammad Kamal and M. K. Md Dahari, "Measuring Usability of Educational Computer Games Based on The User Success Rate," *2011 International Symposium on Humanities, Science and Engineering Research*, pp. 56-60, 2011.

[16] Y. N. Chang, Y.K. Lim and E. Stolterman, "Personas: From Theory to Practices," in *Proceedings: NordiCHI 2008*, 2008.

[17] A. Mejia, R. Juarez-Ramirez, S. Inzunza and R. Valenzuela, "Implementing Adaptive Interfaces: A User Model for the Development of Usability in Interactive Systems," in *ACM International Conference Proceeding, Maharashtra*, 2012.

[18] A. Hijalmarsson, E. Gustafsson and S. Cronholm, "Exploring the Use of Personas in User-Centered Design of Web-based e-services," in *iConference 2015 Proceedings*, 2015.

[19] J. A. Fails, M. L. Guha and A. Druin, "Methods and Techniques for Involving Children in the Design of New Technology for Children", Now Publishers. 2013.

[20] N. H. Mat Zain, A. Jaafar and F. H. Abdul Razak, "A User_Centered Design: Methodological Tools to Design and Develop Computer Games for Motor-Impaired Users," in *Proceedings of the 5th International Conference on Computing and Informatics, ICOCI 2015*, Intanbul, 2015.

[21] P. T. A. Junior and L. V. L. Filgueiras, "User Modeling with Personas," *Proceedings of the 2005 Latin American conference on Humancomputer interaction CLIHC 05*. pp. 277-282, 2005.

[22] L. Malinverni, J. M. Guiard, A. Hervas and A. Padillo, "Participatory Design Strategies to Enhance the Creative Contribution of Children with Special Needs," in *Conference: IDC'14: Proceedings of the 2014 Conference on Interaction Design and Children*, New York, 2014.

[23] C. O'Leary, F. Mtenzi and C. McAvinia, "Towards Reusable Personas for Everyday Design," Late-Breaking Work: People and Contexts, pp. 2915-2922, 2018.

[24] L. Laporte, K. Slegers and D. D. Grooff, "Using Correspondence Analysis to Monitor the Persona Segmentation Process," NordiCHI'12, pp. 265-274, 2012.

[25] S. Mulder and Z. Yaar, "Chapter 3: Approaches to Creating Personas," in The User Is Always Right: A Practical Guide to Creatingand Using Personas for the Web, United States, New Riders, Pearson Education, 2006, pp. 35-53.

[26] R. E. Ladner, "Design for User Empowerment," ACM Interactions, 2015.

[27] N. M. Diah, M. Ismail, S. Ahmad and M. K. M. Dahari, "Usability testing for educational computer game using observation method," *2010 International Conference on Information Retrieval & Knowledge Management (CAMP)*, Shah Alam, Selangor, 2010, pp. 157-161.