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HOW LIGHTING DYNAMICS CREATE SOCIAL INTERACTIVE GAME

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ABSTRACT
By entering preschool age, children's understanding of the world increase significantly and their interactive worlds extend excessively. This will impact not only their social connections but also their connections to the natural world. Preschool age is suitable for teaching concepts such as nurturing plants. By employing interactive game design, children can learn what are needed for a plant to grow properly. Pre-schoolers are attracted to gamified activities. Preschool is a proper environment to deploy interactive game design because it leads to formation of interactive relationships between children, teachers and the environment. In addition to forming social relationships, this design forms a learning environment in which knowledge exchange happens. A preschool located in Tehran city was chosen as a case study. Observation based method was used for collecting practical data in order to suggest an interactively gamified solutions and 56 students were observed in this environment. The collected data was used in designing a gamified concept. As the focus was on enhancing the learning process through the social gaming, the correlation between three theories, MDA framework, key characteristics of a learning game and social characteristics of player experience, was studied and a concept was suggested. The concept uses lighting dynamics to form a socially educational game. Lighting dynamics invite children to participate in the game. A paper prototype got tested with 39 pre-schoolers and its affordance was successful in attracting children to the learning concept.

Keywords: Gamification, social gaming, preschool children, care for plants, light dynamics, learning.

1 INTRODUCTION

In recent years, gamification [8] has been a trending topic to different media as a means of supporting user engagement and enhancing positive patterns in service use, such as increasing user's activity, social interaction, or quality and productivity [16]. Gamification has become a great tool for companies to influence their customers, like Opower, Starbucks and Nike+. The popular interest in gamification is also reflected in academic contexts [8] [27] and has applications in contexts including but not limited to: healthcare [16], sustainability [14], work [13], education [5] [9] and transportation. Gamification is most commonly implemented in education field. Studies in education contexts considered the learning outcomes of gamification as mostly positive, for example, in terms of increased motivation and engagement in the learning tasks as well as enjoyment over them [15].

2 GAMIFICATION

Gamification is defined as "the use of game design elements in non-game contexts" [7]. It is defined as a process of enhancing services with (motivational) affordances in order to invoke gameful experiences and behavioural outcomes. Gamification invokes the same psychological experiences as games do. The affordances implemented in gamification have to be the same as games [8]. Like persuasive technologies, gamification attempts to affect motivations rather than attitude and/or behaviour directly [12] [16]. A well-structured game can lead players to satisfying outcomes. Behaviours which lead to satisfying outcomes are more likely to lead to repeated or ongoing behaviour changes [28]. Habits are formed through providing cues that elicit behaviours and then rewarding the behaviour, thus forming a behavioural loop that requires less and less cognitive resources as the desired behaviour is repeatedly reinforced [10]. Gamification can produce desired behaviour change through the formation of habits by reinforcing the reward and emotional response [26].

2.1 Gamification Principles: MDA Framework

Gamification accepts MDA Framework based on game design theory [8] [9]. It consists of mechanics, dynamics and aesthetics. Mechanics are the goals, rules, setting, context and types of interactions. There are three types of mechanics: setup mechanics, rule mechanics and progression mechanics. Setup mechanics shape the environment of the experience, including the setting, objects and the objects' distribution [11], temporal dimensions, or whether it has a finite end or infinite play and whether the experience is for single or multiple players. Rule mechanics shape the goal of the experience [11]. They prescribe the actions that are permissible and also the constraints that limit those actions to create pressure [19]. Progression mechanics describe different types of instruments that designers embed to affect the game experience [11]. Dynamics are produced by how players follow the mechanics and they describe behaviours and the strategic actions and interactions [3]. Team-based structures can lead to dynamics such as cooperation. Dynamics can lead to unintended behaviours and outcomes [21]. Designers must anticipate the emerging dynamics and develop the mechanics of the experience appropriately. Aesthetics are the emotional responses (e.g., fantasy, fellowship) evoked when interacting with the game. Emotions are product of how players follow the mechanics and then generate dynamics and they should be fun and appealing in both pragmatic and emotional level [21].

3 SOCIALITY CHARACTERISTICS FOR PLAYER EXPERIENCE

Social aspects are essential to typical gamification services: people collect badges and rise in high-score lists for social reasons like receiving recognition. Digital gaming brings many opportunities for social interaction [6]. It is the social interaction that explains game enjoyment [2]. Digital game play is suffused with social motivations, interactions, and effects [6]. Most gamification services, games, social networking services and persuasive systems include affordances for both social as well as gameful interaction [16]. Children playing together have better performance than those playing alone and motivation is highest when they collaborate [17]. Playing against a co-present friend elicits higher engagement, arousal (drive) and more positive emotions than playing against a computer [25]. Self-awareness and self-evaluation increase in the presence of others [4]. People enjoy winning more in front of others and it can be attributed to human motivation for social interaction, affiliation and need to belong [25]. Processes of empathy and mimicry result in emotional contagion [24]. Enhancing emotional experiences of social games can be attributed to self-efficacy [29], identification with the game and/or other players [30], and competitiveness [20]. The presence of others is not sufficient for most social context effects [18]. In their framework, De Kort and Ijsselsteijn indicate that social context effects on game experience are largely determined by the social affordances of a situation. 'Sociality characteristics' shapes social affordances [6]. They allow for social interactions such as awareness, monitoring, mimicry reinforcement and verbal communication [23].The social affordances and characteristics of the game context define the 'sociality' of the play setting. The sociality characteristics of the setting shape the interpersonal dynamics and social mechanisms at play [6].

4 KEY CHARACTERISTICS OF A LEARNING GAME

Four elements of challenge, curiosity, fantasy and control, create a learning game. Challenge is created by having clear, fixed goals. Difficulty levels, hidden information, and randomness create challenge. Curiosity exists in two forms: sensory and cognitive curiosity. Audio and visual effects may enhance sensory curiosity. Fantasy is defined as an environment that 'evokes mental images of things not present to the senses or within the actual experience of the person involved.' It encompasses the emotions and logical thought processes of the learner. Control is the feeling of self-determination and command. Contingency, choice, and power increase the controllability of the learning game [22].

5 INCREASING KIDS' KNOWLEDGE OF PLANTS

For the purpose of research a preschool in Tehran city was chosen as a case study and a number of 56 students aged 5 to 7 were observed for six months. A wide pilot observational research was done on user group. Different school projects were proposed for students. After a visit to a greenhouse each student was given a small plant and they were asked to build a home for them and take care of them in home context. Students then were questioned about their plants' condition. Because of kids' characteristics like being playful, lack of knowledge, having fewer abilities compared to adults and fear of failure, almost all of them leaved the process of taking care of their plants. Gathered data led the researchers to come up with a persuasive design prototype which helped children take care of

plants by themselves. This made the process easier and added fun elements to the process. In the next step, a more social game was created to see whether through the game context knowledge transfer will happen or not. The prototype named My Garden is a competitive/cooperative colour-coded game board. In the process of testing, it was indicated that kid's knowledge of plants increased significantly throughout the game. It was also indicated that knowledge exchange increases in a gamified education.

Figure 1. Testing children learnability with different project and prototypes

As the design became more social and fun, children participated more frequently. These findings led the designers to gamify the learning experience and focus on increasing social interaction of kids. Choosing various object characteristics such as interaction opportunities, shape, and intended use can influence the object affordances and create a particular interaction pattern [1]. Because of the focus of study, the correlations between three theories: MDA framework, key characteristics of a learning game (KCLG) and social characteristics of player experience (SCPE), were studied in detail (Figure2).

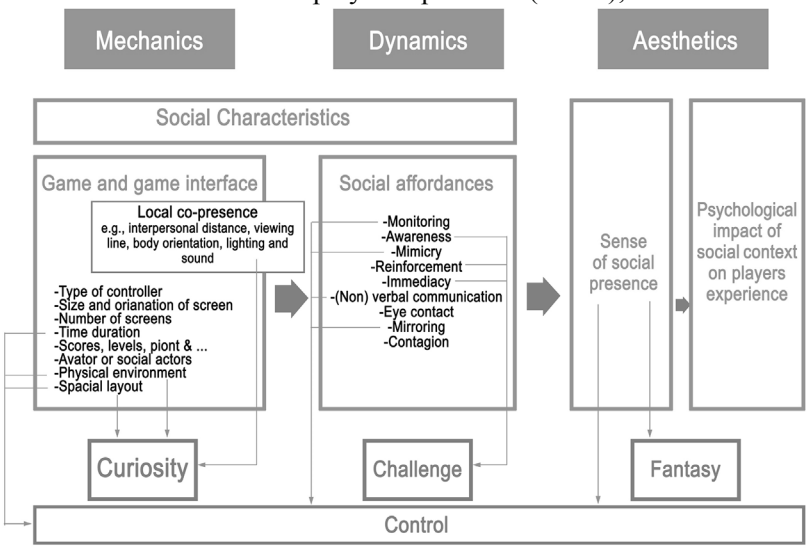

Figure 2. A framework which shows the correlation of MDA, KCLG and SCPE

When matching the features of MDA and KCLG, a link between challenge and dynamics was found. Challenge is created by things like opponent (type of interaction) and time pressure (constraints). Curiosity has a fundamental role in gamification of learning. Curiosity can be evoked by elements like context and appearance of the game which is related to the game mechanics. Audio and visual effects particularly in games enhance sensory curiosity. Fantasy is the strongest emotional factor in game aesthetics and encompasses both the emotional and logical thought process of the learner. As control means a feeling of self-determination, so it is closely related to the whole game play experience and it covers all the MDA factors. In the next step, relativeness between SCPE and MDA was studied. As SCPE model describes a type of game, different features matched MDA features closely. The model starts with game and game interface which includes elements like type of control devices, type of players' interaction, time duration and physical environment. These features describe mechanics in MDA structure. Social affordances like dynamic describe run time behaviours of the game. Precisely social affordances focus on creating social behaviours like monitoring, awareness and contagion throughout the gameplay. The outcome of social affordances brings out the sense of social presence which will have an impact on psychological social context regarding player's experience. This psychological outcome enhances the emotional responses to the game play which is related to the game aesthetics. In the same context, we tried to find relativeness between SCPE and KCLG.

Curiosity is closely related to the physical environment and special layout of the game. Sensory curiosity is enhanced in by lighting and sound level of the game. Challenge is related to the level of difficulty and it can be related to the awareness and reinforcement behaviours. Challenge is created from time pressure so it can also be related to immediacy. Fantasy gaming involves the creation of and interaction with in social realities. Thus gamer located themselves and others within two social realities: the fantasy reality of the game itself and the real world where players act towards other players and game related objects [31]. Different elements like time duration, physical environment, special layout, mimicry, monitoring, communication, mirroring and the sense of presence of others will increase the controllability of the game.

6 DESIGN SOLUTION: GLOWY GREENO

Based on the described framework, a video game concept named "Glowy Greeno" was suggested. Each player owns a Bluetooth bracelet which tracks his/her activities. The game starts with showing different plants with different needs and by touching each plant, a voice tells the fantasized story of that plant and kids also visually notice what is needed for each plant's growth. After this step, children must recall what they learnt and match plants and their vital needs. In higher levels, children also learn about the kind of soil or fertiliser a plant needs. After matching step children have to use their lighting power to scare away insects which are harmful for plants. Insects appear from different directions and children must quickly get them and scare them away by the light power. After scaring the insect a light bull appears on the screen which is related to the plant's needs and children must quickly drag them towards a plant which is in need. By lighting up the whole circle around the plants, players win. In each step players can replay the game or go to the home interface (Figure 3).

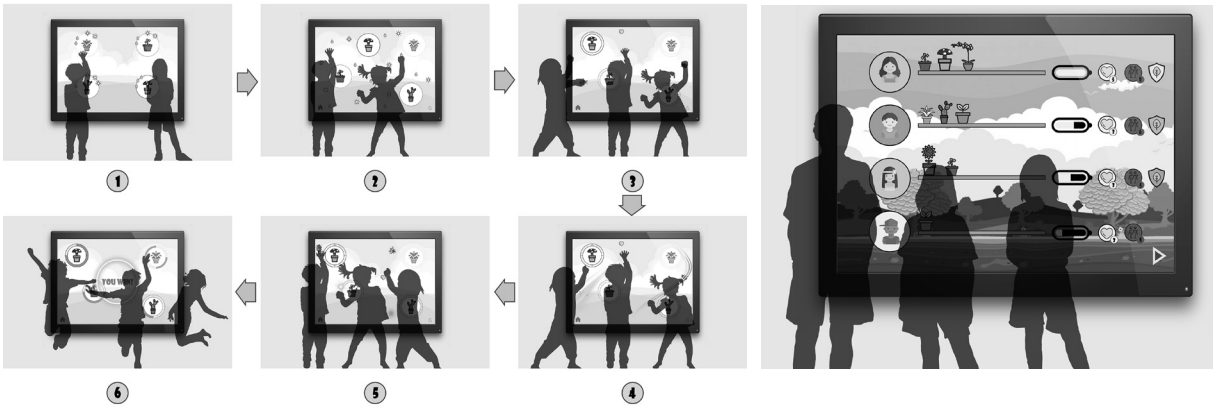

Figure 3. The interfaces of "Glowy Greeno" which shows players' ranking and activities

By using Bluetooth tracker, alongside cooperative structure of the game, players compete to rise up in scores. By the amount of activity and what they have collected, they gain higher position in ranking. Children can buy the plants which appear in the game in exchange for Light Capsules and Green Light Hearts. By increasing their involvement, children gain Light Hero badges which are gold, silver and bronze. Each player has some Glowy friends with whom he/she cooperatively played (Figure 3.).

7 COLLECTING FEEDBACKS FROM USER GROUP

The first and second steps of the concept got tested with a number of 39 Pre-schoolers in school context and by paper prototyping technique. The whole process got video recorded. Testing took place in a semi-crowded environment which allowed other children to notice the game. The prototype included a series of 24 information cards which represented the first step, two series of plant cards without any information along with sun and water cards which represented the second step in figure 3, lighting cards and Light Hero badges which represented home interface in figure 3. Game started with showing the information cards to children and mentioning the plant's name. Children then were asked to memorize plant's needs and arrange the plant card accordingly. Players had to choose single or team structure based on their will, the game interface and number of other players. One of the authors told the fantasized story of each plant. Players were given a light card if their plant card matched the information card. Players then could gain Light Hero badges in exchange for some of their light cards.

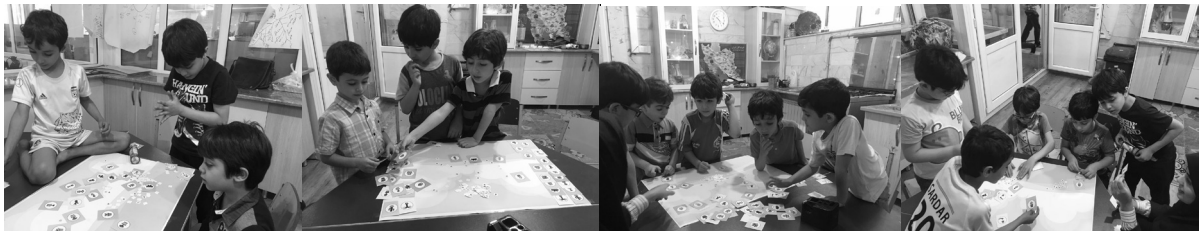

Figure 4. Testing the concept of Glowy Greeno and collecting feedbacks from user group

8 CONCLUSION

An experimental approach was used in order to increase pre-schoolers' knowledge of plants. For this domain a number of game prototypes got tested by 56 pre-schoolers. The results indicated more learning through the gamified social design. These findings led the designers to gamify the learning experience and the correlations between MDA, KCLG and SCPE were studied and a framework was suggested. Based on the framework an interactive video game was suggested and its main feature was lighting which defined the dynamical theme of game. The concept was tested with 39 pre-schoolers. At first, some children had a little complication memorizing the cards and they would ask to see them again. But as they got familiar with the game, they could recall more than 1 card. When a plant's name was mentioned, children repeated the name until they found the card. Visual figure made the process of memorizing easier. Children, who played more than others, recalled the plant's name, its shape and repeated its story for others. As play was repeated, children mentioned the differences and familiarities of plants. The game visual interface invited observers to take part in the experience. 92% of the participants liked the game and said they would like to play it again. Almost all participants liked the concept of collecting light cards to get to the Light Hero badges. Team structure made the process of matching cards easier and players showed more willing to participate in a team rather than playing single. According to the framework, the lighting feature and audio attracted other children (increase curiosity) and increased the game sociality. Game layout and the environment also increased curiosity. Increasing the difficulty in higher level increased the challenge. As immediacy is created by time pressure, it increased challenge. As competition got intense in ranking, the reinforcement behaviour appeared and this also increased challenge significantly. Game layout and time pressure forced player to take control of the game. Physical environment and team structure increased controllability. Special layout and physical environment caused behaviours like monitoring, mimicry or verbal communication which increased controllability. Fantasized features shaped a delightful sense of social presence and involve the creation of social realities of the environment. In comparison to the previous projects (figure 1), this concept was more successful in increasing engagement and understanding.

REFERENCES

[1] Bekker T. Sturm J. and Eggen B. Designing playful interactions for social interaction and physical play. *Personal and Ubiquitous Computing*, 2010, *14*(5), 385-396.

[2] Bryce J. and Rutter J. The gendering of computer gaming: Experience and space. *LSA pub.*, 2003, *79*, 3-22.

[3] Camerer C. *Behavioural game theory: Experiments in strategic interaction*, 2003, Princeton University Press.

[4] Carver C. S. and Scheier M. F. The self-attention-induced feedback loop and social facilitation. *Journal of Experimental Social Psychology*, 1981, *17*(6), 545-568.

[5] Cheong C. Cheong F. and Filippou J. Quick Quiz: A Gamified Approach for Enhancing Learning. *PACIS*, 2013, 206.

[6] De Kort Y. A. and Ijsselsteijn, W. A. People, places, and play: player experience in a socio-spatial context. *Computers in Entertainment (CIE)*, 2008, *6*(2), 18.

[7] Deterding S. Dixon D. Khaled R. and Nacke, L. From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, 2011, 9-15. ACM.

[8] Deterding S. Sicart M. Nacke L. O'Hara K. and Dixon D. Gamification. Using game-design elements in non-gaming contexts. In *CHI'11 Extended Abstracts on Human Factors in Computing Systems*, 2011, 2425-2428.

[9] Domínguez A. Saenz-de-Navarrete J. de-Marcos L. Fernández-Sanz L. Pagés C. and Martínez-Herráiz J. Gamifying learning experiences: Practical implications and outcomes. Computers & Education, 63, 2013.
[10] Duhigg C. *The power of habit: Why we do what we do in life and business*, 2012, 34(10), Random House.
[11] Elverdam C. & Aarseth E. Game classification and game design: Construction through critical analysis. *Games and Culture*, 2007, *2*(1), 3-22.
[12] Fogg B. J. Persuasive technology: using computers to change what we think and do. *Ubiquity*, *2002*, 5.
[13] Grant S. and Betts B. Encouraging User Behaviour with Achievements: An Empirical Study. In Proceedings of the 10th Working Conference on Mining Software Repositories, May 2013, San Francisco, USA, pp. 65-68.
[14] Gustafsson A. Katzeff C. and Bang M. Evaluation of a pervasive game for domestic energy engagement among teenagers. *Computers in Entertainment (CIE), 2009*, *7*(4), 54.
[15] Hamari, J. Koivisto, J. & Sarsa, H. Does Gamification Work? A Literature Review of Empirical Studies on Gamification. In *proceedings of the 47th Hawaii International Conference on System Sciences*, Hawaii, 2014.
[16] Hamari J. and Koivisto J. Social motivations to use gamification: an empirical study of gamifying exercise. In Proceedings of the European Conference on Information Systems, June 2013, Utrecht, The Netherlands.
[17] Inkpen K. Booth K. S. Klawe M. and Upitis R. Playing together beats playing apart, especially for girls. In *The first international conference on Computer support for collaborative learning*, 1995, 177-181.
[18] Jakobs E. Manstead A. S. and Fischer A. H. Social context and the experience of emotion. *Journal of Nonverbal Behaviour*, 1996, *20*(2), 123-142.
[19] Kelly T. (2012, December 8). Real gamification mechanics require simplicity and, yes, game designers can do it. Available at http://techcrunch.com/2012/12/08/ real-vs-fake-gamification-mechanics/
[20] Klimmt C. Schmid H. and Orthmann J. Exploring the enjoyment of playing browser games. *CyberPsychology & Behaviour*, 2009, *12*(2), 231-234.
[21] LeBlanc M. Game design and tuning workshop materials. Presentation at the Game Developers Conference: San Jose, CA, 2004.
[22] Malone T. W. and Lepper M. R. Making learning fun: A taxonomy of intrinsic motivations for learning. *Aptitude, learning, and instruction*, 1987, *3*(1987), 223-253.
[23] Mehrabian A. Silent messages: Implicit communication of emotions and attitudes. 1981, CA: Wadsworth.
[24] Ramanathan S. and McGill A. L. Consuming with others: Social influences on moment-to-moment and retrospective evaluations of an experience. *Journal of Consumer Research*, *34*(4), 2007, 506-524.
[25] Ravaja, N. Saari T. Turpeinen M. Laarni J. Salminen M. and Kivikangas M. Spatial presence and emotions during video game playing: Does it matter with whom you play? *Presence: Teleoperators and Virtual Environments*, 2006, *15*(4), 381-392.
[26] Robson K. Plangger K. Kietzmann J. H. McCarthy I. and Pitt L. Is it all a game? Understanding the principles of gamification. *Business Horizons*, 2015, *58*(4), 411-420.
[27] Reeves B. & Read, J. L. *Total engagement: How games and virtual worlds are changing the way people work and businesses compete*. Harvard Business Press, 2013.
[28] Skinner B. F. The behaviour of organisms: An experimental analysis, 1938, New York: Appleton-Century.
[29] Trepte S. Reinecke L. The pleasures of success: Game-related efficacy experiences as a mediator between player performance and game enjoyment. *Cyberpsychology, Behaviour and Social Networking*, 2011, *14*(9), 555-557.
[30] Van Looy J. Courtois C. De Vocht M. and De Marez L. Player identification in online games: Validation of a scale for measuring identification in MMOGs. *Media Psychology*, 2012, *15*(2), 197-221.
[31] Williams J. P. Hendricks S. Q. and Winkler W. K. (Eds.). *Gaming as culture: Essays on reality, identity and experience in fantasy games*. McFarland. 2006, 11 & 12.