Kinect in Informal Education

A prototype for Orlando science Center

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***Abstract*— In today's hi-tech world, education is more challenging and needs innovation to keep children on the fast and right track. For years, games have entertaining aspects. In recent decades, education system tries to use games as a learning device to bring joy to the classrooms. Also, transferring educational concepts in the real world and getting help from informal learning is one of the main concepts that researchers work on. This paper focuses on an informal learning experience as a prototype Kinect game at Orlando Science center.**

Keywords— Informal learning; Kinect; Educational Game; Science Learning

I. INTRODUCTION AND LITERATURE REVIEW

"They had a great time, but did they actually learn anything?". This is a question that observers and critics sometimes ask after visiting a science center. Many people think pre-imposed curriculum is essential to achieve a goal at a learning environment. It may be correct in formal learning environment such as school or college, however, some other factors such as attraction, engagement, and motivation are important at informal learning area.

The term "informal learning" has been used in education for several reasons. It provides flexibility and freedom for learners to learn everywhere not just in the classrooms. It can improve the social interactions of learners. It draws attention to the learning that can take place outside educational establishments (Eraut, 2004). Informal learning doesn't follow a specified curriculum and mainly happened in association with certain occasions. Being spontaneous and creative is another characteristic of the informal learning. One of the important components in informal learning is Leaning Observing and Pitching In (LOPI), which is a common method on many Indigenous American communities. Based on these factors we try to make a game which follows main characteristics of informal learning method.

A. Informal learning

Reviewing academic literature provides a broad understanding of informal learning. There are a variety of definitions of informal learning. Several fields have examined informal learning focusing in adult and lifelong learning (Holford, Milana, & Mohorčič Špolar, 2014), on museum learning (Play in the Museum: Design and Development of a Game-Based Learning Exhibit for Informal Science Education, 2017), and on workspace leaning (Bancheva & Ivanova, 2015; Manuti, Pastore, Scardigno, Giancaspro, & Morciano, 2015).

According to 70:20:10 framework, informal learning is almost 90% of everything we take in (Marsick, Watkins, Callahan, & Volpe; Mahajan, 2017). This method explains how each person builds their skills and knowledge in a formal and informal environment. It helps organizations to maximize informal learning opportunities. It simulates a natural, self-driven learning experience.

Calley at al. (Colley, Hodkinson, & Malcolm, 2003) mentions four attributes of learning formality which we discuss in this part. The first factor is location. Location may be at school, work, community, home, or science centers and museums. It can be any place that is not specially designed for learning (Misko, 2008). The second factor is process through which degree of formality can distinguish informal learning. Some researchers believe that the most formal learning includes an instructor and a less formal one may involve a friend or a work colleague (Colley, Hodkinson, & Malcolm, 2003) or parents. Livingston (Livingstone, 2001) notes that an instructor without regarding to the curriculum of the course can make a less formal situation for the educator. However, some authors believe that informal learning occurs when the learner is driven by another learner rather than the instructor (Raymond A. Noe, 2014). Next factor is the content. Sometimes the terms of "concept" describes knowledge, understanding, and practice emerging from a formal academic place; however, in informal learning that is based on experience the "content" considered the knowledge from situational or practical area. The last attribute is the purpose.

The question is "why the educator engages in the learning process?" At informal learning, the learner may or may not distinguish that the learning is happening. As Colley says: "learning is the prime and deliberate focus of activity" which declare how engaging to an activity can improve the knowledge.

This project focuses on science learning about Florida nature and its habitats. Based on research on different countries, development and understanding science is not limited in schools. The learning time exposure to the public resources such as museums and science centers (Bathgate, Schunn, & Correnti, 2014; Falk & Needham, 2013). That's why we got encouraged to have current proposal for Orlando Science Center.

B. *Serious Games in Education*

Serious games are considered a combination of entertainment with transferring knowledge to include positive effects in learning areas. From 1970 that Crark Abt (Abt, 1987) established the serious game term in his book of the same title there are many changes in game design and game development. The current definition of serious games appears to follow the lead set by Michael and Chen (2005) that say any game without primary purpose of entertainment, enjoyment, or fun is a serious game. Although serious games can be entertaining, their focus is on training and education the user. The philosopher Bernard Suits, in his book, defines playing a game is to engage in activity with some rules. This perspective is so popular between game developers and educational content developers as well. In general, games have been defined as a rule-based play and voluntary activity (Tekinbaş & Zimmerman, 2004).

The content of games continues to grow. On the other hand, interest in games for learning has grown as well. Learning games are a tool to enhance student's academic performance and engagement (Gee, 2008 (Chih-HsiaoTsai, Kuo, Chu, & Jung-ChuanYen, 2015). Despite early research focuses on the negative impact of computer games (Stoffregen, Faugloire, Yoshida, Flanagan, & Merhi, 2008) such as depression, addiction, and violence, several researches have been examined the potential positive impact of gaming on users (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). To a certain degree games are already used in educational systems to achieve different learning outcomes. Anderson believes that serious games as well as virtual worlds reveals the potential of educational learning (Anderson, et al., 2009). He believes that video games are an ideal medium for multiple purposes such as educational improvement and enhancing engagement. Because of the popularity of video games, especially among the younger people, this research focuses more on the young children as the target group. At the same time there is extensive literatures exploring motivation aspects of game-based learning. Games in general and the challenging and engagement games in particular have a significant effect on learning (Hamari, et al., 2016). Game-based technology whether it is fully or partially integrated into the classrooms, is a useful tool to support teaching, learning, and evaluation. Games provide creative environment for teaching knowledge and improving skills at schools with adding diversity in educational games. It should be a supplemental element in the classrooms or as a partial substitute for traditional education methods (Sitzmann, 2011; Nico Rutten, 2012; Lameras, et al., 2017). Results of research indicate that games promote the knowledge acquisition as well as achieving concept of the lesson through playful learning environment. In particular, games influence students' motivation and engagement in the classroom (Tsekleves, 2016; Whitton, 2007).

To support the idea behind this project, I want to mention "Tree Investigators" project by H.T. Zimmerman (2015). "Tree Investigators" is a research that support science learning with mobile devices during family public programs in an arboretum. The conceptual framework brings research on technology to support science learning and research for on strategies to encourage families to engage in conversation while observing the nature.

The Tree Investigators project supports youth and families, with mobile computers, to engage in conversations about scientific observations and to develop explanations of natural phenomena. The project uses AR to bring web-based media to a smart phone or iPad.

C. *Gesture-Based Games and full-body interaction learning*

One of the ways game-based learning (GBL) is being implemented is with the Microsoft Kinect. Kinect is an accessory to Xbox 360 that has motion sensor. Kinect can physically involve the player in gameplay. There are many articles that explore the potential of Kinect as interactive technology to enhance teaching and learning (Hui-Mei & Hsu, 2011). Full body movement in games such as Kinect Sport and Kinect Adventure show the beneficial of Kinect in physical development. Furthermore, it used successfully for teaching Martial Art, sign language recognition game (Zafrulla, Brashear, Starner, Hamilton, & Presti, 2011), and increasing motivation for physical rehabilitation (Chang, Chen, & Huang, 2011).

There are many research combined "learning" and "education" in embodied interaction, full-body interaction, whole-body interaction, and gesture-based interaction. While doing research in many areas related to informal learning and games in education, we also focused on articles that describe learning environments designed for science lessons. There are many elements in designing a full-body interactive game. Diversity of movement, physical space, and the instruments used in the project are some of the key elements (Koštomaj, 2009, Mujtaba et al. 2018). In early 2004, Sony's EyeToy became a popular video game. This game was developed for the Playstation 2 console. The user interacts with game objects by standing in front of the camera. After that more research was done to see the impacts of interactive games in learning and education improvements. Gesture interactive game-based learning improves children's performances and motor skills (Hsiao & Chen, 2016). One recent research on learning and engagement through museums shows how body engagement enhance learning science particularly for school-age students (Mujtaba et al. 2018).

Kinect creates enjoyable and interesting interaction to boost learners' motivation. This study is a prototype to show how a Kinect-based system can be helpful for gesture-based educational game.

II. THE RESEARCH GOAL, QUESTIONS, AND METHOD

A. *Methodology*

Connect with Florida is an interactive game equipped with a Kinect for motion detection, a large screen display, and a PC using to run Unity game engine.

Orlando Science Center provides an informal learning area for students, teachers, and families. The center tree at OSC close to the glass-window elevator provides many opportunities for a learning step. Learning is a continual conversation with the external world and its artifacts and other learners and teachers. The tree represents lots of information about the Florida environment and the wildlife here.

Many people encourage others to go upstairs and look at the tree and birds and other creatures around it.

The visitors can improve their observations of tree with concentrating on more details about the age of the tree, the creatures that live on it, or the surrounding area of it. Almost everyone on the elevator look down/up to the tree or the mangrove swamp at the base.

Figure 1: Connect with Florida opening screen

Connect with Florida will start with a hand gesture. The scene of the game is built in unity and it is similar to the scene that OSC's visitors see in the middle of the building. If the visitor makes the hand gesture which is shown on the screen of the game correctly, the alligator will start moving. The animation movement is similar to its movement in real world. While the visitor looking at him, he may stop moving and talk about himself. This is the educational part of the game. Now the visitor is an educator that is learning about one of the creatures that found in OSC as well. Another hand gesture will pop-up on the screen and the educator can interact with the alligator through his/her body gesture. The animated alligator can Walk, run, swim, jump, and roar. Other features such as eating and attacking will be added.

Figure 2: CWF in game image

The aim of the game is encouraging visitors of Orlando Science Center interact with a game and learn something useful about creatures at Florida. On the other hand, we make the game as simple as possible, so all group ages can play. All the movements that are needed to start the game is simple because we want kids with movement disabilities can play as well as other kids.

B. *Research Questions*

Museums and science centers are important places for children to learn about science. The purpose of this study is to evaluate the impact on motivation, engagement, and learning of a show game in an informal learning area such as a science center or museum.

Based on the survey, observation, and literature study the following research questions are defined:

RQ1: What are the benefits of using Kinect as a motion capture device for educational purpose?

This research question investigates potential positive effects of Kinect and any devices that encourage learner to move instead of sitting at the desk like traditional classrooms.

RQ2: How much are kids interested in learning at science centers?

This research question looks specifically on how visitors act in front of the Kinect and are they interested to start playing game or stop and watch the others while they are playing.

RQ3: Do players learn any facts from the topic that presented in the game?

The result of the survey will show if there is any facts about Floridian Alligator that they didn't know before and they learn it by playing the game.

Figure 3: OSC Swamp and Trees

Positive aspects of the center tree

It is on the exhibition floor and everyone form each floor can see that. It is the first thing that the visitors may see when they enter from any other doors to the OSC. Visitors may be interested to watch the tree closer by using the glass-window elevator. The tree by itself is not an artifact.

Learning opportunities about the cypress trees

- Know about the cypress trees
- Discover about a variety of fauna on the branches
- Learn about any wild life surrounding a cypress tree

Observing a typical cypress swamp under the tree with live alligators is another interesting thing that visitors may want to know more about.

Learning opportunities about Florida alligators

- What do they look like?
- Where do they live?
- What kind of habitat do they need?
- How long do they live?
- And many other interesting features.

The storyline of the game

Based on many research storytelling is a powerful tool in teaching strategies. Digital storytelling provides opportunities for learners in problem solving (Chung, 2007). In a three year project Di Blas et al explore the advantages of learning in community and adding digital storytelling at K-12 level (Blas, Garzotto, Paolini, & Sabiescu, 2009; Liang, et al., 2015). He approves that using technology has a significant positive impact on student achievement and improves their creativity. For this project, we make up a narrative story from a Floridian alligator who lives in Orlando Science Center (OSC). The player can hear the story or they can choose to read the story from pop up window on the screen or wall. The story is based on the facts about alligators. The data is based on "Florida Fish and Wildlife Conservation Commission" and "National Geographic" websites.

This is part of the story:

Hello I am an American alligator. Scientists describes me as a "living fossil" because I have been living on Earth for millions of years. I can live 30-50 years. But the oldest was 75. I live in south-eastern areas of the United States such as Florida and Louisiana. I can swim and run real fast.

I live in swamps and lakes. If you see me by your house, call 911. Do not give me food though, because I will get aggressive and dangerous.

I am not an adult, but daddies can be 15 feet long and weight 1000 pound, WOW. But mommies are usually smaller.

I like to eat fish and turtles. If you find me at OSC next to the turtles, ask the tour guide why I am not eating them! I hope you have a good time at the Orlando Science Center!

C. Participation

Participants would be all visitors of OSC. They can be friends or family members. Kinect can track up to two people. The final goal is having the game to show two animals at the same time following the movement of two participants. But, for this prototype we focus on one body engagement and alligator as our first animal to be recognized in Florida.

III. TECHNOLOGY

This project runs on a computer using Kinect SDK as a sensor motion tool. It can be projected on a wall or on a screen. The Kinect gives player a controller-free experience. The point of using Kinect is having a series of physical gestures. Kinect transform ordinary learning lessons into extraordinary and joyful immersive education (Homer, 2014).

The list below is all the technology and software and assets that we uses in this project.

Hardware – Kinect v2 for Windows SDK: Motion sensing input device made by Microsoft for the Xbox One. It is a webcam-style controller that enables user to interact with a computer with their body movements.

Software – Unity 5: Cross-platform game engine developed by Unity Technologies, which is used to develop 2D and 3D simulations and video games for multiple devices.

Autodesk Maya: Animation and modeling program used to create three-dimensional models.

Adobe Photoshop/Illustrator:Graphic editing software. Will be used to create UI elements and textures.

Substance Painter: 3D Painting Software to assist in texturing 3D assets.

Digital Media Art Assets - Unity Asset Store: Alligator Asset (http://u3d.as/ndm)

Standard Environmental Assets: Assets included with Unity, purchased on the Unity Asset Store, or created.

Sound Effects (https://freesound.org/

https://www.gettyimages.com/Music): Sound Effects for animals, ambient noises and potentially music.

Microsoft Kinect System

Microsoft's Kinect for windows SDK is used to provide an Application Programmer's Interface (API) to the Kinect Hardware. Kinect can recognize people and their skeleton by Skeletal Tracking sensor. Based on Kinect for Windows documentation, Kinect can recognize up to 6 people and can track up to 2. Kinect can recognize bodies if they are sitting or standing and better tracking happens when they are facing the Kinect not sideways poses (Kinet Document, 2018). In this project, we used the default range of Kinect which is from 2.6 to 13.1 feet.

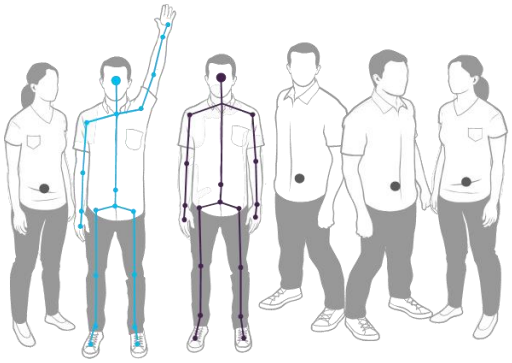

Figure 4: Kinect can track two people's joints (https://msdn.microsoft.com/en-us/library/hh973074.aspx)

IV. THE USERS AND THE STAKEHOLDERS

This project can present in any indoor and outdoor place. Stakeholders are researchers and people that works in evaluation learning methods, any scientists in primary education, museum curators, game designers, and teachers. Since it shows in the literature review part, this project has an inter-disciplinary scenario. We try to focus mostly on the education part although we present that in an enjoyable interactive game. The users of the game can be any visitor of the Orlando Science Center (OSC). Based on the place that this instrument set up, the user can be changed to home school students at home, or students in at schools or any other person who is eager to learn about Florida animals such as alligator in this case.

V. DATA ANALYSIS AND EXPECTED RESULT

The variable that the scientist changes during the experiment is the independent variable. Think of the experiment as a "cause and effect" exercise. For example, we have the sound of the narrative on or off, and the pop-up narrative windows on or off based on the visitor need.

The dependent variable is what is measured or observed. It is the "effect" in the cause-and-effect relationship. We can add ambient sound to the environment and observe that if it affects visitors to engage more into the game. The sound is the independent variable, but the engagement factor is dependent.

In order for the test to be fair, other factors that could affect the outcome of the experiment should be kept the same or controlled. Whenever we want to check the effect of sound on the visitor engagement, we should have constant controlled variables. So, for this project the data would be gathered in the OSC. If we change the place, we need to change the dependent and independent variables as well. For example, the place of showing the game can be the independent variable and the attraction factor of the game can be the dependent.

We are focusing on watching the video and hearing the narration with the facts about an alligator as an independent variable and the post-survey will show that how much the user learned after playing the game. One of the important points that we want to highlight is to encourage visitors to be an active learner. If after playing and interacting with Connect with Florida or even if they don't play and just visit the players and watch the video, they want to know more about the American alligator or look for it at OSC, we catch a big goal.

The plan is to have conversation before and after playing or watching the game and record the engagement of the visitors. We expected all group ranges show interest in watching the game.

The questions of the pre-survey and post-survey are in the Appendix A & B. Also, the visitor will be asked to fill out a quick questionnaire about the facts they learned through watching or playing the game (Appendix C).

Up to this step of the project, the game last for about two minutes and for analyzing the data recorded videos will be coded into different experimental group. Based on the answers of the surveys' questions the enjoyment factor, the collaboration engagement, and the learning factors will be evaluated. For statistical analysis SPSS software will be used.

VI. CONCLUSION AND FUTURE WORK

"Learning is a process of active engagement with experience. It is what people do when they want to make sense of the world. It may involve the development or deepening of skills, knowledge, understanding, awareness, values, ideas and feelings, increase in the capacity to reflect. Effective learning leads to change, development, and the desire to learn more." Campaign for Learning in Museums & Galleries, quoted by Hawkey (2004). Focusing on bringing joy to the learning process, the future work will include the creation and experimentation with continue this prototype to test motion base learning in science center by adding more creatures such as turtle and eagle. Results from pre-test and post-test questionnaire will show us that what changes we need to apply to improve the game. Also, we will add more movement to the animated animals such as eating and attacking.

VII. Potential Conferences and Jouranals to Publish

There are many conferences and Journals that focusing on games, Educational games, serious games, informal learning, and games for kids. Based on the literature review part and the articles that the idea of this project derives from them, the below list is available journals and conferences for publishing the final version of this project:

1. Educational Media International is covered by Australian Research Council (ARC) Ranked Journal List; British Education Index; EBSCOhost; Educational Research Abstracts online (ERA); Education Resources Information Center (ERIC); ERIH (European Reference Index for the Humanities, Pedagogical and Educational Research); Emerging Sources Citation Index (ESCI); ProQuest Information and Learning; PsycINFO; Research into Higher Education Abstracts and SCOPUS. This Journal has 4 issues per year.
2. Art Education Journal founded by National Art Education Association (NAEA)
3. International Journal of Training and Development the latest version is a special issue about Digital technologies in training and adult education.
4. International Journal of Computer Games Technology that is a peer-reviewed, open access journal that publishes articles on research and development aspects of games and game technology.
5. IEEE Transactions on Computational Intelligence and AI in Games (T-CIAIG) publishes journal quality papers in mathematical games, human-computer interaction games, and games with physical objects.
6. Game Development Conference (GDC)
7. Special Interest Group on Computer GRAPHics and Interactive Techniques (SIGGRAPH) conference: It is an annual conference on innovations in production and animation, research and education, art and design, gaming and interactive, and new technologies.

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