Serious Game for Human’s Environmental Consciousness Education in Residents’ Daily Life

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ABSTRACT:

It has been challenging to find ways to educate people to have better environmental consciousness. In some cases, people don’t know what the right behaviors are to protect the environment. Game engine has been used in the AEC industry for visualization. However, it has barely been used in environmental consciousness education, for example, what operation can reduce building energy consumption, what items are recyclables. As social psychology studies show that video game can influence human behavior, a good designed game should provide the game player with right incentives and guide the users to make wiser choices for better environmental protection. This paper discussed a method to use serious game engines to educate the players the right actions that should be taken under in different scenarios. These actions in real life will results in a better environmental protection. The game proposed in this study is for residential home operation. Other scenarios such as restaurant operation, grocery store operations are discussed as expansion of this study. The game players’ points will be calculated based on their performance on different choices and when they surpass a certain level, different rewards will be gained in order for them to adjust their current living style. The purpose of the game is to raise
the environmental consciousness among the game players and educate them the right actions they can make to better protect the environment while they are spending time on games.

**Keywords:** Human Conscious, Serious Game, Environment, BIM

**INTRODUCTION AND PROBLEM STATEMENT**

It has been challenging to find ways to educate people to have better attitude and take actions towards sustainable goals such as saving energy and recycling. Common people in their daily life choose their behavior according to their needs and convenience, rather than to environmental protection. Most of the time, they don’t even know their behavior will result in waste of energy and harm the environment. As a result, it is important to educate the massive population what are the right activities and how they can save the environment and raise their environmental consciousness. Sustainability has been offered as a required class in some university curriculums (Liu and Hatipkarasulu 2014).

Inspired by active learning, a serious game can create an immersive learning environment to develop critical thinking and motivation on environment sustainability consciousness. Therefore, the serious game technology could be used to train players with knowledge, environmental sustainability, and the effect of everyday life activities on the environment. Because the serious game offers complex questioning on the issues of efficiency and the energy consumption reduction, and renewable energies and sustainable development. Through playing game, the game player could gain a comprehensive selection of information, and a vivid learning about sustainable development. It also makes theoretical concepts lively in environmental sustainability education. The player’s objectives are to
reduce the consumption of energy, increase energy efficiency and choose optimal activities to consider environmental sustainability.

Rather to build green buildings, we should build green people who know about how to live a green living. The key to corporate green living is by education. How to bring the environmental conscious to a massive population including children and other non-experts? A fun game may serve as the solution.

**LITERATURE REVIEW**

This section summarizes previous related research that provide as a basis of our proposed methodology to solve the problem of human consciousness of environmental health in their daily life.

**Serious Game for Environment Related Issues**

Some serious games for environmental protection and responsible behaviors have been discussed in previous studies. For example, Climate Challenges (BBC 2007), EnerCities (Knol and De Vries 2011) and shortfall (Sivak and Sivak 2007). In Climate Challenges players can take a role as president of the European Nations, and choose policies to tackle climate changes and stay popular for reelection. The player in EnerCities serves as the city’s mayor and makes decisions on residential building types for real estate development, environmental actions, citizen well-beings and the source for energy generation to support city needs. Points are given when the mayor achieve the goals in the game. Shortfall focuses on the supply chain management of an automotive plant. Players serve as the manager of one company in the game, the goal of the players is to make a profit and environmental benign. Shortfall is a narrative interface, but not virtual immersive game.
These three games are designed from a policy maker’s point of view, even the players can achieve a super performance in the game, and they rarely have a chance to implement it in their daily life.

On the other hand, some other researchers focused on the common human’s daily life behavior with the environment impact especially from the perspective of energy saving and energy efficiency. Madeira et al. proposed to use serious game-based pervasive system to change domestic energy consumption behavior (Madeira et al. 2011). Yang designed a serious BIM game about energy-related design and living style to raise the public awareness of energy efficiency and sustainability (Yang 2009). Bang et al. presented the design and rationale of a mobile energy conservation game from a persuasive and learning point of view for players to learn their energy behaviors with feedback from peers (Bång et al. 2009).

**Serious Game and Behavior Training**

In addition, game engine has been adopted to study human behavior or used human behavior education. Several serious game applications has been reported for safety training in three major areas: construction, public safety and pedestrian safety. For construction site safety, Dickinson et al. reported positive feedback using a serous game to teach trench health and safety lessons(Dickinson et al. 2011). Lin et al. presented game for the safety inspector to identify hazards for construction sites(Lin et al. 2011). On the perspective of public safety, first trial is a serious game aiming at training fireman to the release of chlorine gas. (McGowan and Pecheux 2008). Another game is Sidth, a firefighter training simulator based on cave technology (Backlund et al. 2007). Moreover, Liu et al. proposed to use immersive serious game to solicit human behavior in emergency
situations (Liu et al. 2014a; Liu et al. 2014b), which can make up the deficiency of the traditional Agent Based Modeling (ABD) method. For pedestrian safety, a desktop virtual reality application, McComas, taught children to safely cross intersections (McComas et al. 2002). Liu and Ariffin et al. demonstrated another two games designed to educate children on traffic safety are using cartoon(Ariffin et al. 2010; Liu 2006).

**BIM-based Gaming Environment**

Gaming environment can be created by using Building Information Modeling (BIM) tools. In the past decade, BIM has gained tremendous attention for the AECO industry (Liu et al. 2010). BIM has been served in different areas. Some researchers has investigated BIM and facility management integration for database communication between software packages(Liu and Issa 2012). BIM technology has been applied to improve the design professional’s knowledge (Liu and Issa 2013; Liu and Issa 2014). As BIM potential started to extend to FM phase, existing problems have been explored (Liu 2012; Liu and Issa 2013). In addition, this new technology is integrated with GIS technology to extend the database computing potential (Liu and Issa 2012). In order to provide a variety of gaming environment, BIM can be integrated with game engine and set up the corresponding gaming environment(Brouchoud 2013; Liu et al. 2014a). Which can not only provide the gaming environment geometries but also carry in the construction material information in the gaming environment.

**PROPOSED APPROACH**

**Behavior and Learning**

A fundamental part of learning is to get feedback from the actions (Piaget 1977). Many recent research has shown that behaviors can be controlled by adjusting the antecedents
or the consequences of an action (Bång et al. 2009). Immediate feedback is used as a means to change peoples’ inappropriate behavior at home. For example, in order to promote energy conservation, instead of providing an aggregated metering of the household, feedback on the appliance-level consumption is provided. If the player forget to turn off the light or oven when he leaves home, warnings will be sent to the player on the screen and tell him what he should do for these appliance.

**Game Scoring**

In order to attract the players to keep stay in the game. A scoring reward system is embedded to the game. The principle of the reward system is to reward the right choice and advise the wrong choice. When a right option is made, points will be added to the player’s account, cumulate to a certain level of point, the player can gain some rewards as their incentives to play. Every time when the players make wrong choices, the game would deduct a certain amount of points from the player’s account and would send feedback about what the player has done wrong so the environment responsible knowledge is delivered to the player and he/she can make better choices to the next game in their daily life. Based on the player’s points gained, there are different level of rewards, for example, twenty points is the wood level, and the player can choose from the gift shop a gift for their home. For example, a vase for decoration, a bunch of flower, or $20 to spend in the game. More points can help the player achieve higher levels and gain more valuable gifts in the gaming environment. In the meanwhile, the system is not only reward the player with their environmental related behavior, but also their economic expenses. There will be two information send to the player every time they finish an action. One is the points for environment impact as stated above, another one is the money the player would save
or waste for this action. As sustainability is not only about environment, but also economic, it is important for the player to understand both impact at the same time. For example, if the player decided to install a solar panel for their home, their initial cost, their energy savings and their related environmental impact points will be shown to the player.

**GAME ENVIRONMENT DEMONSTRATION**

**Monitored Behaviors**

For the pilot of this game, behaviors that should be to monitor include recyclables handling, lighting control, home appliance usage, temperature settings in different seasons, home improvement activities. Each scene in the game have some operations related to the behaviors listed above. For example, the player can decide to turn on or off the light. If it is daytime and daylight is enough for the home at this location, this action will results in a negative points in the player’s account and warnings will be shown. Another example is temperature setting, without sensor, the player may not feel big difference with the whether change and room temperature change. This module serves like a knowledge transfer to the player. If the player set a very low temperature in the summer, the system will give the energy consumption data to the player and deduct corresponding point from the account. A corrective action will also be provided to the player as what degree is more appropriate.

**Game Scenarios Demonstration**

One scenario in the game is about recyclables. When the player access this module, she/he will be asked to decide which items should go to the recycle bin and what should go to the trash bin. Items should go the recycle bin are shown in Figure 1.
Figure 1. Recycled items list (adapted from Automated Curbside Recycling, 2014)

When the player is in this scene, each item the player throw into the recycle bin will checked against the recyclable item list, if the player get the items right, points are awarded, if not, points will be deducted and a warning will pop up on the screen. In the meanwhile, this action will be saved to the feedback database, when the player sign out from the game, a list of inappropriate actions will be listed for the player.
DISCUSSION

This paper proposed to use a serious gaming environment to educate the non-expert people to understand more environmental responsible behaviors. There are several follow up directions this research can go. First of all, it can be expanded to work with sensors at the players’ real home, and monitoring their real daily operation and give them corresponding feedback. Secondly, besides the home environment, a small business owner can also adopt this game to explore more environmental friendly operations. Business related actions should be listed first in order to build the game rules, score system and feedback systems. Thirdly, this paper proposed a single PC game, to protect our environment, it is very important that such knowledge can be speeded to a broad population. This game can be deployed online to a massive population to get a better education results.

Serious game technology is a promising strategy for influencing individual behavior and its effect on environmental sustainability. This pilot illustrates the potential results associated with a community-leveraging fun and social approach to environmental
sustainability. Too often we take the education in environmental sustainability in a techno-speak rational way; this effort suggests game players can achieve better education in a pleasant (game fun) way for people to explore options, have conversations about their actions and, share their achievements through social network, ultimately, create new social norms within their community. By giving people credit for their sustainable options in their everyday life, e.g., using re-usable shopping bags at the grocery store, we created space for them to think about other actions like re-programming their thermostats or even carpooling.

CONCLUSION

This paper discussed the possibility of the integration of BIM, serious games to educate non-expert people to become more environment responsible for their home environment. The approach allows the gamers to get feedback on their actions and gain the knowledge of ways to reduce the harm to our environment and health in a fun way. In addition, as the game has a potential to be published online, it can be exposed to a massive population which solve the problem of public education of environment conscious and responsible behavior.

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