Chang, M. et al. (Eds.) (2019). Proceedings of the 27th International Conference on Computers in Education. Taiwan: Asia-Pacific Society for Computers in Education

Drug Defense: A Mobile Game for Prevention of Alcohol Abuse

Divine-kia T. TAN*, Rodrigo Emmanuel ROY, Jose Rafael LASALA, Anton Gabriel YAP, Ma. Mercedes T. RODRIGO, Walfrido David DIY & Ma. Regina M. HECHANOVA
Ateneo de Manila University, Philippines
*divinekiatagletan@gmail.com

Abstract: We present *Drug Defense*, a mobile tower defense game designed to prevent alcohol abuse. The game makes use of the Cognitive Behavioral Game Design (CBGD) methodology to encourage the retention of knowledge about the consequences of excessive alcohol use. The researchers compared used pretest and posttest to determine the game aided in greater retention. The researchers also assessed the playability of the game was also evaluated using a questionnaire adapted from the Heuristics to Evaluate the Playability (HEP) of Games. Data analysis showed that the players had significantly increased knowledge on alcohol and its use. Players also enjoyed the game's narrative and the need to strategize.

Keywords: Digital game-based learning, Alcohol knowledge, Health, CBGD

1. Introduction

The World Health Organization (WHO) reports that alcohol misuse caused three million deaths worldwide – 5.3% of all deaths – and 132.6 million disability-adjusted life years (DALYs) in 2016. More people died due to excessive alcohol consumption than people afflicted with tuberculosis, HIV/AIDS and diabetes combined. Out of all the deaths rooted in harmful alcohol intake in the same year around the world, 28.7% were due to injuries, 21.3% due to digestive diseases, 19% due to cardiovascular diseases, 12.9% due to infectious diseases and 12.6% due to cancers. Approximately 49% of alcohol-related DALYs were caused by noncommunicable and mental health conditions, and around 40% of DALYs are due to injuries (WHO, 2018).

Alcohol abuse has a wide variety of detrimental effects. Most alcoholics have a deficiency of Thiamine or Vitamin B1, which affects the cerebellum (National Institute on Alcohol Abuse and Alcoholism, 2004). Excessive intake of alcohol also can lead to alcoholic liver disease. The first stage of alcoholic liver disease is steatosis, or fatty liver, in which too much fat is present in liver cells (National Institute on Alcohol Abuse and Alcoholism, 2005). If alcohol use is not significantly decreased, then one is prone to alcoholic hepatitis, or liver inflammation (National Institute on Alcohol Abuse and Alcoholism, 2005). The most severe stage of the disease is cirrhosis, where the liver can no longer perform vital functions due to liver cells being replaced by scar tissue (National Institute on Alcohol Abuse and Alcoholism, 2005).

Alcoholism causes harm not only to the drinker themselves, but also to others, including their family or household, relatives and friends, and street counters. The harms are not limited to health (e.g. a family member's anxiety or depression), but also social (e.g. assault, community nuisance), and economic (e.g. damage to property, money) (Karriker-Jaffe et al., 2018).

Nations have established policies and interventions to lessen alcohol consumption and its consequences. One example is implementing drink-driving countermeasures which entail creating checkpoints by the police on public roadways to deter drunk drivers, penalizing those caught. Other than national policies, nationwide awareness-raising activities are being conducted. The availability of alcohol is also being regulated by controlling the production and sale of alcohol on a national level. In 2016, a national or subnational legal purchase age for on-premise beer and wine sales was observed in 152 countries, with 18 years old being the most common age limit (WHO, 2018). One of the most effective strategies for reducing the harmful use of alcohol is increasing its price (WHO, 2010). Another

technique for reducing the negative consequences of drinking is disclosing alcohol content on the labels of alcohol containers (WHO, 2018).

Another form of alcohol use prevention utilizes advertising and media. Studies show that adolescents' favorite alcohol brands are those most visible in music, film, television, and advertising (Moreno, 2011). A study estimated that reducing alcohol advertisements can significantly decrease adolescent alcohol use, and even binge drinking (Saffer & Dave, 2006). In addition to this, a longitudinal study found that those exposed to alcohol through media in early adolescence have an earlier onset of alcohol use (Ellickson et al., 2005). A systematic review on mass media campaigns established that the strength of media is in the recall of presented stimulus (Young et al., 2018). The use of media, primarily television and radio, also led to positive changes in knowledge, beliefs, and attitudes on alcohol consumption (Young et al., 2018).

Video games are one medium that can be used to educate people about the effects of alcohol abuse and persuade them to consume alcohol with moderation. Video games are persuasive. A literature review by Primack et al. (2012) concluded that video games have the potential to improve health-related outcomes. These changes, with the end goal of changing behavior, can also affect beliefs, attitudes, knowledge, skills, and risk perception (Thompson, 2012).

While the scope of the current build of Drug Defense is limited to alcohol abuse, the researchers hope to branch out to other addictive substances which are prevalent in the Philippines, such as methamphetamine and cannabis, to be a tool for educating the public. The game serves as a part of a larger program in substance abuse called *Katatagan Kontra Droga sa Komunidad* (KKDK). This program provides psychological and social support for low- to mild-risk drug users in the Philippines. Developing Drug Defense gives it a potential to be used in KKDK to alleviate observed monotony and increase engagement among participants.

2. Cognitive Behavioral Game Design

The researchers used Starks's CBGD (2014) to create Drug Defense, a game for alcohol use intervention. CBGD is the use of elements Bandura's Social Cognitive Theory (SCT) and Gardner's Multiple Intelligences (MI) theory for the purpose of creating games that induce real-world behavior change in the player (Starks, 2014).

Bandura's SCT claims that personal, environmental, and behavioral factors all affect one another into a resulting action (Bandura, 1999). An application of the theory (Bandura, 2004) states that there are five core elements that help facilitate behavior change and these are gamified through CBGD (Starks, 2014). These are knowledge, goals, outcome expectation, encouragement, and barriers. Knowledge refers to information that the game wants players to obtain (Starks, 2014). In Drug Defense, these are the facts about alcohol. Encouragement is facilitated in the game mainly through the doctor. The doctor praises the player through text, sound effects, and rewards whenever they answer correctly in the quiz.

The second set of elements in CBGD is based on Gardner's (1983) Multiple Intelligences (MI) theory, that combines learning with activities that engage students in accordance to their unique patterns of thought, or intelligences. The ideas of MI are concretized through correct expressions of various in-game assets, such as art and music (Starks, 2014). Logic/patterns are used to exercise reason (Starks, 2014). This can be seen through the consistent pricing of turrets and enemy behavior to help the give the player a sense of consistency throughout the game. The verbal intelligence of the MI theory was translated by Starks into words/languages in a game (2014). Drug Defense uses a dialogue box to convey texts needed in the game, such as the alcohol facts and the tutorial.

Beyond cognition, elements that heighten enjoyment are also present. The Enjoyment Process consists of engagement, challenge, flow, persistence, and mastery (Starks, 2014). Engagement is achieved when a player's attention is caught, leading to immersion in the game. Often, challenge refers to why players continue through the game (Starks, 2014). Flow is the state when the player is highly engaged and loses track of time (Csikszentmihalyi & LeFevre, 1989). Persistence is honed through the player's response to mistakes. Finally, mastery is what the player experiences when they win at a game and feels successful (Starks, 2014).

2.1 Gameplay

Drug Defense drew from the tower defense game design pattern. This pattern entails defending a base from incoming enemies using towers or turrets that the player can build and upgrade. Because the placement of the turret is important, players must use strategy in order to determine the best location for building the turret. Also, since building turrets cost limited in-game currency, the player must learn how to properly manage this resource. This combination of strategy and resource management helps form the foundation of the game's appeal.

Players took on the role of a medical apprentice. As an introduction, the doctor teaches the apprentice about the core mechanics of the tower defense gameplay. Afterward, players can enter the first stage. Each stage contains three to four waves, and each wave follows a similar flow. First, the player is presented a journal entry that tells the story of a day in the life of Miguel San Juan. Next, the doctor gives a fact pertaining to alcohol use. Then, the player undergoes the tower defense part of the game, which entails strategically positioning turrets in order to protect the liver from incoming alcohol. Afterward, the player is presented a multiple-choice quiz. The answer to said quiz should be known to the player if they had paid attention to the fact the doctor gave previously. This core gameplay loop repeats for eight stages, and the game takes approximately 35 to 45 minutes to complete.

In the tower defense part of the game, the player has to place turrets strategically along paths leading to the liver to avoid enemies from damaging it. They also have to manage and allocate resources, which can be used to buy turrets and upgrade them. Breaks between waves will provide player time to rest, re-evaluate their strategy, and upgrade the turrets as they wish. The moment that the enemies reach the liver, it will lose health. When the liver's health drops to zero, the player loses. The material of the liver gradually changes as it loses health, from healthy to that of one which has cirrhosis.

The emphasis of the gameplay is the defensive strategy the player employs. The player must understand how the enemy behaves and apply an effective strategy to stop them before they reach the liver. Some enemy substances are weak and fast, while others are strong but slow. The enemies take the form of an alcohol bottle. The alcohol bottles are designed according to the strength of each enemy. Strong enemies have more alcohol content in real life, while weak enemies have less alcohol content. Figure 1 shows an example of an attack.

Figure 1. Beer bottles attacking the liver.

A different enemy is spawned in waves. One wave emerges per time period. No new wave will be spawned until all enemies of the current wave are destroyed.

The narrative that accompanies the tower defense and strategy aspects of Drug Defense is intended to foster player attachment and sympathy. Each wave of enemies is prefaced by a journal entry, showing the main character's state. Each level starts easy then slowly becomes more difficult and

difficult. The last part of the game will be biased towards player victory, indicating the character's recovery. The game has a total of eight stages, 32 journal entries, and 31 waves.

The doctor figure in the game (Figure 2) serves as a general guide to the player. At the start of the game, the doctor administers a tutorial. Next, after showing the journal entry at the start of each wave, the doctor gives facts pertaining to alcohol use.

Figure 2. The doctor in the game.

Then, she administers a quiz (Figure 3) at the end of each wave in order to check if the player is retaining the alcohol use facts.

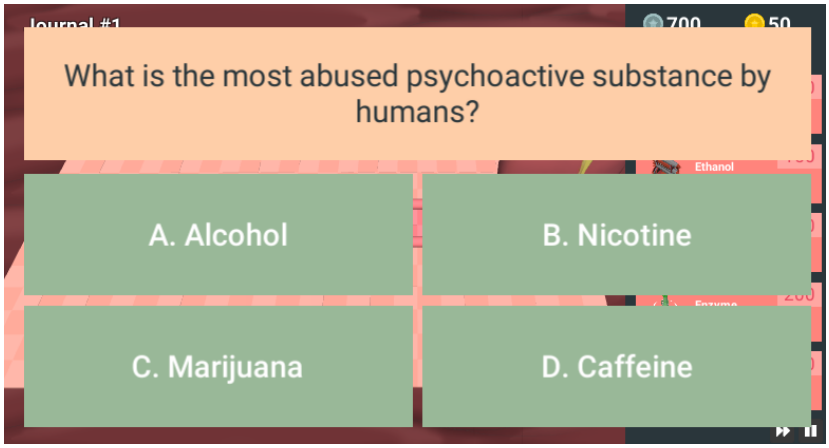

Figure 3. Quiz.

The doctor then responds to the results of the mini-quiz. Correct answers will result in an increase an in-game currency that the player can use for building or upgrading turrets. This encourages the player to pay attention to the facts that are given throughout the game.

3. Testing

To determine the game's effectiveness, the researchers designed and conducted a field test testing the knowledge retention of participants who played Drug Defense. Ethics approval was obtained prior to the study.

To be eligible, participants had to have drunk alcohol at least once in their lifetime. Thus, participants recruited and sampled purposively from a university in Metro Manila. A total of 69 participants joined the study. Their ages ranged from 18 to 21.

Each participant selected a timeslot and was provided with a consent form. Each timeslot accommodated at most six participants.

At the start of the experiment, all participants completed the Alcohol Knowledge Test. The test consisted of 20 multiple choice questions about alcohol use facts, alcohol use disorder symptoms, as

well as the negative physical and cognitive effects of excessive alcohol use. This was followed by 10 true or false questions regarding protective behavioral techniques. Reliability analysis was conducted, and pretest Cronbach's alpha was 0.67 while posttest Cronbach's alpha was 0.71.

The participants were asked to play through the whole game, a total of 20 to 40 minutes. After playing, the Drug Defense participants were emailed a Google Form consisting of rating scale questions adapted from Desurvire's HEP (Desurvire et al., 2004) and open-ended questions relating to the game. In the latter, the players were asked what parts of the game they like the least, what parts they liked the most and if they have other comments. A total of 56 respondents answered the questionnaire. One week after each participant's timeslot, they were asked to complete the Alcohol Knowledge Test again.

4. Results

There is a significant difference between pre- and post-tests with an effect size of d=2.54, indicating an increase in knowledge about alcohol. In this regard, the game succeeded in achieving its goal of increasing player knowledge.

A total of 56 participants answered the questionnaire adapted the HEP. The highest possible score for each component is five. The average for gameplay, story, and mechanics are 3.92, 4.08, and 3.77 accordingly. Upon averaging all the heuristics, the game received a total score of 3.89/5. The findings imply that Drug Defense succeeded in providing players with an enjoyable gaming experience.

For the parts that the players liked the least, notable answers are the game was too easy, there was a bit a lot to read, and the mechanics were confusing at the first try. The last two were caused by the long text tutorial design. From this, the developers have improved the game to add a challenge mode and changed the tutorial from just a long text to an interactive one where the player can follow as each gameplay component is explained.

For the parts that the player liked the most, they mentioned that they enjoyed protecting the liver or strategizing, the dialogue and storyline, the knowledge the doctor gives them, and the quizzes. One of the most notable answers is that one player said that they genuinely wanted to know more.

In the other comments section of the survey, one player said that they found the game to be fun and that they learned a lot. Some respondents mentioned wanting to have the game released officially. In response to this request, one month after the experiment, the developers were able to put Drug Defense on Google Play Store and Apple App Store.

5. Conclusion

The researchers have developed Drug Defense, a mobile game designed using CBGD which aims to increase knowledge of alcohol. The game was tested for retention. Data analysis showed that the mobile game was successful in increasing student knowledge about alcohol. Game playability evaluation showed that although the game has its areas of improvement, the players found it playable and fun.

The researchers and developers consider expanding Drug Defense not only to cover alcoholism but also discuss the problem of other harmful substances and run similar experiments and game testing.

Acknowledgments

We thank the other members of the development team, Jan Michael Santos and Lance Hernandez for the 2D assets and Allen Ace Fortunato for the 3D assets used in the game. We thank the Ateneo Laboratory for the Learning Sciences and *Katatagan Kontra Droga sa Komunidad* for their support.

References

Bandura, A. (1999). Social Cognitive Theory: An Agentic Perspective. *Asian Journal of Social Psychology, 2*(1), 21-41. doi:10.1111/1467-839x.00024

Bandura, A. (2004). Health Promotion by Social Cognitive Means. *Health Education & Behavior, 31*(2), 143-164. doi:10.1177/1090198104263660

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology, 56*(5), 815-822. http://dx.doi.org/10.1037/0022-3514.56.5.815

Desurvire, H., Caplan, M., & Toth, J. A. (2004). Using heuristics to evaluate the playability of games. *Extended Abstracts of the 2004 Conference on Human Factors and Computing Systems - CHI 04*. doi:10.1145/985921.986102

Ellickson, P. L., Collins, R. L., Hambarsoomians, K., & Mccaffrey, D. F. (2005). Does alcohol advertising promote adolescent drinking? Results from a longitudinal assessment. *Addiction, 100*(2), 235-246. doi:10.1111/j.1360-0443.2005.00974.x

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. New York, NY: Basic Books.

Karriker-Jaffe, K. J., Room, R., Giesbrecht, N., & Greenfield, T. K. (2018). Alcohol's Harm to Others: Opportunities and Challenges in a Public Health Framework. *Journal of Studies on Alcohol and Drugs 79*(2), 239-243. doi:10.15288/jsad.2018.79.239

Moreno, M. A. (2011). Media Influence on Adolescent Alcohol Use. *Archives of Pediatrics & Adolescent Medicine,165*(7), 680. doi:10.1001/archpediatrics.2011.121

National Institute on Alcohol Abuse and Alcoholism (2004, October). Alcohol's Damaging Effect on The Brain. Retrieved from https://pubs.niaaa.nih.gov/publications/aa63/aa63.htm

National Institute on Alcohol Abuse and Alcoholism (2005, January). Alcohol Alert #64. Retrieved from https://pubs.niaaa.nih.gov/publications/aa64/aa64.htm

Primack, B. A., Carroll, M. V., McNamara, M., Klem, M. L., King, B., Rich, M., . . . Nayak, S. (2012). Role of Video Games in Improving Health-Related Outcomes. *American Journal of Preventive Medicine*, *42*(6), 630–638.

Saffer, H., & Dave, D. (2006). Alcohol Advertising and Alcohol Consumption by Adolescents. *Health Economics, 15*(6), 617-637. doi:10.3386/w9676

Starks, K. (2014). Cognitive behavioral game design: A unified model for designing serious games. *Frontiers in Psychology, 5*. doi:10.3389/fpsyg.2014.00028

Thompson, D. (2012). Designing Serious Video Games for Health Behavior Change: Current Status and Future Directions. *Journal of Diabetes Science and Technology*, *6*(4), 807-811. doi:10.1177/193229681200600411

World Health Organization (2010). *Global strategy to reduce the harmful use of alcohol* [PDF file]. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/44395/9789241599931_eng.pdf

World Health Organization (2018). *Global status report on alcohol and health* [PDF file]. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/274603/9789241565639-eng.pdf

Young, B., Lewis, S., Katikireddi, S. V., Bauld, L., Stead, M., Angus, K., . . . Langley, T. (2018). Effectiveness of Mass Media Campaigns to Reduce Alcohol Consumption and Harm: A Systematic Review. *Alcohol and Alcoholism, 53*(3), 302-316. https://doi.org/10.1093/alcalc/agx094