Gamifying Behaviour that Leads to Learning

Diane Watson
University of Waterloo
Waterloo, Canada
diane.watson@uwaterloo.ca

Mark Hancock
University of Waterloo
Waterloo, Canada
mark.hancock@uwaterloo.ca

Regan L Mandryk
University of Saskatchewan
Saskatoon, Canada
regan.mandryk@usask.ca

ABSTRACT
Many courses require self-study to succeed. This is especially true of online courses. However, self-study activities, such as reading the textbook and completing the associated workbook, are not motivating and do not contribute directly to grades. As a result many students do not complete these activities and this may lead to a lower understanding of the material and a lower overall grade in the class. In this paper we present the prototype of a casual game, Reading Garden, which encourages self-study through casual gameplay.

Author Keywords
Gamification, casual game, education, self study

ACM Classification Keywords
K.8.0 Personal Computing: Games

INTRODUCTION
University and college courses often assign a lot of self-study activities. This is especially true of online courses or in the flipped (inverted) classroom [22], where students learn the material at home and practice at school. Self-study activities include reading the assigned readings and completing the corresponding workbook and are often not counted for marks. The problem is that, while it is generally accepted that completing these self-study activities makes for stronger students [1,13,15], these activities are often not completed [2]. This may be for several reasons: these activities may take a long time, may be perceived as unimportant, or students may simply not be motivated enough to do them [4].

Our solution to this problem is to create a casual game, Reading Garden, which encourages self-study activities through gameplay. In this casual game, players grow flowers. Like many casual games it has a special currency that allows advanced game play. In many commercial casual games, this game currency is bought with real money. In Reading Garden, this currency is earned by completing

self-study challenges in the form of short comprehension quizzes based on assigned readings. The game is designed to be played as part of a course, and includes an interface that allows course instructors to create the challenges—the challenges are intended to be short, and could easily be drawn from sample quiz questions offered by many textbooks and workbooks.

In this paper, we make two contributions: First we present the design and prototype of a casual game that is intended to change behaviour/habits that *lead* to learning, rather than to teach content. Second, we discuss how this may motivate players to change their course-related behaviours.

RELATED WORK
We describe three areas of related work: theories of motivation, gamification, and existing casual games that encourage behaviour.

Theories of Motivation
There are several theories related to player motivation. *Reinforcement Theory of Motivation* indicates that when behaviours are linked with outcomes, behaviour may change over time [21]. For example, Cameron and Pierce [3] provide a review of studies using punishments and rewards to change behaviour. In *self-determination theory* (SDT) there are two types of motivation, *intrinsic (*motivated by the behaviour itself) and *extrinsic* (motivated by a separable goal). While it can be very difficult to create intrinsic motivation, extrinsic motivation can be easier to foster [19]. SDT also proposes that games should support three types of player needs [20]: *competence, autonomy, and relatedness.* Competence is the need to feel skilled. Autonomy is the need to feel in control. Relatedness is the need to feel related to other players. Supporting these needs can lead to higher player engagement [17]. We leverage these theories in the design of Reading Garden to motivate players to read course material. We refer again to this work in both our motivation and discussion of the game later in the paper.

Gamification
Gamification has been defined as *the use of game elements in non-game contexts* [8], that is, a game or game elements are used for a purpose other than entertainment. Gamification has been deployed quite successfully. For example, gamification may be used to tap into human intelligence and have players solve tasks that are difficult for computers [6,23,24], an example being the classic *ESP game* where pairs of players are shown an image and asked to guess what the other player is thinking. The resulting guesses are used to label the image for later reference in a search en-

gine [23]. Gamification is often applied in work [9,10] or educational settings [26]. Our game is designed to encourage healthy reading behaviours and is thus the gamification of self-study. Note that, while our game may affect educational outcomes, our focus is on the motivation of self-study rather than teaching content, so we do not include a review of educational games (see [26] for a recent review).

Casual Games that Encourage Behaviour

Because of their low barrier to entry and resulting popularity, we are interested in gamification using casual games. Casual games are games that can be played at any time for short periods or bursts. They require a minimal amount of skill and instruction. These games are often non-violent and have forgiving gameplay [14]. Finally, these games have been shown to improve mood and decrease stress [18]. There are many casual games of note that modify or encourage specific behaviours. These are different from games that teach players how to complete a task or learn a lesson. Below is an illustrative list of games that are both casual and encourage specific behaviour or habits.

GrabApple [11] is a casual exergame that encourages people to perform aerobic exercise for short periods of time throughout the day. In this fashion, players receive the acute cognitive benefits associated with short bursts of exercise, such as improvements in concentration. *Lunchtime* [16], is a casual game designed to encourage long-term dietary behaviour change through healthy choices while eating out. The results show that this game promotes a positive change in attitude. *Sketch and Learn* [25] is designed to encourage art history students to spend more time studying classic art by finding and tracing hidden shapes in classic paintings. *Cytarius* [12] is a serious game designed for children with cancer designed to both teach children about particularities of the disease and possibly invoke discussion among parents, patients and medical staff. *Chore Wars* [5] is an online game designed to encourage better house-cleaning habits, where players create quests for family members and earn points by completing household chores. Tasks are further gamified by adding special conditions (e.g., take out the trash while singing).

We follow these examples of successful casual games, and leverage their benefits in our own design; namely, our game is intended to have a low barrier to entry and be playable in short bursts, which we think is amenable to the reading activity we intend to motivate.

MOTIVATING THROUGH A CASUAL GAME

Our goal is to design a casual game that supports habit-building related to self-study. To ensure that our game is effective, our game design decisions should be grounded in the aforementioned theories on game play motivation.

Reinforcement Theory of Motivation: The game should tie the desired behaviour to strong positive reward using positive reinforcement. These positive rewards can include currency or advanced game play mechanics as well as prizes such as decorative elements. Since the game is casual, failures should be met with weak or no negative consequence.

Intrinsic and Extrinsic Motivation: While playing the game may be intrinsically motivating, as the game may be fun, it is unlikely that the self-study activities will be intrinsically motivating. However, in-game rewards or goals may mean these activities could be extrinsically motivated. The game should not make these activities any less motivating.

Player Needs: Games should support as many of the player needs as possible. Casual games, by nature require little skill and this may support a player's need to feel competent. Giving the player many choices and actions also supports their need to feel autonomous or in control. Finally, a player's need to feel related can be supported by having options for social play or even a simple leaderboard.

THE GAME

In Reading Garden (Figure 1), players manage a virtual garden by decorating, watering, and other activities related to growing. Self-study activities are rewarded with a special currency (gold) that unlocks advanced gameplay, flowers, fruits, and decorative items.

Flowers are grown in real time, varying from a minute to a day. Players can harvest flowers, which explode into a number of stars that are collected as experience points. Flowers vary in cost, grow speed, and the number of stars on harvest. Games are saved automatically when the program is closed and saved games are loaded automatically when the program opens.

Interface

Grow Spots: Grow spots are where a tree or flower can be grown. They are slowly unlocked as the player levels. An empty grow spot is green; a locked grow spot is grayed out.

Flowers: Growing flowers show a progress bar (Figure 1e). Flowers are grown from the grow menu (Figure 1a), opened by clicking on an empty, unlocked, grow spot. The flower menu shows the cost, experience points gained on harvest, and growing time of each flower. When a flower has not yet been unlocked (i.e. the player's level is too low) it is shown as greyed out. There are currently 15 different types of flowers that can be grown. Experience gained roughly correlates with grow time.

Stars: Players are rewarded with an explosion of stars when a flower is harvested. These stars bounce around the screen, finally settling at the bottom. They can be collected for one experience point each (Figure 1f). When a star is clicked, an animation occurs where it flies off the top of the screen.

Combos: If a star hits a flower that has finished growing, this flower is automatically harvested and a combo occurs. The user is informed that a combo has occurred with text feedback and bursts of colourful confetti. Combos can stack several times. Each combo adds one additional star to the screen at the end of the combo (Figure 1f).
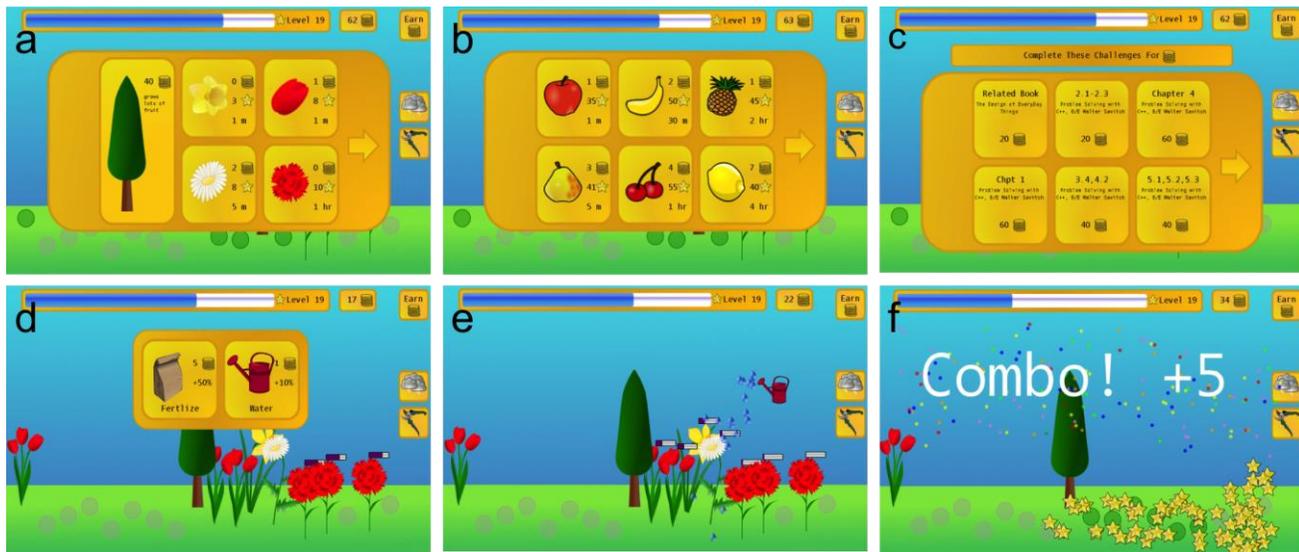
Figure 1 a) grow menu b) fruit menu c) challenge menu d) garden menu e) watering a garden f) a successful combo

Gold: Like many casual games, special items and higher level flowers can be bought with a special currency. Gold is earned by completing self-study challenges. Gold can be used to buy trees, fertilizer, water and decorations. Total gold is indicated on the upper-right side of the screen.

To get gold, players click on the "Earn Gold" button on the top-right, which opens the challenge interface (Figure 1c). Players then select a challenge and must answer the comprehension multiple-choice questions correctly to earn gold. Incomplete challenges can be retried after a delay to encourage players to think carefully about their responses.

Trees: Trees are bought with gold and grow fruit. Fruit is worth a lot of experience and can be used to level up quickly. To grow a tree, players select it from the flower menu, which they open by clicking on a grow spot (Figure 1a). To grow fruit on a tree they click on an empty tree, which opens the fruit menu (Figure 1b). There are 12 types of fruit currently available to be grown. Experience gained roughly correlates with growing time.

Fertilizer and Water: Flowers and trees can have their growing time shortened by buying fertilizer and water in the garden menu (Figure 1d). After purchase, players use the mouse to sprinkle fertilizer and water droplets on the playing field. Fertilizer reduces the total growing time in half and water by ten percent. Flowers and trees can only be fertilized and watered once (Figure 1e).

Experience and Leveling: As players level up, they unlock more grow spots and different types of flowers and fruits. Each time a player levels they are greeted with a short message describing the new items they have unlocked. When an item is not unlocked it is greyed out. Player level is indicated with a progress bar at the top of the screen. There is enough in-game content (grow spots, flowers and fruit) for 40 levels, although there is no maximum level.

Social Play: Players can water other player's gardens at no cost, earning a few experience points. While in another player's garden, they can also encourage players to complete a reading challenge they themselves have already completed. When the encouraged reading is completed they will earn a few gold. Players can encourage once per day. Finally, there is a simple leaderboard.

Implementation
Reading Garden is implemented in C#, using XNA. Instructors add challenges using an XML file, although we plan to add a server-side graphical interface for this task. Game state and social play mechanics will be handled by a server, which is implemented using Google App Engine.

DISCUSSION
Reading Garden ties self-study activities to in-game rewards using positive reinforcement. The first most obvious reward is the introduction of currency to reward for self-study challenges. Furthermore, players are rewarded by unlocking new content when they level up and are rewarded visually with explosions of stars when they completely harvest a flower or tree. Eventually we will add sounds and achievements (which unlock bonus readings) to make game play more engaging. In correspondence with casual game design, players are not punished for failing to complete a self-study activity, but are encouraged to do so.

If the game is fun, players may find it intrinsically motivating to play, but it is unlikely that the self-study activities will be intrinsically motivated. Rather, the use of in-game rewards ties these activities to external outcomes and can make the self-study activities extrinsically motivated.

We expect this game to satisfy all three player needs as described by SDT [20]. The game offers autonomy, as the player can make choices about how they spend their gold, what flowers they grow, et cetera. Because the game is simple to play, and reinforces good study habits, players feel competent. Finally, we support relatedness through a leaderboard, by allowing players to water other player's gardens, and by allowing players to encourage others to complete a reading challenge.

CONCLUSION & FUTURE WORK

In this paper, we describe the motivation for and prototype of a casual game for encouraging self-study. We discuss how it may motivate players to do more self-study.

In the future, self-study challenges will be rewarded with bonus gold if completed by a deadline. Text in-game cannot be copied and pasted, making it difficult for players to cheat. We ultimately cannot ensure that players do not cheat; however, we postulate that by looking up the answers they may stumble across work and learn something.

We plan to evaluate the efficacy of the game by piloting and then evaluating it in two courses. The courses already contain many smaller readings, and larger readings will be easily broken up, so that there is a lot of game content. We expect that participants who play Reading Garden more will complete more self-study activities, which may subsequently enhance educational outcomes.

REFERENCES

1. Altman, H. B. & Cashin, W. E. Writing a syllabus. IDEA Paper No. 27, (1992), Manhattan, KS: Kansas State University, Center for Faculty Evaluation and Development.

2. Burchfield, C. M. & Sappington, J. Compliance with Required Reading Assignments. *Teaching of Psychology* (2000), 27(1), 58-60.

3. Cameron J. & Pierce, W. D. Reinforcement, reward, and intrinsic motivation: a meta-analysis. *Rev Educ Res* (1994), 64(3), 363–423

4. Brost, B. D., & Bradley, K. A. Student Compliance with Assigned Reading: A Case Study. *J. Scholarship of Teaching and Learning* (2006), 6(2), 101-111.

5. www.chorewars.com

6. Cooper, S., Khatib, F., Treuille, A., Barbero, J., Lee, J., Beenen, M., Leaver-Fay, A., Baker, D., and Popovic, Z., Predicting protein structures with a multiplayer online game. *Nature* (2010), 466, 756-760.

7. Csikszentmihalyi, M., & LeFevre, J. Optimal experience in work and leisure. *J. Personality and Social Psychology* (1989), 56(5), 815.

8. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. From game design elements to gamefulness: defining gamification. *MindTrek* (2011), 9-15.

9. Fleming, P., & Sturdy, A. 'Being yourself' in the electronic sweatshop: New Forms of normative control. *Human Relations* (2011), 64(2), 177-200.

10. Fluegge, E. R. Who Put the Fun in Functional? Fun and Work and its Effects on Job Performance. PhD thesis, University of Florida.

11. Gao, Y., & Mandryk, R. L. The acute cognitive benefits of casual exergame play. In *Proc. CHI* (2012), 1862-1872.

12. Gerling, K., Fuchslocher, A., Schmidt, R., Krämer, N., & Masuch, M. Designing and evaluating casual health games for children and teenagers with cancer. *Entertainment Computing–ICEC* (2011), 198-209.

13. O'Brien, J. G., Millis, B. J., & Cohen, M. W. *The Course Syllabus: A Learning-centered Approach* (1997). Wiley. com

14. Kuittinen, J., Kultima, A., Niemelä, J., & Paavilainen, J. Casual games discussion. *Future Play* (2007),105-112..

15. Nilson, L. B. *Teaching at its Best: A Research-based Resource for College Instructors* (1998), Wiley. com..

16. Orji, R., Vassileva, J., & Mandryk, R. L. LunchTime: a slow-casual game for long-term dietary behavior change. *Personal and Ubiquitous Computing* (2012), 1-11.

17. Przybylski, A. K., Rigby, C. S., & Ryan, R. M. A motivational model of video game engagement. *Rev Gen Psych* (2009), 14(2), 154-166.

18. Russoniello, C. V., O'Brien, K., & Parks, J. M. The effectiveness of casual video games in improving mood and decreasing stress. *J. Cyber Therapy and Rehabilitation* (2009), 2(1), 53-66.

19. Ryan, R. M., & Deci, E. L. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology* (2000), 25(1), 4-67.

20. Ryan, R. M., Rigby, C. S., & Przybylski, A. Motivational pull of video games: A self-determination theory approach. *Motivation and Emotion* (2006), 30, 347-365.

21. Skinner B.F. *Science and human behavior*. Macmillan, Oxford (1953).

22. Tucker, B. The flipped classroom. *Education Next* (2012), 12(1), 82-83.

23. Von Ahn, L., & Dabbish, L. Labeling images with a computer game. In *Proc. CHI* (2004), 319-326.

24. Von Ahn, L., Ginosar, S., Kedia, M., Liu, R., & Blum, M.Improving accessibility of the web with a computer game. In *Proc. CHI (*2006), 79-82.

25. Wasson, R., Mould, D., Biddle, R. & Martinez C.S. Sketching Game for Art History Instruction. *Sketch-Based Interfaces and Modeling* (2013).

26. Young, M. F., Slota, S., Cutter, A. B., ,... & Yukhymenko, M.. Our princess is in another castle a review of trends in serious gaming for education. *Rev Educ Res* (2012). 82(1), 61-89.