DECONSTRUCTING CANDY CRUSH: WHAT INSTRUCTIONAL DESIGN CAN LEARN FROM GAME DESIGN

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Abstract

Candy Crush Saga has more than 100 million daily users (Sinclair, 2013) motivated to work through multiple levels with challenges of increasing difficulty. What motivates this type of dedication and effort by users who do not experience any extrinsic reward and may be spending money to achieve success? And what can course designers learn from game design that might motivate students to persist from the beginning to the end of a course? This paper will summarize research and explore strategies that make games like Candy Crush Saga successful, offering suggestions for applications of these strategies to course design.

Introduction

In 2013 it was estimated that Candy Crush Saga, released in 2012 by King Digital Entertainment, had over 100 million daily active users (Sinclair, 2013), and that it was the most downloaded game on the Google play store chart (Kim, 2013). Players of this game plow through level after level, and, when more levels are added, they move through those, too. Why is Candy Crush as addictive as the worst kind of real life candy habit? When retention in online courses is perceived as a growing problem by chief academic officers (Allen & Seaman, 2014,), what is Candy Crush doing right that can encourage such devotion, and what can instructional design learn from it?

This paper will:

1. "Deconstruct" Candy Crush to identify structural, social, cognitive, and emotional design strategies that motivate users to move through successively more difficult levels.
2. Suggest how these strategies could be used in course design to motivate students to persist.

Structural Features of Candy Crush Design

Candy Crush is a *matching tile game* (Juul, 2007) that involves swapping colorful candy items on a board to set up a match of three, which then are cleared or *crushed*. Matching four or five can create special candies, and these special candies allow the creation of more robust combinations that will clear more than their own space. In general, when a space is cleared, it allows the items above to move down and make room for new candies that enter from the top of the board. It provides constant visual stimulation, an always changing, moving work of art.

The look of the board is embedded within a structural design that facilitates ease of use. Most levels engage cognitive as opposed to psychomotor skill, except for timed levels where some dexterity is required.

Candy Crush is Cross Platform
The game can be played with or without access to the Web, and therefore it is ultra-portable. In addition, it can be played on a touch screen or with a keyboard or mouse. King Digital Entertainment has described its intent to create a game that was "playable anytime, anywhere and on any device" with seamless integration (2014, p. 84). Cross-platform delivery may offer more than convenience; according to King's chief marketing officer, "When users play more than one device, they have much more engagement and monetization" (Geron, 2014, para. 9).

Course design takeaway. To accommodate today's multi-tasking learners, design for delivery on mobile devices as well as computers, and provide explicit instructions about activities that are not recommended for mobile.

Content Is Chunked into Episodes and Levels
Currently at over 500 levels, the game is chunked into thematic episodes, each of which contains multiple levels. Players can achieve milestones, e.g., completing a level or episode, along the way to game completion, and they advance rapidly at the beginning. The game allows short playing sessions, so it is fairly easy to squeeze one in when time is limited. The default view depicts a small set of the total levels that need to be accomplished, so the player is not overwhelmed. It is also possible to zoom out for a fuller view so players can see the extent of where they are with respect to where they have been and where they need to go. The next level or episode always feels like an attainable goal; players are rewarded when completing an episode with the comment "Wow, splendid days!" and the image of a vehicle (e.g., train or boat) about to take the player on another journey.

Course design takeaway. Chunk content into clearly identifiable, compact modules and sub-modules, and provide access only when previous modules have been completed. Provide students with a way of measuring their progress, e.g., by a progress bar that automatically shows them how much they have completed, by awarding digital badges, or by providing a downloadable checklist that they can fill out themselves. Congratulate them for completing a sub-module or module.

Objectives for Each Level Are Clearly Stated and Measurable
Candy Crush explicitly includes two of the three components of an instructional objective as defined by Mager (1997, pp. 46-47): *performance (*e .g., to score x points) and *condition (*e.g., to do so in y moves). Subsequent levels can include multiple performance objectives, e.g., to clear all the jelly *and* to score 200,000 points (performance) within 60 seconds (condition). Mager's third component, *criterion of acceptable performance,* comes into play only with the awarding of two or three stars if the points earned are above a minimum level. The objectives are measurable and shared both verbally and visually at the beginning of every

level. The performance goal (e.g., "bring all the ingredients down to the bottom!") appears in written form and is further demonstrated with a visual depiction (i.e., an image of the required ingredient). Instructions are brief; objectives are not overstated or belittling to skilled players who know what to do and simply want to get started. Context cues at the top and/or bottom of the screen help players track their progress during play. Players that need further assistance can select an icon for added instruction, e.g., "This is a Jelly Level: Clear all the jelly and reach the target score to complete the level." The game categorizes each level with one or two words--Jelly Level, Ingredients Level, Candy Order Level, etc.--so players come to recognize the goal of each section simply by these lexical triggers.

Course design takeaway. Articulate clear, measurable objectives for each behavior expected of learners. Share this information in multiple ways and make additional directions available to learners on demand.

Information is Available in Multiple Modalities
The game addresses the needs of players with different learning styles, including visual (brightly colored candies); reading/writing (written instructions and announcement of outcomes); auditory (music and sound effect that reinforce outcomes); and kinesthetic (players can use a mouse, a keyboard, or a touch screen). There are a total of six colors available in the game, including primary colors red, yellow, and blue, and secondary colors orange, green, and purple; therefore, contrast is as high as possible. Resolution is sharp enough, and contrast is great enough that images and text are clear even on mobile devices.

Course design takeaway. Both content and activities should utilize available technologies and include clear visual, audio, and tactile components in addition to text when such inclusion enhances the achievement of learning objectives.

Hints and Shuffles Keep the Game Moving
If a player waits too long before a move, Candy Crush identifies a possible combination and causes each item to gently blink. However, taking the hint is not always the best option, as the algorithm does not set up the creation or mix of special candies. Therefore, the hints, while helpful, leave room for players to demonstrate mastery by doing better than "the machine." If no moves are available at all, the player is notified "No more possible switches. Shuffling." and the board is reset with the same items.

Course design takeaway. Don't let learners get stuck. Provide hints when activities are likely to be challenging. Use intelligent agents built into a learning management system to communicate with learners who appear to have stalled.

Bonuses Are Offered for Surpassing Acceptable Performance
Candy Crush can set off extra crushes and thus award extra points when a player surpasses acceptable performance; this can lead to the award of two or three stars for a level. For example, a "Sugar Crush" occurs if a player achieves an objective

with time or moves remaining. This can set off a cascade of crushes and allow the player to achieve or surpass a second objective, reaching a minimum score.

Course design takeaway. Provide students with the opportunity to earn easy, small bonuses on activities or assessments. It might give them the perk they need.

Immediate Feedback Is Offered on Performance
During a level, players can view their progress, e.g., by a running score total and count of items that still need to be removed. If players succeed, they receive an enthusiastic "Wonderful! Level Completed!" There is also an indication of the level of performance - up to three stars. If players do not succeed, they receive a summary of the performance ("Out of moves!") and a list of the outcomes: a green check next to an objective that was accomplished ("Get 200000 points") and a red X next to an objective that was not accomplished ("Remove jelly"). Players who do not succeed are given the opportunity to "Play on" for a cost or to "Give up." If the players are close, the game offers instructions on exactly what needs to be done to satisfy the level, e.g., "You only need 1 more jelly." If the players give up, they receive two final assessments, a banner that reads, "You failed! You did not reach the goal!" and then a new screen that reads, for example, "You failed! You did not clear all the jelly" with a statement of the score reached on the attempt.

Course design takeaway. Offer feedback promptly and tailor it to the objectives. Using rubrics for assessment, and making these rubrics available to learners in advance of assessment, is a great way to reinforce what you are looking for and demonstrate where a specific submission succeeded or did not meet expectations. Summary comments can include what the learner still needs to do to succeed.

Levels Are Scaffolded to Build Skills
The game includes many elements, and difficulty increases as a player moves through the levels and develops new skills. Not all difficult elements are present in every level. However, skills learned on one level are likely to be needed again, in combination with others, on a subsequent level.

Course design takeaway. Introduce needed skills slowly so learners are not overwhelmed; revisit skills practiced early in a course by inviting synthesis in activities and assessments throughout the course. Requiring only one skill at a time promotes serial processing. Instead, encourage students to practice their skills together so that they can parallel process when the environment becomes more complex.

Success Involves Some Element of Chance
Unlike chess, where a skilled player can be successful by predicting many moves in advance, Candy Crush involves a "mix of randomness and design" (Sinclair, 2013, para. 10). Players cannot predict the items that will populate the board once others have been removed, and therefore good planning too far in advance is not always an effective strategy. This intentional structure may encourage player

persistence. One game writer commented, "Unapologetic games of chance, like Candy Crush, offer ways to prove to ourselves that luck really is on our side, that the odds are actually in our favor, that our desires are momentarily aligned with the universe" (Thompson, 2013, para. 9).

Course design takeaway. Introducing an element of chance into activities and assessments can increase engagement. This could be done by creating assessments based on a random subset of all questions, or by creating small groups randomly.

Players Have Limitless Opportunities to Repeat Levels
While the element of chance means skill alone is not enough to succeed, the possibility of trying again encourages growth through failure. Both Web and mobile versions of the game "remember" what level a player is on, so it is not necessary to return to the beginning, and players only use up lives when they don't succeed on a level. When a player does not complete a level, at the bottom of the screen, a large button gently pulses and encourages the player to "Retry."

Course design takeaway. Rather than creating "one-and-done" assessments, create multiple opportunities for students to succeed. Learners who do poorly on a once-only assessment may predict their final grade and give up. Giving them the opportunity to take an assessment again, or to drop a lowest grade, can motivate them to continue despite an initial failure. This encourages students to focus on mastery rather than grades.

Players Have Some Control Over Their Environment
Players can control where they play the game, what device they play it on, whether the audio is on or off, whether just the music is on or off, and whether they see additional instructions on how to play. On mobile devices, on most levels (but not the timed ones), it is possible for players to take a quick look at the screen and back out to reset the board in the hope of a better start. Finally, players can choose whether or not they will spend money to buy lives or boosters that will enable them to advance more quickly.

Course design takeaway. Player autonomy may provide insight into the variables involved in *transactional distance* (Moore, 1993), the space between learners and instructor, especially in distance education, which can interfere with learning outcomes. Transactional distance in a course is a function of the relationship of dialogue, structure, and learner autonomy. If dialogue (e.g., with the instructor) is low, then a learner may need to be more autonomous to compensate. In the game, dialogue is by default nonexistent, but there is a high degree of learner autonomy. While this theory does not make predictions about the need to provide autonomy for learners, the success of the game suggests that providing learners with some autonomy can enhance learning outcomes. For example, allowing learners a window in which to complete activities and assessments, or a choice of assessment options, or a choice of delivery methods for a project, may help

increase learner autonomy and decrease transactional distance even in a well-designed course.

Waiting Periods for Rest and Reflection Are Built In
Each time they fail a level, players use up one of their five lives. When they have exhausted their lives, the screen reads "No more lives" above an image of a crying heart and the time remaining before they can play again. They also have two options for continuing play immediately: a button that enables them to "Ask friends" through Facebook, and a button that enables them to obtain "More lives now" by paying. When they complete an episode, again several options are available for continuing on: they can ask friends through Facebook; they can "Unlock now!" by paying; or they can play quests, which require them to complete three previous levels of the game. When playing quests, the player must wait 24 hours after completing one quest to access another. These natural breaks set boundaries for players by temporarily denying their access to the game, or forcing them to weigh the cost of continuing immediately.

Course design takeaway. Incorporate timed release for modules or assessments to control learners' movement through a course. This sets them up for distributed as opposed to massed practice of material, which is helpful for retention of learning (Keppel, 1964). Timed release can also assist with creation of a learning community via discussion boards (as described by Waltonen-Moore, Stuart, Newton, Oswald, & Varonis. 2006) and provide a "breather" to help learners regroup.

Alternative Activities Are Available During Waiting Periods
During enforced waits between episodes, or during periods of frustration, players who have achieved a minimum level can access the alternate *Dreamworld* game-within-a-game. Dreamworld is branded with a different "nighttime" look/feel, and players can easily toggle back and forth between the worlds. It introduces an additional challenge in that the clearing of two colors must be kept in relative balance; if too many of one color are crushed, the game is over even if lives remain. Dreamworld allows participants to rehearse and advance their skills.

Course design takeaway. Provide additional, optional resources or activities that are available to learners even if the next unit is not. Those who are motivated can continue while those who are not are not penalized for not engaging.

Outcomes Are Used as Formative Assessment
King has demonstrated a willingness to listen to players and modify design as a result of feedback. For example, when players expressed frustration with a specific level, King altered the level to make it easier (Dockterman, 2013).

Course design takeaway. Review student performance and dialogue with your students. "That's the way I've always done it," is not a rationale for continuing a practice that, if modified, would lead to better learning outcomes.

Social Features of Candy Crush Design

In its Form F-1 Registration Statement to the U.S. Securities and Exchange Commission, King commented, "The inherently social nature of our games drives virality...We enjoy a virtuous cycle where players that play our games on various platforms and devices share their enjoyment and progress with their friends who in turn then discover our games" (2014, p. 87). The notion of *gamification* has been applied to educational contexts with specific reference to how social aspects of learning can increase engagement (Kaufman & Phipps, 2014). While King's motivation is financial, in fact the social feature of Candy Crush enhances enjoyment of the game for many players. An analysis of mobile games reveals that the most popular include two of the following three features: "simple rules, social interactions or no enemies against which to fight" (Kim, 2013, p. 51); Candy Crush includes all three.

Success Can Be Broadcast
Designed as a single player game, Candy Crush makes it easy to announce progress. Those playing it on Facebook, for example, can have their level completions or innovations (combining a striped and wrapped candy, for example) announced on their timeline and news-feed. Not only is this good marketing for the game, but "it also serves as a subtle personal endorsement for the game's quality (Upsight, 2014, para 8), encouraging even more to play.

Course design takeaway. Many countries have strict laws about protecting student privacy, and announcing the success of one student in a course may bring undue attention to others who have not succeeded yet. Even so, it might be possible with permission to recognize model performance by acknowledging a great discussion thread posting or sharing a well-composed presentation, for example, which could encourage others students to reach for the same recognition through enhanced performance. Broadcasting success more widely, e.g., through a departmental website or newsletter, may also further publicize a course or program.

Friends Can Help Each Other Succeed
Through Facebook, players can offer and receive help by giving or receiving lives. In the fall, one friend of ours reached out for help on behalf of his wife, requesting that friends please give her lives, "so she can finish this game before Christmas." Interacting in this way not only benefits players, but also increases their engagement as members of a community. In addition, numerous players have created blogs or help sites that provide strategies and walk-throughs.

Course design takeaway. Create opportunities for learners to help each other. Build in peer review of paper drafts, for example. If your course is supported by a learning management system, create a CyberCafe discussion thread where learners can post questions and receive help from others; you can provide a bonus for a good response and address two course design takeaways simultaneously.

Friendly Competition Can Encourage Success
Players are able to access information on the levels Facebook friends have reached, and this may spur them to remain engaged and to continue progressing in the game. Those who don't share their status on Facebook may still trade information with friends who play, and step up their game to catch up or stay ahead.

Course design takeaway. If you assign learners to groups for activities, build in some way to acknowledge the group that finishes the fastest or performs particularly well. This could be via an announcement or a bonus point to members of the group. The same strategy could be used to recognize individual performance.

Cognitive Features of Candy Crush Design

While Candy Crush is at some level a social game, its real strength lies in the increasing cognitive demands it makes upon players. These demands make it challenging enough to engage intelligent players and may also help players transfer skills to other areas, including visual acuity, spatial reasoning, and hand-eye coordination (Denworth, 2013).

Candy Crush Is Computationally Complex
Walsh (2014) commented that "part of its addictiveness may be that Candy Crush is a computationally hard puzzle to solve" (p. 1), demonstrating this through a description of the puzzle that leads to its classification as NP-hard, a measure of its computational complexity. Both objectives and conditions become more demanding through the levels, with some brief interludes of easier levels that provide a breather; this makes the game challenging enough to maintain the interest of adult players with wallets. Five features that contribute to the game's complexity are described individually below.

1. Some levels include consequences that must be avoided. Exploding time bombs must be eliminated before they go off and end the game prematurely. Chocolate blocks access to other candies and, like the Blob in the 60's science fiction film, grows if not controlled. These obstacles require the player to focus simultaneously on meeting objectives and avoiding negative outcomes.

2. The layout of the board can violate spatial expectations. A candy dropping from the bottom right of the screen can end up re-entering from the top left of the screen. Players must assume multiple perspectives, e.g., putting themselves in the place of a person whose writing system has a different linearity than their own; such activities encourage field independence.

3. Players need to discover patterns to predict the consequences of their actions. For example, chocolate spreads unless you create a match adjacent to the chocolate, but this is never made clear by the directions. To succeed on the more

difficult levels, players must predict the consequences of alternative actions and select the action that will most effectively carry them towards their objective.

4. Strategies that work on one board may not work on another. Multiple contexts require different strategies. Success comes not only by learning how to use special strategies, e.g., mixing candies or setting off a color bomb, but also by learning how not to use those strategies when they will not facilitate the desired outcome. A bigger explosion is not always better, and it is sometimes necessary to fail in order to understand the consequences of an action in a new context. The game offers a constant reminder to focus on the goal.

5. Learners must remain aware of the status of resources. Focusing only on the objective will result in failure on a level if deadlines are passed or turns are depleted.

Course design takeaway.   Real life examples are rarely as clean as those in a textbook, and if learners are truly preparing themselves for the workforce and lifelong learning, then problem solving that requires analysis of the situation and synthesis is great preparation for what is to follow. Instructors can introduce additional complexity by incorporating problem-based learning in the form of case studies or projects that require learners to apply theoretical concepts to practical real-world situations.

Candy Crush Requires Innovation in Small Iterations
According to Candy Crush designer Tony Palm, "People need innovation in small iterations. One step at a time is how you have to innovate for broad demographics" (Sinclair, 2013, para. 7). The innovation comes about with the ability to create special candies or use those provided on the board in creative ways; as difficulty increases, so does the need for greater innovation. This strategy in game design is parallel to the educational theory, introduced by Vygotsky, of the "zone of proximal development"(1978, p. 86) or the distance between what a learner is capable of doing and not yet capable of doing without *assistance*. Although Vygotsky envisioned the assistance being that of an adult or capable peers, in fact this assistance can come from the environment itself, by setting up a situation that requires more advanced problem solving to achieve success. Research on the gaming experience suggests that the level of challenge has an effect on the player's *immersion* into a game: "As the level of challenge increases, experts become more immersed in the game and novices become less immersed in the game" (Cox et al., 2012, p. 86). Therefore, the goal of the designer is to find the sweet spot that will inspire continued play but not be so great as to frustrate players into quitting.

Course design takeaway.   Present new concepts or skills sequentially, but constantly build on what learners have accomplished by presenting activities and assessments that require not only that they demonstrate knowledge but also that they can apply this knowledge creatively in novel situations. Make them stretch.

Tasks Require Both Power and Finesse
Different levels require different skills from players; in terms normally applied to soccer drills, some levels involve *power* while others involve f*inesse*. Especially complex boards might require players to behave like trained rats in a Skinner box, accomplishing multiple actions in a particular order so that they can access the resources that will enable them to complete the level, i.e., by setting up special candies to blast through obstacles in a different location.

Course design takeaway. Balance the types of activities learners will engage in by blending broad activities with those that demand greater control with a narrower focus.

Players Must Balance Deliberation and Risk-taking
Making a move too quickly can result in a bad short or long-term outcome. Waiting too long to get everything into place may result in running out of moves or time. Playing well requires finding a balance between using strategies that are time-consuming and strategies that are risky. Risk-taking is not inhibited because there are no fatal consequences to failing; a learner can always try again in another life.

Course design takeaway.   Courses should offer the opportunity for learners to take a risk and fail at an assessment through a novel or risky approach, and then be able to try again, e.g., through ungraded self-assessments, the submission of a first draft for instructor or peer review, or the opportunity for multiple attempts at an assessment.

Emotional Features of Candy Crush Design

Candy Crush Saga's appeal comes in part from how players respond emotionally to the game. The joy of success can encourage them to continue, but a little frustration can encourage persistence as well. As King Chief Creative Officer Sebastian Knuttson explained, "Finding that mixture of pleasure and pain is the goal behind level design" (Dickey, 2014, para. 12).

Happy Affirmations and Tough Love Encourage Success
Colorful candy and fruit, cheerful whistling, and exclamation marks heighten the player's emotional experience by invoking positive associations. Celebratory explosions or comments during a level ("Delicious!", "Tasty!") or when a level is completed ("Wonderful! Level Completed!") make players feel good. A study of brain chemistry during videogame playing revealed that video games stimulate dopamine release: the greater the dopamine, the better the performance (Koepp et al., 1998). It has been argued that Candy Crush similarly stimulates dopamine and therefore provides "a strong sense of satisfaction" (Smith, 2014, para. 4). At the same time, the game does not sugar coat failure, and player performance is brutally summarized ("You failed") and analyzed ("You did not collect all the orders").

Course design takeaway. Reward positive effort towards meeting objectives, both during and after an activity. It is easy to focus on what needs to be "fixed" when evaluating a submission, and it is important to provide a clear analysis of shortcomings. But it is also very important to recognize what a learner has done well and to comment positively about it.

Choices Make Players Feel Like Active Participants
Whether choosing to continue the game, read further instruction, play in the Dreamworld, or buy boosters, having options makes players feel like an integral part of the game and its outcome, much like the popular *Give Yourself Goosebumps* book series that allows young readers to choose which page to turn to, thus creating their own story. According to Patall, "Motivation is enhanced when contextual conditions allow people to feel that their actions are freely emanating from the self" (2013, p. 523). With choices, players are further motivated to play on.

Course design takeaway.   Offer learners options (e.g., choose between these three essays; complete two of the five modules; select a film to review from this list) so they maintain a choice in the curriculum they are pursuing, ushering it forward as they personalize it. Having choices other than "do this and pass" or "don't do this and fail" will motivate learners to actively participate in the learning process.

The Game's Intermittent Rewards Encourage Persistence
The study of operant conditioning led to the discovery that desired behavior that is rewarded intermittently, in other words not every time, becomes stronger and is less likely to extinguish when positive reinforcement ceases (Rogers & Skinner, 1956). It has been projected that intermittent reinforcement can explain addictive behavior, such as gambling; an intermittent win can encourage continued responses even after many failures. Candy Crush seems to capitalize on this by rewarding successes and varying particularly difficult levels with easier levels that provide affirmation and a breather. One business writer who was asked by her editors to play "to figure out why people are so addicted" (Dickey, 2013, para. 7) explained simply that her addiction "comes down to the rush you get when you match two special candies (which explode)" (para. 9). While psychologist Mark Griffiths, Director of the International Gaming Research Unit, argued that obsession with games is not necessarily addiction, he conceded, "For those not doing very well, the only way to stop this cognitive regret is to play again immediately. For those that do well, they immediately want to play again to try and beat their high score" (2014, para. 7). This might explain why one psychology professor, who had completed the game, circled back to every level on which she had not earned three stars to try again. As Candy Crush combines skill with chance, "small unpredictable rewards lead to highly engaged, repetitive behavior" (para. 11).

Course design takeaway. While intermittent reinforcement is not a concept that would seem to correlate with effective course design, designing modules to

balance difficult and easy activities will allow learners to receive positive reinforcement with some frequency but not complete regularity.

Surprises Motivate Players to Keep Exploring
When a board changes after a move, candies fall from the top like manna from heaven. Sometimes this results in the formation of desirable special candies that inspire players to continue; as Dickey commented, her addiction is fueled by situations "when you think you're not going to complete the round, and all of sudden you get a special sprinkled candy" (2013, para. 9). The fact that new candies cannot be predicted suggests that they fit the model of "reward bonuses," linked to dopamine production, which motivates "behaviors that allow novel stimuli or states to be approached and explored" (Kakade & Dayan, 2002, p. 557). And therefore, players continue.

Course design takeaway. Provide surprises that delight and compel further exploration. Easy bonus questions on an assessment or extra credit points for completing all work up to a certain point on time can be a reward, as can be a one-off content topic that is of inherent interest even though it is not strictly part of the curriculum of the course.

Investment of Time or Money Encourages Continuing to Completion
Players who are committed to finishing may try levels again or again; others frustrated by repeated failures may decide to shorten their playing time by extra buying lives or boosters. Either way, the investment may motivate them to continue to the end, even though the end is a moving target as the game keeps adding levels. The integration of web-based and mobile applications allows the game to keep track of a player's personal high score, which can provide further motivation to continue. As Dickey commented after spending $127 in one week, "Since I've made such a huge investment, I have to keep playing, right?" (2013, para. 14).

Course design takeaway. Throughout the course, remind learners how much they have completed and that there is a finite end in sight. Present knowledge and skills already gained as an investment in a culminating unit or project or degree.

A Round of Candy Crush Can Relieve Stress
Candy Crush is a happy distraction; the map invokes memories of the winding and colorful Candy Land board game many remember from their youth, putting players in touch with their "inner child" (Dockterman, 2013, para. 14). The game is designed so that stress-inducing timed levels never follow each other, allowing players to complete most levels at a leisurely pace.

Course design takeaway.   Include activities that reinforce skills and on which learners are likely to be successful, so they can experience joy without stress.

Conclusion

Candy Crush successfully combines structural, social, cognitive, and emotional design elements into a popular game that is entertaining, challenging, and, many would say, worthless. As Walsh (2014) mused, "Many millions of hours have been spent solving Candy Crush. Perhaps we can put this to even better use by hiding some practical NP-hard problems within these puzzles?" (p. 9). If individuals are willing to spend millions of hours playing a game, how can they be motivated instead to focus their time on educational activities that will help them solve real problems in the real world? The answer might lie in enabling learners, like game players, to achieve a sense of "flow," a state in which they are focused, feel in control, and are intrinsically rewarded by their activity (Nakamura & Csikszentmihalyi, 2002, p. 90). According to this theory, being "in flow" is facilitated when challenges "stretch (neither overmatching nor underutilizing) existing skills," when there are "clear proximal goals," and when there is "immediate feedback." All of these are characteristics of Candy Crush, and all have been suggested here as course design takeaways. The authors argue that "staying in flow" requires the right level of challenge and skill, as too low a challenge leads to apathy or boredom and too high a challenge can create anxiety (Nakamura & Csikszentmihalyi, 2002, p. 92). On the other hand, being in flow "fosters the growth of skills over time." (Nakamura & Csikszentmihalyi, 2002, pp. 95-96).

We can apply the concept of flow to course design, and in particular online course design, which holds such promise for democratizing education, but which also has been associated with a "negative relationship with both course persistence and course grade" (Xu & Jaggars, 2013, p. 23). How can we encourage learners to persist? If they experience challenges that are too low for their skills, they lose interest; if the challenges are too great, they can become frustrated and either attempt to cheat or withdraw. What if the course as designed is a requirement for a learner's program but not a good fit for the learner's skills? Articulating pre-requisites, including competencies, may guide low-skill learners to prepare in advance or seek extra help during a course. On the other hand, providing options for completing activities and assessments may allow high-skill learners to create their own challenges and thus maintain interest and forward movement. And including opportunities for authentic problem solving by presenting case studies or including service learning in the curriculum could increase the engagement of all learners and help them make connections between course content and real life.

Acknowledgments

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