# Khan Academy Gamifies Computer Science

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## ABSTRACT
*Gamification* is the buzzword for adding gaming elements such as points or badges to learning experiences to make them more engaging and to increase motivation. In this paper we explore how Khan Academy has incorporated gaming elements into its CS learning platform. By mapping the literature on motivational processes to popular games we critically analyze how successful Khan Academy is at gamifying their site.

## Categories and Subject Descriptors
K.3.2 [**Computer and Information Science Education**]: Computer Science education

## General Terms
Design

## Keywords
Khan Academy, motivation, gamification.

## 1. INTRODUCTION
Within the past year, a number of organizations have publicly begun a more vocal push for additional computer science education within K-12 in the United States. While some organizations (e.g., ACM and CSTA) have been active in this area for years, others (e.g., code.org) are more recent. Many sites on the internet have appeared which allow anyone with a desire to learn to program. Khan Academy, an internet learning site founded in 2006, added computer science to its content in September, 2012. Because Khan Academy has approximately 6 million users a month [13] from around the world who desire to learn specific educational content, it deserves to be critically examined in terms of its learning environment and curriculum.

Khan Academy also has incorporated the notion of gamification into its site by adding gaming elements to the learning environment. This paper critically explores how Khan Academy approaches its computer science curriculum and its use of gaming elements to motivate learners.

In this paper we first provide an overview of Khan Academy, its learning environment, and its computer science curriculum. Then we discuss gamification and how it has been incorporated into Khan Academy. Finally we map motivational processes to gamification and critically analyze Khan Academy's use of gaming elements in relationship to motivation. We conclude with a discussion of how each motivational process could successfully be implemented in an online learning environment.


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## 2. DEFINING KHAN ACADEMY
Khan Academy defines itself as "a not-for-profit with the goal of changing education for the better by providing a free world-class education for anyone anywhere."[1] The site has over 4500 mini-lectures that are accessed via online videos. It also contains a web-based self-assessment mechanism which generates problems for students based on their skill level and past performance. Most of the practice exercises are found in the math area of the site, but some do exist for other areas as well.

The site contains a community forum which allows for peer-to-peer tutoring. Parents and teachers can create "classrooms" and have students enroll in the class so the instructor can follow the learner's progress, provide assignments, and offer support.

The philosophy behind Khan Academy is to provide content for almost every subject to create "the world's first free, world-class virtual school where anyone can learn anything."[1] This is in keeping with the recommendations of Bloom's 1984 study on the effectiveness of one-on-one tutoring. Khan Academy attempts to provide "almost" individual tutoring for students at a reasonable cost (free to the student) and allow the solution to scale via the internet. In 2010 Khan introduced badges and points into the environment. Now the site is "full of game mechanics."[1]

### 2.1 Content
Khan Academy contains lessons in math, science, economics, humanities, and computer programming. The math section covers everything from arithmetic to linear algebra and is where the bulk of the content is located. The science section includes biology, physics, chemistry, organic chemistry, cosmology and astronomy. In addition there are lessons on healthcare and medicine. The site includes a projects and discovery lab section which contains videos showing common science labs such as building a projectile launcher. In the science area is also an entire section on learning how to program in Python. This set of lessons is completely separate from the computer programming section of the site.

Micro- and macroeconomics as well as finance and capital markets and entrepreneurship are covered in the economics and finance section of the site. The humanities section includes world history, art history, and American civics. The computer programming section is discussed in depth in sections 2.2 and 2.3.

In addition to these content areas, there are sections of the site that contain "partner content," content developed outside of Khan Academy. These include crash courses in world history, biology and ecology, health and medicine information developed by the Stanford School of Medicine, and content on physics, natural

[1] https://www.khanacademy.org/about

science, materials, and measurement provided by MIT. There is also a section from the J. Paul Getty Museum.

## 2.2 Learning Environment

The majority of the Khan Academy learning environment involves watching a video explanation of the topic followed by self-assessments in the form of questions (short answer or multiple choice). However, the Computer Programming learning environment is different, as it involves a built in code editor and execution window (Figure 1).

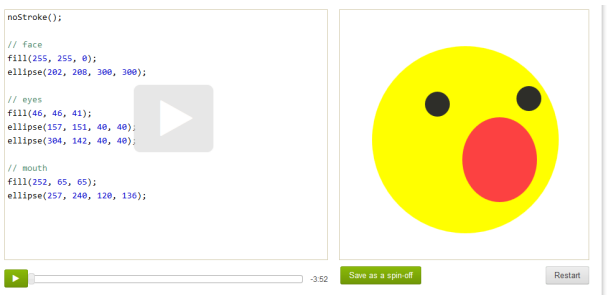


**Figure 1. JavaScript Programming Environment**

The left frame contains and editor with the Processing.js (a specialized version of JavaScript) code that generates the output in the right frame. At the bottom of the left frame are the controls for the video. The video is a demonstration of how to code the solution for the topic (e.g., the introduction of variables to allow all elements to be offset from a central location). The video contains a developer "talking-through" the development of the code. While the code is being altered, the output on the right changes *immediately* to reflect the new code, much like Bret Victor's environment[2]. At any time the user can pause the video and begin to explore and alter the code, and the changes are immediately reflected in the output frame. Within the editor frame, users may also use the "drag" feature to alter values. When the user clicks on a specific number, a box will appear to allow the user to "drag" the number to a larger or smaller value. This also works with colors, as a color shade box appears to allow the user select a specific color and the associated RGB values are reflected back in the code.

The JavaScript lessons primarily use a drawing and animation context – users create their own pictures and animations using code. Users are encouraged to remix existing programs by creating "spin-offs." Learners are encouraged to take others' programs and modify them to explore the environment and serve as starting point for learning.

Instead of compilation errors, a character appears overlaying the output frame with the explanation of the error, along with a prompt to "show me where" the error occurs in the code (Figure 2). Once the error has been corrected, the appropriate output appears once again.

Each programming lesson begins with code already in the editor frame. The video then shows the learner how to create the new code or alter the existing code to learn a new concept. At any time the user can stop the video, experiment with the code and then restart the video from the beginning or continue where he or she left off. If the user continues the video after changing the code, the code immediately reverts to where it was when the video was stopped, erasing the user's changes.

Interspersed with the lessons are challenge assignments. Challenge assignments are specific assignments (e.g., color the ice cream cone) that allow the learner to practice the material learned in the previous lesson. The code is scaffolded (much of it already exists) and hints are provided to the learner. Each challenge is broken down into several steps where each step is a single line of code to be added or modified.

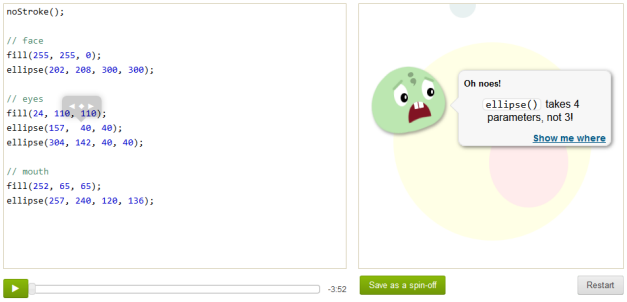


**Figure 2. Error Condition**

## 2.3 CS Curriculum

As mentioned earlier, there are two distinct sets of lessons for CS, one for learning JavaScript and another for learning Python. As of this writing the lessons for Python are more developed, but do not use the new learning environment discussed in the previous section. Instead, the Python lessons are all videos of a computer screen with voice over instructions. The Python lessons begin with an introduction to data types and variables but also cover loops (both for and while), function definitions, function calls, recursion, and insertion sort.

The JavaScript lessons are less developed at this time, but are slowly being introduced. As of this writing, there are 12 categories of lessons: Introduction, Drawing basics, Variables, Animation basics, Manipulating text on the screen, Functions, Logic and if statements, Looping, Arrays, Objects, Becoming a better programmer, and Object-Oriented design. The Introduction lessons give an overview of programming in general, a glimpse into writing programs, and an overview of the learning programming environment within Khan Academy.

The remaining content can be broken down into three categories: (1) beginning programming lessons, (2) drawing and animation lessons, and (3) programming standards. The introductory programming content include lessons on variables and expressions, including arithmetic operations, introduction to functions, Boolean logic and conditional statements, loops, arrays, and even some object based programming.

The next category of lessons teach students how to draw or animate using JavaScript: drawing, simple shapes, coloring, animation, mouse interaction, and displaying text.

The final category of lessons aim to teach some of the less technical, but still important, aspects of programming such as the power of documentation, pseudo-code, commenting, and object oriented design with the purposes of creating more re-usable code. These lessons were added to provide additional techniques "that will help you be more productive and write more beautiful code."[3]

While the current programming lessons in Khan Academy cannot yet be considered equivalent with a full introductory programming course, it is still expanding (based on answers to questions within

[2] http://worrydream.com/#!/InventingOnPrinciple

[3] https://www.khanacademy.org/cs/programming

the discussion forums of Khan Academy). It also represents an environment for the casual learner.

# 3. GAMIFICATION

The term "gamification" was coined in 2002 by Nick Pelling, a British programmer and inventor who created a series of computer games in the 1980s for BBC Micro, the machine used by most schools in the UK at the time. Gamification is the use of game mechanics in a non-game context [7]. Its purpose within a learning environment is to engage the users within the learning context while allowing them to master the material. The use of gamification has both its supporters and detractors.

The main purpose behind gamification is to enhance the user's motivation [14]. Proponents of gamification suggest that it leverages the user's natural desires to compete and obtain achievements. Gamification allows the users to boost their status within the context while at the same time allowing self-expression. Finally, gamification satisfies the need for closure for many people, by allowing them to "beat" the game indicating completion of the task.

Detractors of gamification suggest that it is exploitive [5] and "pointsification" [6], rather than tied to the essential elements of gaming. They argue that the use of the term gamification is primarily a cheap marketing tool that promises the rich immersive experience of games but leaves the user collecting points for no understandable reason. There are also potential negative impacts of gamification. Nicholson argues that once gamification is used to provide external motivation, the user's internal motivation decreases [18].

Despite the very vocal and often colorful debate around gamification, we found little rigorous academic work that looked at the use of game mechanics in learning environments. This prompted us to critically analyze the gaming elements in Khan Academy, a unique learning environment available to anyone via the Internet with approximately 15 million registered users [13]. Because we do not have access to user data within the Khan Academy site, we cannot definitively state whether or not the added game mechanics are having any effect on users. However for the gaming elements to be successful they must rely on aspects of motivational theory, which we discuss in section 4.

## 3.1 Gamification in Khan Academy

Khan Academy has implemented several specific gaming elements within its online environment. Each is discussed below.

**Knowledge Map** – A common element in gaming is to show an overall map or tree structure to guide the user in accomplishing the next task. Khan Academy has its own version of this entitled the "Knowledge Map." A portion of this map can be seen in Figure 3. Each dot on the map represents a mathematical skill (decimals, addition and subtraction, factors and multiples. etc.). Each of these dots can be further broken down into a specific unit. For example, Addition and Subtraction breaks into 1-digit addition, 2-digit addition, 1-digit subtraction, multiple digit subtraction, addition and subtraction word problems and so forth. Each of these topics represents a single skill unit within Khan Academy which can be mastered through video and practice problems. While the Knowledge Map illustrates some of the pre-requisite topics needed for a unit, it does not necessarily act as a map toward completion of a "game" or goal. Various topics can be chosen at random to explore without enforcement of the pre-requisites, which is much different from a traditional game. While only math content is currently represented in the Knowledge Map, we can easily see this expanding to include the CS content or providing a separate Knowledge Map for the computing topics.

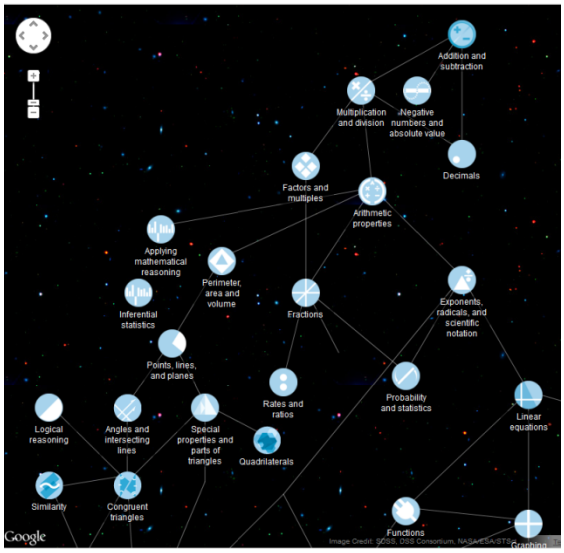


**Figure 3. Knowledge Tree in Khan Academy**

**Badges** – One very common element in gamification is the use of badges and points. Khan Academy has both. Khan Academy has 5 different types of badges as well as challenge patches, all of which are listed in Table 1. The badges represent achievement of different levels. Badges appear in the user's profile and may be shared through Facebook.

**Table 1. Khan Academy Badges**

| Badge Name | # | How Earned | CS Specific |
|---|---|---|---|
| Meteorite | 35 | Mastering a certain number of skills, participating in a discussion forum, or watching a certain amount of video instruction | Yes - 6 |
| Moon | 33 | Master a specific area or through consistent learning (mastering a number of unique skills, watching videos for a specific number of sequential days) | Yes - 2 |
| Earth | 17 | Mastering additional skills, correctly answering problems in a row, watching a number of hours of video, forum participation, or by donating money | Yes - 2 |
| Sun | 11 | Additional mastery of skills, large participation in discussion forums, or vast video watching (10 hours of a single topic). | No |
| Black Hole | 3 | Unknown – not given | ? |
| Challenge Patches | 35 | Proving proficiency in a specific skill | No |

**Energy Points** – Completing activities will allow the user to earn energy points, which are then displayed on their personalized dashboard, along with the number of videos they have completed

watching and the badges they have earned. Earning enough energy points will also earn the user specific badges.

**Goals** – Goals can be ones the system suggests for you (watching any 5 videos or completing 5 skills) or may be defined by the user (custom goals). Custom goals originally have suggestions based on past performance or can be selected by the user. Currently only math topics can be selected as skill goals, but any video from any topic can be added as a goal as well.

**Progress Indicators** – Khan Academy provides several different indicators for showing progress to the user. It will display information for achieving goals, activity indicators, focus information and skill progression. For accomplishing goals, a bar indicator is used to display how many goals have been accomplished and how many have yet to be attained. Activity information is displayed through a bar graph indicating the amount of activity within Khan Academy each day and how many energy points were earned within a specific time period. Focus progression illustrates in a circle graph the skills and topic areas on which the user has spent their time. The graph displays the amount of time spent in different areas for selected time units (past 24 hours, past week, past month, etc.). There is one circle graph for videos and another for skills.

The final indicator is one of skill progression. All of the skills are listed for the user and each one lists the users' overall progress. The viewer can drill down for each topic unit to see the exact number of attempts and correct and incorrect answers for each subset of practice problems. An example of this progression is given in Figure 4.

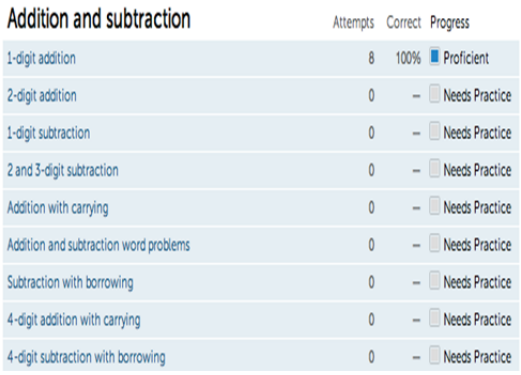


**Figure 4. Progress Indicator**

# 4. MOTIVATIONAL PROCESSES

Some critical motivational processes include goals and self-evaluation, outcome expectations, values, social comparisons, and self-efficacy [20]. Our analysis finds that aspects of gaming align with these motivational processes. In this section we outline these motivational processes and the gaming mechanics that can help facilitate these processes.

## 4.1 Setting Goals

Setting goals is an important element in learning motivation. It would seem that gamification of learning environments is ultimately about goal setting with all of the badges and stars and points awarded. However, goal setting is not just about gaining more points but a willingness to attempt the goals and self-evaluation on attaining the goals. And the user must be allowed to set their own goals [18].

### *4.1.1 Specific rather than general*

Games that give specific rather than general goals are considered more motivational [3]. An example of this type of specific goal setting is stating exactly how many points are needed to earn a specific badge. Examples of this can be found in many different games (e.g., Hay Day displays exactly how many orders must be filled in order to earn a specific badge). Within Khan Academy, some badges are very explicit in how they can be earned while others are vague or depend on the actions of others in order to be obtained. Several Khan Academy badges have more general goals (any five unique skills, any videos). By allowing general goals it may allow the user to earn the badge more quickly, however it may not serve as motivation to continue down a certain path to master a skill.

### *4.1.2 Indicate the effort needed*

Self-evaluation of the effort needed to attain goals is important in motivation [3]. In game environments, goals that allow the users to estimate the amount of effort needed to attain the next level or badge would be more effective. Most games display this through either the map or progression indicator. Khan Academy shows the skill progression but has no effort indicator. The learner has no way of knowing how much effort is required before completing the next skill level. The learner does not know how many practice set problems are going to be presented or how much time it will take to complete the task.

### *4.1.3 Proximal, near goals*

Short-term goals can enhance motivation and learning better than long term goals [4]. To be motivating, games should offer proximal goals that are easy to understand and can be readily attained. A good example of this can be found in the game Pet Rescue. It readily shows how many levels are required until the next power-up is awarded. Khan Academy's version of short-term goals is to complete another skill level or watch another video, with suggestions based on past performance. These suggestions do not illustrate a specific path or explicitly state the next step in achieving a specific badge or challenge patch. Earning badges cannot be an explicit goal currently within Khan Academy. The idea of "just earning points" can actually reduce motivation. The goal of scoring points is less likely to be relevant to a learner if the activity that the points measure is not first relevant to that learner [18]. In other words, the user must want to learn the material to earn points; simply having the points isn't enough to motivate the user to learn. Having a scoring system that has no deeper connection to the underlying activity than a quantification process provides no way for the user to make a meaningful connection to the activity [18].

### *4.1.4 Setting difficulty for motivation*

If people perceive a goal to be more difficult they will be more willing to expend energy on it than if they perceive it to be easy [20]. So while short-term goals are important, making long-term objectives apparent while noting that time and effort are needed to attain them is also valuable in motivation. In games we can see this type of difficulty introduced when an epic narrative unfolds in the opening sequence that sets the ultimate quest for the player. In contrast, Khan Academy never lays out the difficulty and persistence needed to attain mastery of computer science or any other skill set. Yet, setting this difficulty level is about finding the balance between what is challenging and requires effort and what is so difficult that it overwhelming.

#### 4.1.5 Focus on process vs. outcome

Children working on a goal of learning how to solve a problem and then reflecting on their progress toward that goal tend to be more motivated and learn more than children motivated just to achieve an outcome [1]. The use of game elements in learning environments such as Khan Academy is frequently only applied to outcomes and the process of learning is treated as a separate portion of the experience. Game elements can focus on process, rather than outcomes, in a number of ways. For example in Candy Crush Saga, one is not just trying to earn points but is also required to perform special moves (such as setting off double striped candy). This special move is required to pass a level in the game and move on, but this also teaches the process of playing the game and methods for achieving more points. A program like Khan could focus on incorporating gaming elements in novel ways, such as requiring a process oriented task such as design or documentation to be completed before leveling up.

### 4.2 Outcome Expectation

Outcome expectations are beliefs about what will come from a set of actions and are shaped by our expectations of internal changes, external accomplishments, and models of outcomes we observe. In gaming, outcome expectations could be described by what we expect the experience with a game to provide, both in terms of internal changes and external accomplishments, and the models we have for those changes.

#### 4.2.1 Internal and external expectations

Both internal outcome expectations and external outcome expectations provide motivation [3]. For internal motivation, the user should feel pride in their accomplishments. For external motivation, the ability to show that they have beaten the game or passed the level is motivating. Many games frequently include the internal expectation that it is relaxing to play the game or it is considered "fun". External expectations are the ability to demonstrate to others that they are competitive or skilled. Khan allows for the internal expectation of the learner knowing they have completed or mastered the skill but limited external expectation because sharing accomplishments is difficult.

#### 4.2.2 Models

People can be more motivated if they have models for what success looks like in any given domain [20]. In gaming models that motivate, behavior may be made apparent through non-player characters who navigate a difficult pathway, or in friends that achieve higher levels or points in a game. In Khan Academy the CS videos are excellent models of how to achieve the programming task at hand, and the young female voice who narrates them may be a model to other young women. However, these aspects of modeling do not tie into the gaming elements of Khan. There is no model for how to achieve points or badges.

### 4.3 Values

The role of values is important in motivation literature [20]. Values are individuals' beliefs about the importance of acting in certain ways in the world. Motivational theory suggests that if one believes learning, working, or playing are important, then they will act on those values.

#### 4.3.1 Value on agency leads to motivation

People who place a value on agency, the ability to exert control over what they can achieve, are more motivated to try and achieve [2, 9]. In games, the agency is exerted in the choice to play and in a feeling that that one can become skilled enough to win. In Khan Academy, one is exhibiting his or her agency by being there and participating in learning. However, the gaming elements offer no agency; you cannot opt out and you cannot make private selected gaming elements of your participation. A user's profile showing their accomplishments is a completely public or private setting, sharing all accomplishments (and user information) or none.

#### 4.3.2 Values lead to learning and non-learning

Values can lead to learning because the learner values the outcomes or actions needed to produce said learning [10]. Values can also motivate the student to reject learning, because the outcomes or actions needed to produce learning is in contrast to their own values [15]. Gaming elements offer these non-learners an opportunity to construct face saving tactics when learning is in conflict with values [8]. For example, a student who rejects an identity of being interested in math can still try at math if they state their motivation is earning points or badges. In this way game elements may offer face saving strategies for navigating around cultural values that conflict with learning motivation.

### 4.4 Social Comparisons

In addition to the social element of values impacting motivation, social comparisons also impact motivation. The plethora of social gaming suggests opportunities for these aspects of gaming to be incorporated into online learning environments to improve motivation. However, it is important to construct correct comparisons and to not overemphasize social comparisons.

#### 4.4.1 Comparisons with similar people

Social comparisons encourage self-evaluation, an effective motivational process [19]. However, comparisons with dissimilar people can thwart motivation. If someone is much more advanced it can seem like a daunting task to reach their level of mastery. If someone is far behind, one is not motivated to move forward to keep pace. Players comparing themselves to others, in a game can be very motivating and lead to higher self-efficacy. Many casual social games do this very well by linking into the user's Facebook profile and showing the user's friends on the overall map (e.g., Candy Crush Saga) as well as their friends' scores on individual levels. If the user beats a friend's score on a particular level, they can "share" that information on their timeline. This non-synchronous sharing offers continual similar comparisons. Within Khan Academy there are no social comparisons. The learner is a solitary unit within the environment. While the learner can share accomplishments through their Facebook profile, there is no direct comparison with other users. Another shortcoming of Khan with respect to social comparisons is that user profiles are private by default. All user accomplishments are private and there is no ability to share accomplishments while hiding other user information. Thus, it is nearly impossible to see the activities and accomplishments of others on the site.

#### 4.4.2 Setting difficult goals

While competitive elements can seem like easy gaming aspects to incorporate, it is important to temper the desire to construct social comparisons for motivation. Researchers have found that elements that contribute to goals, such as setting difficult goals (see section 4.1.4), leads to greater motivation than social comparisons [20]. Allowing users to self-identify with goals that are meaningful is more likely to produce autonomous, internalized behaviors [18].

## 5. DISCUSSION

We admire Khan Academy as an informal CS learning environment. There are qualities that make it ideal for novice informal learners that are self-motivated. Drawing users that are

self-motivated suggests that Khan Academy is addressing issues of short-term engagement and seeks to use gamification to keep learners engaged and moving forward to more difficult tasks. However, in our analysis Khan has missed critical motivational elements in the application of gamification that might dramatically improve the quality of the gaming elements and increase motivation. Table 2 is a summary of promising approaches that may better address the motivational aspects of the gamification of Khan Academy than their current system.

Specifically, Khan is missing the notion of meaningful gamification, where the user is at the center. Nicholson defines meaningful gamification as the integration of user-centered game design elements into non-game contexts [18]. Using external rewards such as points without matching them to the underlying activities can create a hollow gamification experience and actually create a negative feeling in the user [18]. Instead, meaningful gamification also involves adding elements of pure play to the system instead of just scoring systems. By simply tacking on the gaming elements to the existing system, Khan Academy has missed the opportunity to make the gaming "playful."

**Table 2. Learning Examples of Gamification**

| Motivational Processes | Gamification of Learning Example |
|---|---|
| Setting goals that are specific rather than general | Clear specification as to what needs to be completed to earn points, badges and complete map/tree. |
| Indicating effort needed | Allow "level testing" to move through lower level achievements quickly. This will serve as a formative assessment to gauge where participants should start for challenging yet achievable levels |
| Setting proximal, near goals that are easy to understand and attain are more motivating | Award badges / points upon mastery of individual control structures, topics, etc. |
| Demonstrating difficulty of long-term goals (if they have self-efficacy) | Initially letting learners know that achieving difficult or long-term goal and will take effort and time, and reinforcing their self-efficacy to achieve these more difficult goals. |
| Focusing on process vs. outcome | Peer awards for projects that encourage reflection, development of process oriented game elements that match learning goals. |
| Providing comparisons with similar people | Dashboards showing your progress against others in your class / cohort and the amount of time each spent studying, completing level. |

In opposition to Khan Academy, we offer two other CS learning systems as better examples of incorporating gaming elements with motivational elements. Sarah Esper's work with CodeSpells [11, 12] and Michael Lee's work with Gidget [16, 17] represent true games which also teach introductory programming skills.

# 6. CONCLUSION

Combining gaming with an informal learning environment is very difficult. To create a user-centered meaningful gamification learning environment is even more difficult. While Khan Academy has included gaming elements, we believe they have missed an opportunity to have the desired motivational impact. By changing the implementation of the badges and points system to allow more well-defined goals (both near-term and long-term) and expanding the social aspects of the gaming elements the gamification of the site may provide better and more long term impact on motivation in this informal learning environment.

# 7. REFERENCES


[1] Anderman, E.M. and Wolters, C.A. 2006. Goals, Values, and Affect: Influences on Student Motivation. (2006).

[2] Bandura, A. 1994. *Self-efficacy*. Wiley Online Library.

[3] Bandura, A. 1986. Social foundations of thought and action. *Englewood Cliffs, NJ*. (1986).

[4] Bandura, A. and Schunk, D.H. 1981. Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of personality and social psychology*. 41, 3 (1981), 586.

[5] Bogost, I. 2011. Gamification is bullshit. *Ian Bogost blog*. 8, (2011).

[6] Robertson, M. Can't play, won't play: 2010. *http://hideandseek.net/2010/10/06/cant-play-wont-play/*. Accessed: 2013-09-06.

[7] Deterding, S. et al. 2011. From game design elements to gamefulness: defining gamification. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (2011), 9–15.

[8] DiSalvo, B. et al. Saving face while geeking out: Navigating motivations of non-learners. *Journal of Learning Sciences*. In Press.

[9] Dweck, C.S. 2000. *Self-theories: Their role in motivation, personality, and development*. Psychology Press.

[10] Eccles, J.S. and Wigfield, A. 2002. Motivational beliefs, values, and goals. *Annual review of psychology*. 53, 1 (2002), 109–132.

[11] Esper, S. et al. 2013. CodeSpells: Embodying the Metaphor of Wizardry for Programming. *2013 ITiCSE Conference* (Canterbury, England, 2013), 249–254.

[12] Esper, S. et al. 2013. On the Nature of Fires and How to Spark Them when You'Re Not There. *2013 SIGCSE Conference* (Denver, CO, USA, 2013), 305–310.

[13] High Scalability - High Scalability - Khan Academy Checkbook Scaling to 6 Million Users a Month on GAE: *http://highscalability.com/blog/2013/4/1/khan-academy-checkbook-scaling-to-6-million-users-a-month-on.html*. Accessed: 2013-09-06.

[14] Kapp, K.M. 2012. *The gamification of learning and instruction: game-based methods and strategies for training and education*. Wiley. com.

[15] Kohl, H.R. 1994. *I won't learn from you*. New Press New York.

[16] Lee, M.J. 2013. How Can a Social Debugging Game Effectively Teach Computer Programming Concepts? *2013 ICER Conference* (San Diego, CA, USA, 2013), 181–182.

[17] Lee, M.J. et al. 2013. In-game assessments increase novice programmers' engagement and level completion speed. *2013 ICER Conference* (San Diego, CA, USA, 2013), 153–160.

[18] Nicholson, S. 2012. A user-centered theoretical framework for meaningful gamification. *Proceedings GLS*. 8, (2012).

[19] Schunk, D.H. 1987. Peer models and children's behavioral change. *Review of educational research*. 57, 2 (1987), 149–174.

[20] Schunk, D.H. and Usher, E.L. 2012. Social Cognitive Theory and. *The Oxford Handbook of Human Motivation*. (2012), 13.